June 2022

Context Analysis and Model Farm Design for regenerative cotton in Voi, Kenya

A re**Nature** report for Labl

reNature

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Abstract

Labl is a social, sustainable and fair clothing producer for fashion brands with a big vision to make the fashion industry planet positive through a new way of creating and selling. Their systemic redesign offers a connected value chain - from regenerative cotton farming to processing, from textiles to fairly made clothing production.

reNature is working closely with Labl to ensure that the local farming community have the tools and expertise to produce regeneratively grown cotton to supply their first full-scale production facility in Voi, Kenya. This report centers around the proposed design, specifications, and management techniques for the regenerative production of cotton, with the aim to replicate this amongst the target group of 1.000 farmers.

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Executive Summary

Project overview

As a first step towards development of a model farm design for regenerative agriculture cotton farming, reNature conducted a Context Analysis (CA) in Taita Taveta County. The objective was to understand the current social, economic and environmental status in Voi, Mwatate and Wundanyi sub-counties in order to inform strategies for scaling up adoption of regenerative practices among cotton farmers.

Following the insights from the CA, we developed a context-specific Model Farm design to support small-holder farmers to adopt key regenerative cotton practices, with a strong focus on local challenges, opportunities, wants, and needs.

Context Analysis

Findings from that analysis show that 75% of the respondents are farmers aged between 35-65 years and the majority get their main source of income from farming. Land is generally community owned with individuals accessing on average more than 5 acres. Only 25% of the respondents have food produced on their farm that lasts for more than 10 months.

Among the main challenges facing farmers are human-wildlife conflict and water scarcity. 75% of respondents use boreholes as their main source of water. For 63% of them, boreholes are situated more than 1km away from their homes. 67% of respondents grow maize and beans as a source of food, as well as mangoes and sisal for income. They also keep livestock, namely poultry, goats, sheep and zebu cattle. Only 10% of the respondents have a history of growing cotton.

Access to financial services is limited while extension services are non-existent.

Farmers grow crops in March (long rains) and October (short rains), though this is challenged by climate change impacts including prolonged dry periods, erratic rains, pest and disease infestation and declining soil fertility. Soil health in terms of structure, presence of organic matter, compaction, soil cover, presence of invertebrates and

infiltration rate was found to be poor-to-moderate due to erosion and lack of organic matter input.

Model Farm Design

The regenerative agriculture design will address key challenges that have emerged from the context analysis, including:

- Water stress
- Low tree cover
- Low soil organic matter and poor soil health
- Poor management and application of farm yard manure
- Climate variability
- Inadequate diversification of farm incomes and interventions
- Low crop and livestock productivity
- Inadequate understanding of sustainable and regenerative farming.

Regenerative agriculture refers to holistic farming practices that aim to improve soil health and reverse the impacts of climate change through increasing biodiversity and organic matter in the soil, improving the water cycle and sequestering carbon from the atmosphere to the soil.

These elements will be addressed by key interventions including regenerative techniques and good agronomic practices for cotton and selected complementary crops. The model farm will also use agroforestry practices by integrating trees and shrubs into cotton fields, along with livestock, improved compost management, on-farm water management options and integrated pest management.

The regenerative agricultural set-up of the model farm will enhance ecosystem services as well as striving to sustain high production levels of cotton. The recommended practices are:

- **Agroforestry practices,** integrating longer term, permanent trees with short rotation shrubs. Alley intercropping will provide a windbreak and fix nitrogen when leguminous trees are intercropped. Other recommended agroforestry systems include boundary planting and rotational woodlot fallows. Recommended species include *mangifera indica, carica papaya*, leguminous shrubs such as *calliandra calothyrsus* and *gliricidia sepium* and long rotation trees including *senna siamea*, *tamarindus indica, moringa oleifera, grevillea robusta, tectona grandis* and *gmelina arborea*.
- **Compost systems** will improve soil structure and stability, recycle nutrients, improve soil water retention capacity, stabilize volatile nitrogen, convert wastes into resources and suppress soil-borne diseases.
- **Cover crops** will be grown to cover the ground surface between rows of crops. Recommended species include pigeon pea, *dolichos lablab* and lucerne.
- **Crop rotation** involves a systematic approach of growing different annual and herbaceous perennial crops in succession in the same field over different cropping seasons.
- **Minimum tillage** will be incorporated to reduce soil disturbance, such that it will only occur during planting, if at all.
- **Livestock integration** will result in fodder production to feed animals whilst also improving soil fertility through the use of manure. A recommended species for this is *bracheria* grass.
- Pests will be managed by a combination of **integrated pests management**, cultural practices, biological methods, physical methods and wise use of chemicals

Development of a strong cotton value chain

Labl's holistic, community-centred approach has huge potential to make real impact in the region. In the process of value chain development, Labl will support farmers in producing cotton of the right quality and in adequate quantities (see annex 4 for more details on fiber quality).

In order to solve the challenges observed during the context analysis, it is recommended that Labl:

- Invests in the regenerative model training farm, thereby supporting measures to restore soil health and productivity
- Establishes and strengthens a functional cotton value chain
- Strengthens capacity and functionality of farmer organizations
- Strengthens extension service systems
- Upscales adoption of cotton value chain
- Enhances participation of youth in agricultural value chains
- Embarks relevant certification for the cotton value chain to relevant certification or sustainability standards (see annex 1 for a list of global cotton sustainability initiatives)
- Involves stakeholders in value chain development and find lasting solutions to human wildlife conflict.

1. Context Analysis

The findings from the context analysis demonstrate that regenerative practices would provide many solutions to the challenges faced by the community. This, accompanied with the development of the cotton value chain in the area, will lead to a vast array of social, economic and environmental benefits.

Table 1 provides an overview of the findings of the context analysis based on these three pillars:

Table 1: Summarized description of the context analysis findings

Social	Economic	Environmental
• Low adoption of cotton farming and value chain • Weak organization of farmers, including cooperatives • Low levels of youth involvement in agriculture • Mindsets are generally not orientated to market-led farming • There are serious difficulties in accessing water • There is a high expectation of Labl investment in regenerative cotton value chain by farmers	• Inadequate access to agricultural extension services • Disjointed cotton value chain • Low agricultural productivity for both crops and livestock • Inadequate access to affordable financial services • Poor market access • Inadequate access to sustainable certified cotton markets by cotton farmers	• Lack of clear understanding of regenerative agriculture and its application to cotton farming • Poor soil health - all soil health parameters ranged from low to moderate • Climate variability • Lack of a functional system for access to tree and cover crop seeds and seedlings • Inadequate access to soil testing services • Poor management and application of soil fertility improvement resources e.g. farm yard manure and compost • Inadequate integration of trees on farms which exposes farm to wind and erosion • Wildlife human conflicts

1.1 Background information

1.1.1 Physical and topographic features

According to the County Integrated Development Plan (2018 – 2022), Taita Taveta County is classified into three major topographical zones, namely:

1. **Upper zone:** Mwambirwa, Taita and Sagalla hills regions with altitudes ranging from 304 - 2,208 meters above sea level. The zone is suitable for horticultural farming.
2. **Lower zone:** Plains where the national parks, mines and ranches are found.
3. **Volcanic foothills zone:** The Taveta region with underground water and springs sourcing from Mt. Kilimanjaro.

1.1.2 Climatic conditions

Average temperature in Taita Taveta County is 23○C, with lows of 18○C in hilly areas (Sagalla, Taita ad Mwambirwa) and highs of around 25○C in lower zones.

Taita Taveta County is mainly dry, with the exception of Taita Hills which are considerably wet. The south-easterly winds influence climate in the area, creating ideal conditions for moisture condensation resulting in relief rainfall in the hilly areas. Long rains are usually experienced between March and May where on average, highlands record 265mm compared to 157mm in the lowlands. Short rains are usually between October and December, with annual rainfall being recorded at 1,200mm (highlands) and 341mm (lowlands).

The average farm size for small scale farmers is about 0.4 Ha in the highlands, 1.3 Ha in the midlands, and 4.8 Ha in the lowlands. This is however rapidly changing due to population pressure which has led to land sub-division. Mwatate, Voi and Taveta also have large scale farms (mostly sisal estates) which average at around 7,400 Ha.

Rainfall distribution is usually uneven, with higher rainfall in highland areas. Annually, mean rainfall is 650mm.

The main crops grown and livestock reared in the county are:

- Cereals (maize, sorghum and rice)
- Pulses (beans, cowpeas, green grams and pigeon pea)
- Root crops (cassava, and sweet potatoes)
- Horticultural (kale, tomatoes, cabbages, French beans, snow peas, capsicum, Asian vegetables)
- Fruit crops (bananas, mangoes, oranges, passion fruit and guava)
- Nut and oil crops (macadamia, groundnuts, sunflower, coconut and cashew nut)
- Fibre crops (cotton, sisal)
- Other emerging crops (jojoba, moringa, mushroom, aloe vera and jatropa)
- Livestock includes beef cattle, dairy cattle, goats, sheep, camels, donkeys, poultry, bee keeping, rabbit and pigs. Chicken is the main poultry reared, and to a lesser extent guinea fowl, turkey, geese, ducks, peacock and pigeons.

According to the Taita Taveta County climate risk profile, Agriculture is the main source of livelihood in Taita Taveta. It contributes about 95% to household income and more than 80% of employment. Absolute poverty stands at 57%, while 48% of the population experience food poverty.

The agriculture sector is greatly affected by droughts, floods, unpredictable and unreliable rainfall, and high temperatures brought about by climate change.

1.1.3 Agroecological zones

The County is divided into eight Agro ecological Zones (AEZs) (Jaetzold et al. 2010). These are:

Table 2: Agroecological zones along with the altitude range and mean annual rainfall

Agroecological zone	Regions	Altitude range (m)	Mean annual rainfall (mm)
Lower highland zone (LH2)	Wundanyi	1,680	1,200
Upper midland zone 3 (UM3)	Wundanyi	1,370 - 1,680	900 - 1,200
Upper midland zone 4 (UM4)	Wundanyi	1,220 - 1,520	700 - 900
Lower midland zone 4 (LM4)	Wundanyi, Mwatate and Taveta	910 - 1,220	600 - 800
Lower midland zone 5 (LM5)	Wundanyi, Mwatate, Taveta and Voi	790 - 980	480 - 700
Lower midland zone 6 (LM6)	Taveta National Park, Mwatate and Voi	Below 790	Receives bimodal rain
Lowland zone 5 (L5)	Mwatate, Taveta and Voi	610 - 790	480 - 680
Lowland zone 6 (L6)	Tsavo National Park and Voi	Below 610	Receives bimodal rain

1.2 Social, economic and environmental highlights

The context analysis was conducted across Taita Taveta County targeting potential and current cotton farmers. Farmers participating in the analysis were drawn from Mwatate, Voi and Wundanyi sub counties. The context analysis provides an understanding of the current status in relation to social issues, economic activities and key environmental issues which included a soil health assessment.

The context analysis findings were intended to inform the development and design of regenerative cotton model farm design, with the ultimate objective of underpinning farmer trainings to scale the adoption of regenerative practices in cotton farms in Taita Taveta county.

Below is the summary of the key findings.

1.2.1 Social context

Table 3: Social context highlights - key findings and challenges

Key findings
Farming is the main occupation and source of livelihood for 75% of respondents (85% in the Kenya population and housing census)
Most farmers interviewed were between the ages of 35 to 65
Most farmers interviewed are members of self-help groups (75%)
The majority of farmers own over 5 acres of land
Most of the land is family owned without a title deed, but is considered secure
75% of farmers use boreholes as the main source of water. 63% of them have to walk a distance of more than 1km to access them
Only 25% of the farmers interviewed harvest food that can last more than 10 months
Half of the respondents stated that both men and women collectively make decisions
Farmers use both family and hired labour when implementing farm practices - the average cost of labour is Kes. 300 per day
Key challenges
Involving young people in the cotton value chain
Maximizing participation of farmers in the cotton value chain
Strengthening capacity and role of farmer organizations in cotton value chain development
Transforming mindsets to be more attuned to business challenges and investing in the cotton value chain
Addressing challenges of accessibility to water

1.2.2. Economic context

Table 4: Economic context highlights - key findings and challenges

Key findings
For 67% of farmers, agriculture is their main source of income
67% of farmers interviewed grow crops both for food and income
Mango farming, sisal and rearing of local cattle (zebu) are the main farm enterprises
Land preparation is mainly done by use of oxen ploughs (46%). Hand tilling and use of tractors are used by 31% and 23% of the respondents respectively
Level of access to extension services was either limited or non-existent
There is limited or no access to financial services
A market for agricultural products is available within Taita Taveta County (in Voi, Mwatate, Wundanyi etc.)
Maize and beans are the main food crop
Only 10% of the respondents were engaged in cotton farming
The majority of farmers market their products individually
The main types of livestock are indigenous chicken, goat, sheep and local cows (zebu)
Human wildlife conflict was reported as a major challenge to agricultural activities
Key challenges
Accelerating adoption of cotton by farmers
Increasing agricultural productivity in crop and livestock production
Enhancing diversification of income generating activities
Enhancing access to extension services for cotton farmers
Enhancing access to financial services for cotton farmers
Access to stable markets
Mitigating effects of human wildlife conflict
Enhancing partnerships

1.2.3 Environmental context

Table 5: Environmental context highlights - key findings and challenges

Key findings
Wood is the main source of energy for cooking and heating
Deforestation, particularly when converting forest land for agricultural purposes, has resulted in low levels of tree cover and compounded low investment in tree planting
Hedgerow intercropping, boundary planting and dispersed trees in cropland are the main agroforestry systems adopted
Crops are mainly planted in March and October with harvesting taking place in July and January
The main climate related challenges affecting farmers are prolonged dry periods, erratic rains, pest and disease infestations along with declining soil fertility
Only 25% of farmers interviewed have been trained in sustainable agricultural land management practices
Half of farmers interviewed applied top dressing inorganic fertilizer with 38% applying fertilizer at planting
Only 6% of farmers interviewed used chemicals in pest and disease control
Herbicides are not used in weed control
There is poor management and application of farm yard manure
Most of the land is located on sloped terrain which results in susceptibility to soil erosion
Key challenges
Accelerating transformation and transition to regenerative farming practices
Addressing the challenge of climate variability
Establishing a demand-driven seed and seedlings supply system
Enhancing access to soil testing services
Sustainably managing and applying farm yard manure, a readily available soil fertility improving resource

1.3 Soil health assessment

The soil health assessment applied simple visual and physical soil assessment tools to analyse structure, organic matter, compaction, cover, presence of invertebrates and water infiltration. The table below illustrates the assessment scores.

Table 6: Soil analysis findings from each farm

	Sub county	Soil Structure	Soil Organic Matter	Soil Compaction	Soil Cover	Presence of Invertebrates	Water Infiltration
Farm 1	Voi	2	1	1	1	2	5
Farm 2	Voi	1	1	1	1	1	1
Farm 3	Voi	2	1	1	2	1	1
Farm 4	Wundayi	2	1	1	1	1	5
Farm 5	Voi	2	1	1	1	1	1
Farm 6	Voi	4	5	5	4	1	5
Farm 7	Mwatate	3	1	1	2	1	1
Farm 8	Mwatate	1	1	2	1	1	1
Average Score		2	2	2	2	1	3
Mode		1	1	1	1	1	1

Score key:
0 - 1: Poor state
2 - 3: Moderate condition
4 - 5: Good condition

Overall soil health rating: Based on the analysis, the health status of the soil assessed ranged from poor to moderate. Corrective interventions are required to improve soil properties as per the listed parameters.

Table 7: Summary of findings of soil analysis

Parameter	Analysis Score	Comments
Structure	2	This implies the extent to which soil crumbles into smaller particles of less than 1cm size, Most of the soils exhibit almost poor structure. The clods were more 5cm in size and in some cases too hard to crush. In other areas, soils were sandy which makes it poor in water retention.
Organic matter	2	This refers to the observed presence of organic matter often on the surface or within the sub-surface layer. Most soils can be described to have lacked observable traces of organic matter. This was a result of erosion in some cases or absence of vegetation cover to contribute to its build up
Compaction	2	This refers to the extent to which wire probe or machete can penetrate into the soil under moderate pressure. When a probe was used to test compaction of the soil, most soils had a penetration depth of less than10cm. This is far below the recommended 20cm for healthy soil. The poor condition state of soil is attributable to lack of organic matter.
Soil cover	2	This is the percentage of the soil surface that is not exposed to direct sunlight. Assessment of soil cover indicated that most had a cover of less than 20%. Healthy soil should have a cover of more than 70%. Soil cover enhances soil organic matter.
Presence of invertebrates	1	This refers to the number of invertebrates, especially earth worms present in the soil. Healthy soils have more than 6 invertebrates in one scoop of a shovel. Assessment of soil in the study area had no count of invertebrates. This means that the soils had no moisture and organic matter to support invertebrate's life.
Infiltration rate	3	Infiltration is the speed at which water percolates to below ground. Most soils had a moderate infiltration rate. Good soils have an infiltration rate of up to 3 minutes. Moderate rating is attributable to the fact that most soils have a higher percentage of sand than loam. Most farms had slow rate of water percolation.

1.4 Cotton value chain players in Taita Taveta County

The major players in the cotton sector were formerly **Thika Textiles** who provided cotton seeds and marketing services. **Kishushe farmers' cooperative society** provided linkages to Thika Textiles, distributed inputs to members and offered basic training in cotton farming. They appear to no longer operate in Taita Taveta, despite continuing to work in other parts of Kenya.

Due to the current lack of activity of these cotton players, the **cotton value chain is not well developed** in the evaluated area, with Farmers receiving limited service only in combination with supply of input materials.

1.4.1 Cotton production trends in Kenya

According to Kenya Fibre Directorate (see table 8), cotton production in Kenya declined from 13,000 MT (70,000 bales) at its height in 1986 to an average of 2,000MT (10,000 bales) in the last 2 years (2020 – 2021). In 2021, annual lint consumption by the textile mills was estimated at 8,000MT (41,200 bales) while national domestic demand stood at about 26,000MT (140,000 bales). The country has the potential to produce up to 37,000MT (200,000 bales) of lint cotton annually from 385,000ha of arable land that is suitable for cotton growing. However, only about 20,000ha is currently being utilized for this purpose by about 40,000 farmers.

Table 8: Summarized cotton production trend over the last 6 years in Kenya

	2015	2016	2017	2018	2019	2020
Area (Ha)	28,627	28,700	20,717	13,432	18,000	9,837
Yield (Kg/ha)	650	550	570	400	170	350
Seed cotton production (MT)	15,726	15,800	11,850	5,321	3,045	3,389
Seed cotton price (USD cents/kg)	42	42	46	46	52	48
Value of seed cotton (Ksh. Million)	660	664	545	245	157	172
Lint cotton (MT)	5,200	5,300	4,000	2.000	1,000	1.100
Price of lint (USD/Kg)	1.42	1.42	1.64	1.64	1.90	1.80

Source: Kenya Fibre Directorate

There are two commercial cotton varieties in the country, namely; **HART 89M** and **KSA 81M** which, when grown under rain-fed conditions, have a potential yield of 2,500kg and 2,000kg per hectare respectively. However, in reality growers only realize an average yield of 572kg/ha. When irrigated, farmers produce an average of 1500kg/ha against a potential of 3500kg/ha.

According to the Kenya Fibre Directorate, the following are key challenges in the cotton sub-sector in Kenya:

- **Lack of superior cotton seeds**. As mentioned above, there is low productivity at an average of 572kgs/ha due to the use of local recycled 'fuzzy' cotton seeds.
- **Cotton is not prioritized in Kenya**. Most of the cotton growing counties have not included cotton in their County Integrated Development Programs (CIDPs). In this regard, the plan and strategy to develop cotton is currently lacking.

- **Lack of funding for research to produce superior cotton seeds**. The Kenya Agriculture and Livestock Research Organisation (KALRO) is inadequate in both structural, equipment and funding capacity for Research and Development of superior seeds.
- **The availability of certified high quality seeds is currently limited to a few international suppliers**. There is no competition in the supply of superior seeds, which is unlikely to change as the industry is currently not attractive to private sector investment.
- **Lack of extension services within the counties**. Extension service is a critical missing link in cotton production in all the cotton producing counties. Absence of quality extension services for farmers is a major hindrance in achieving the desired cotton production, productivity and quality.
- **Collapse of cotton ginneries**. There is limited ginning capacity with only four operational private ginneries across the 24 cotton growing counties. This severely affects the processing and marketing ecosystem thus limiting the sub-sector's capacity to grow.
- **The diversified and scattered nature of cotton growing counties and growers**. Cotton is grown by smallholder farmers on farms of less than 1ha, which are scattered over vast areas in all cotton producing counties. This denies the sector essential economies of scale and efficiency.
- **Weak aggregation system for economies of scale**. Farmers lack the organizational capacity to aggregate their produce as well as acquire inputs in bulk. This denies the farmers bargaining power in the marketplace and increases their cost of production.
- **High cost of production for cotton in Kenya**. Cotton is a resource intensive cash crop. In Kenya, there is low application of inputs including fertilizer and poor quality seeds. This leads to low yields which increases the unit cost of production and makes Kenyan cotton uncompetitive in the region.
- **Inadequate value addition facilities**. The existing ginneries do not integrate by-product processing (value addition). This lowers income to both the ginneries and farmers.
- **Lack of empathy in contract farming in the cotton value chain**. Ginneries and millers are not willing to enter into contract farming with growers because of price uncertainty and quality assurance from growers.

The following strategies were recommended by the Kenya Fibre Directorate and echoed by the findings from the context analysis. It is recommended that Labl takes these recommendations into account as part of their strategy, particularly points 3-5 which are relevant for their operations:

1. Cluster counties into viable production, processing and marketing units.
2. Produce and disseminate high quality cotton seeds.
3. Establish adequate ginning capacity.
4. Strengthen farmer organizations/co-operatives.
5. Enhance cotton extension services and research.

1.4.2 Current state of regenerative cotton farming in Kenya

According to a policy brief by Feed the Future on enhancing investment attractiveness in Kenyan cotton sector, there are low rates of participation in certified sustainable cotton farming in Kenya. Voluntary adoption of cotton based sustainable agricultural practices is low and primarily confined to smallholder's participation in donor supported projects.

Although the pilot projects below demonstrate how cotton production can successfully be improved while simultaneously seeking sustainable certification pathways, scaling up such efforts to the national level requires public sector support and private sector willingness to invest in extension and certification services. Please see annex 1 for a detailed description of Global sustainable Cotton Initiatives.

The below examples can still offer valuable learnings for Labl:

The Australian government supported Ethical **Cotton Production Project** promoting sustainable cotton farming which was implemented as planned in 2017, but its reach remains low, serving 1,500 smallholders in Kwale County.

The Better Cotton Initiative (BCI) pilot project in Elgeyo Marakwet County was supported by the **Cotton Development Authority** and **Solidaridad International** to increase productivity, enhance market access, and improve growers' knowledge and technical capacity to apply more sustainable techniques in cotton farming. Understandably, the BCI partnership has since been suspended.

2. Design report

The purpose of the regenerative cotton model farm is to create a tangible example of regenerative production, to inspire adoption of this new way of working, and share knowledge and skills towards accelerating adoption of regenerative practices within the cotton value chain by small holder farmers in Taita Taveta County, Kenya. The model farm design will be influenced by the findings of the context analysis and global sustainable and regenerative cotton principles.

2.1 Introduction to Regenerative Agriculture

Regenerative agriculture, a term coined by organic farming researchers at the Rodale Institute in the 1980s, consists of holistic farming practices that aim at improving soil health and reversing effects of climate change by conserving biodiversity, improving the water cycle, increasing organic matter in soil structure and transferring carbon from the atmosphere to the soil. Regenerative agriculture increases the amount of healthier topsoil, which results in a better food system.

Regenerative agriculture can be understood as a system of farming principles that rehabilitates the entire ecosystem and enhances natural resources, rather than depleting them. Regenerative agriculture is the process of restoring degraded soils using practices based on ecological principles which promotes:

- Building soil organic matter and biodiversity
- Healthier and more productive soil that is resilient to drought and floods
- Decreased use of chemical inputs and subsequent pollution
- Cleaner air and water
- Enhanced wildlife habitat
- Soil carbon sequestration

The transition to regenerative agriculture is a journey, not a destination. It's about moving in the right direction, not perfection. The model farm will contribute to partners' efforts to support cotton farmers to move in the right direction.

Table 9: Comparison between conventional and sustainable/regenerative farming

	Conventional Farming	Sustainable/regenerative farming
Environment	Pesticides kill beneficial insects Pollutes soil and water pests Builds resistance to chemicals	Increased biodiversity Eco balance between pests and beneficial insects No pollution
Health	Possibility of accidents involving pesticides Exposure to harmful pesticides	No health risks from pesticides Healthy and sustainable food crops
Soil fertility	Risk of declining soil fertility due to use of chemical fertilizers and poor crop rotations	Soil fertility is improved by farm yard manure, compost, organic matter and crop rotation
Market	Open market with no loyalty of the buyers to farmers Dependence on general market rates Mostly target individual farmers	Closer relationship with market partners Presents opportunity to sale products as organic at higher price Farmers organized in groups
Economy	High production costs High financial risks High yields only in good years	Lower costs for inputs Lower financial risk Satisfying soil fertility once soil fertility is improved

Source: FiBL Organic Cotton Training Manual

The proposed regenerative practices are expected to offer farmers various benefits, some of which are highlighted below:

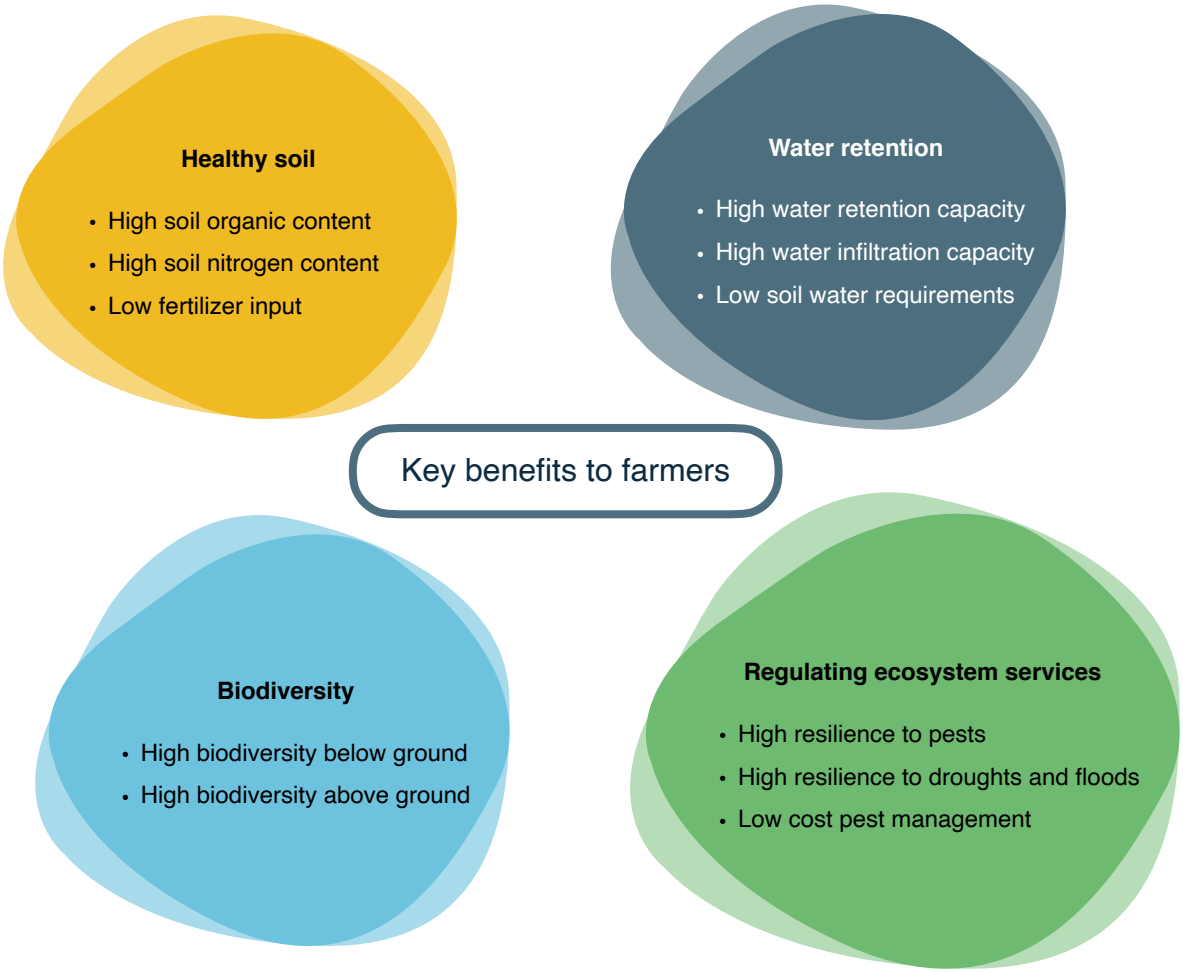


Figure 1: Key regenerative agricultural benefits to a farmer

Source: Lunn-Rockliffe, S., Davies, M.I., Willman, A., Moore, H.L., McGlade, J.M. and Bent, D. 2020. *Farmer Led Regenerative Agriculture for Africa*. London, Institute for Global Prosperity.

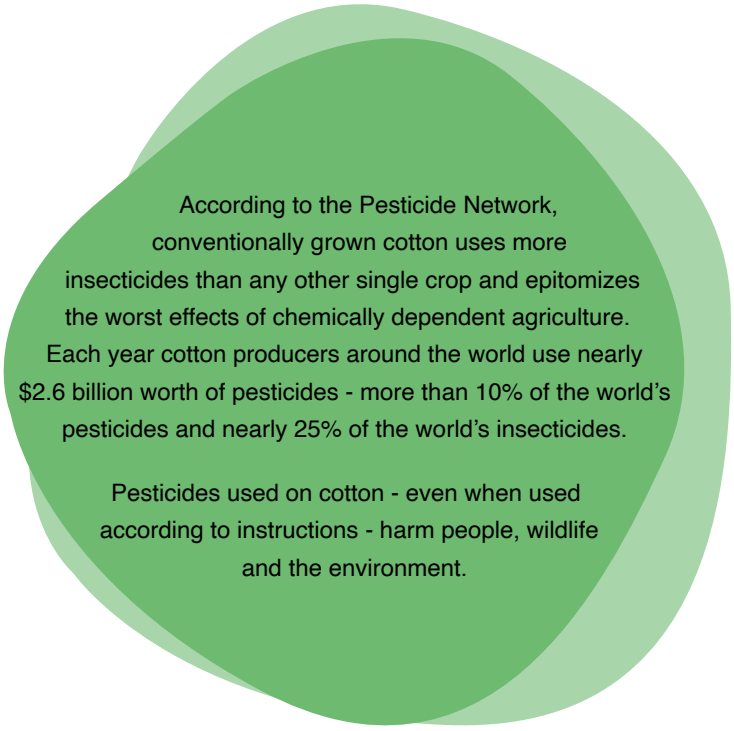
2.2 Design justification

The context analysis identified the following challenges which the model farm will need to address.

- Inadequate understanding of sustainable and regenerative farming practices and their integration in cotton farming
- Low productivity of crops (including cotton) and livestock
- Poor soil health (soil structure, cover, organic matter, water moisture retention etc.)
- Water stress, especially soil water moisture retention
- Low tree cover
- Poor management and application of farm yard manure
- Climate variability
- Inadequate diversification of farm interventions

In view of the above, the model farm will demonstrate the following practices with cotton as the major crop:

- Integration of various regenerative technical options (trees, shrubs, crops, livestock, cover crops, crop rotation) in a farming system
- Good agronomic practices for cotton and other crops
- Integration of agroforestry trees and shrubs in cotton fields for soil fertility management and windbreak
- Livestock integration focusing on fodder, pasture production and residue management (manure recycling as farm yard manure)
- Improved management of compost-based soil fertility management techniques (farm yard manure, compost, liquid manure and vermicomposting)
- On farm water management options, roof catchment, rain water harvesting, etc.)
- Crop and livestock diversification
- Integrated pest management



2.3 Guiding principles and standards for the design

The Model Farm design will be guided by the principles highlighted below. For a deeper dive into the principles behind regenerative thinking please see annex 2.

1

Know your context

- Understand the current individual situation, including prevailing climate, geography, resources, skills, family dynamics and goals.
- Understand how the ecosystem processes function on your land so that you can work with those processes.
- What works for someone else may not work for you because your context is different. Find what works for you, but recognize your context is always changing.
- Be willing to learn, grow and adapt with it.

2

Cover the soil

- Soil health cannot be built if the soil is uncovered or is moving.
- Using a diversity of plants and leaving the proper amount of forage residue minimizes bare ground and builds soil organic matter.
- Plant cover further protects the soil from erosion and serves as a barrier between the sun and the open soil, preventing high soil temperatures that can decrease microbial life.

3

Minimize soil disturbance

- Mechanical soil disturbance, such as tillage, alters the structure of the soil and limits biological activity.
- If the goal is to build healthy, functional soil systems, tillage should be limited and only used in specific circumstances.
- Tillage of any specific acre even once each year is too much.
- However, tillage is not the only disturbance: grazing, fire, fertilizer and pesticide applications all can disturb the soil.
- For grazing land, ensure that the timing, frequency, intensity and duration of these management activities are implemented in a planned manner that support the regenerative of ecosystem processes.

4

Increase diversity

- Increasing plant diversity creates an enabling environment and catalyst for a diverse underground community.
- Grasses, legumes, forbs and woody species all work together in a native, diverse rangeland setting.
- The complex interactions of roots and other living organisms within the soil impact its dynamic properties, affect carbon sequestration and enable nutrient availability for plant productivity.
- Managing for increased diversity can also be applied to grazing animals, wildlife, and other organisms above and below the soil.

5 Maintain continuous living plants and roots

- Maintaining actively growing living plant roots is encouraged to keep the soil biology processes working, no matter the season.
- Perennials are vital even when dormant as their roots are living and functioning (though slower compared to during the growing season).
- Soil microbes use active carbon first, which comes from living roots.
- These roots provide food for beneficial microbes and spark beneficial relationships between these microbes and the plant.
- Greater plant species diversity allows for living roots during an extended period of the year.

6 Integrate livestock

- Livestock supports healthy soils and ecosystems.
- Soil and plant health is improved by proper adaptive grazing of one or more animal species, which recycles nutrients, reduces plant selectivity and increases plant diversity.
- As with any management practice, grazing is a tool that requires intentional application.
- Fodder, pasture and improved feeding are critical aspects to consider.

Species selection and spatial arrangement should conform to the regenerative agroforestry standards highlighted in the table below. This applies where tree are integrated into cotton farms.

Table 10: Regenerative agroforestry standards

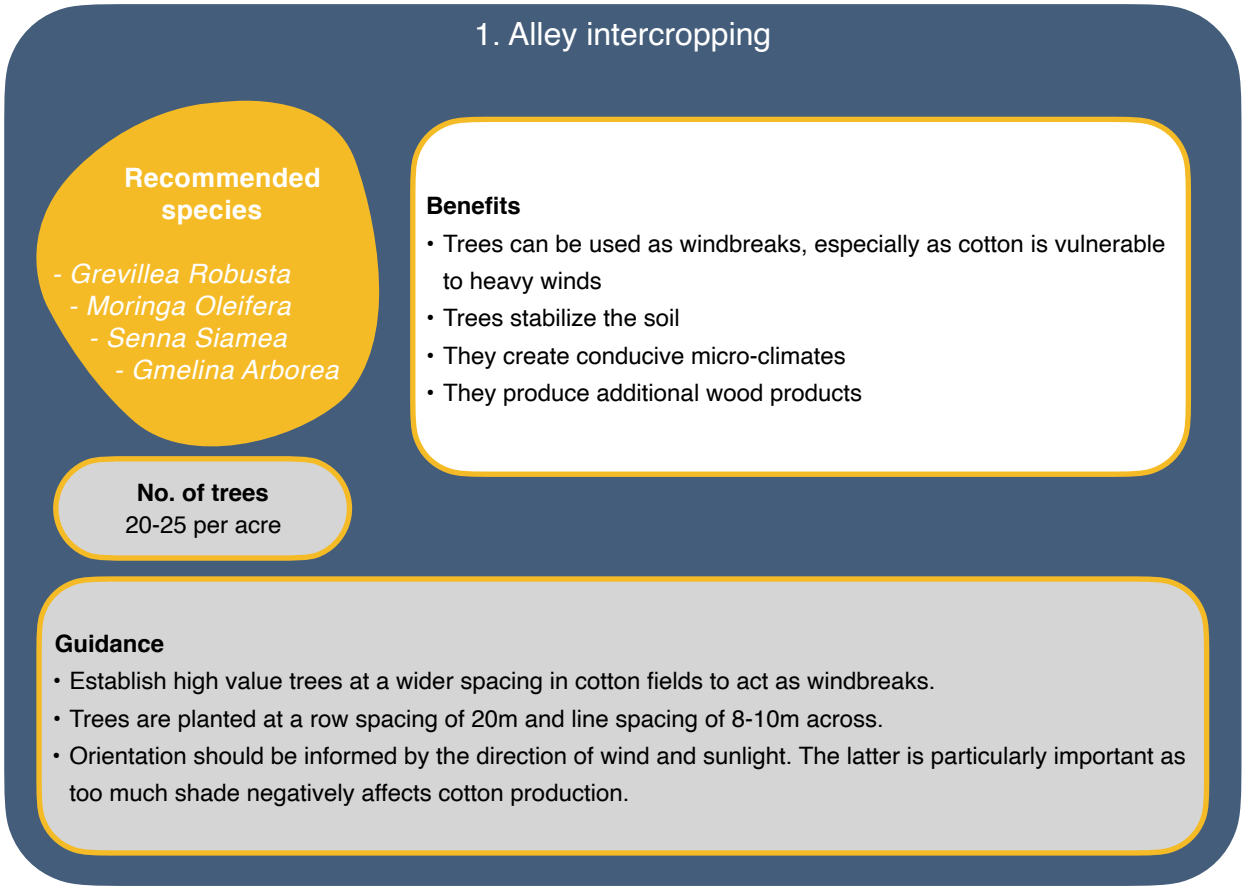
Standard Criteria	Criteria Measurement	Description of Measure
1. Integration	Presence of trees, shrubs, and other woody perennials in coffee farms	Annuals have an essential early successional role to play in agroforestry, while the long-term structure of the system emphasizes both woody and herbaceous perennials.
2. Density	Refers to woody perennials per unit area.	This measure ensures continuous soil cover for erosion control, capture of nutrients, shade provisioning and weed suppression.
3. Multistory	Layers of trees created in the agroforestry canopy structure and root systems. Require planting Trees of different heights.	Based upon five potential vegetation layers (emergent, upper canopy, lower canopy layer or understory, shrub, and herbaceous) occupied per unit area of coffee
4. Multiple species	Number of woody perennial (a variety of tree and shrubs spp) families, genera, species, and varieties. Use different species and varieties within the system	A measure of biodiversity intentionally planted or protected in the coffee agroforestry system
Source: Craig R. Elevitch, et al. 2018. Agroforestry Standards for Regenerative Agriculture.		

2.4 Recommended regenerative practices

2.4.1. Agroforestry

Agroforestry is the practice of cultivating and conserving trees as part of an agricultural operation. It enhances **soil protection, erosion control, carbon sequestration, moisture retention rates and biodiversity, while increasing income due to the additional production of trees and crops**.

Specific recommended agroforestry options are:



2. Intercropping leguminous trees and shrubs

Recommended species

- Sesbania sesban
- Gliricidia sepium
- Leucaena leucocephala
- Calliandra calothyrsus

Benefits

- Produces livestock fodder
- Increases soil fertility
- Leguminous tree species are nitrogen fixers
- These trees can be used as fodder, which results in manure for nutrient cycling. These species also increase milk production in livestock. This also creates savings on the cost of livestock feed

No. of trees/shrubs
405 - 1000 per acre

Guidance

- Establish leguminous trees and shrub species in rows within cotton farms either on:
  - Rows spaced between 8-10m with line spacing of 0.5 - 1m along the contour, or
  - On soil conservation structures (i.e. terraces)
- The trees and shrubs can be managed as hedgerows where they are periodically trimmed
- Prunings can be applied to cotton fields as mulch

3. Fodder production (livestock integration)

Recommended species

- Gliricidia sepium
- Calliandra calothyrsus
- Bracheria grass

Benefits

- Produces livestock fodder
- Improves soil fertility through manure recycling
- 3kg of fresh tree fodder provides around the same milk yield as 1kg of dairy meal

Guidance

- Establish fodder trees and pasture within cotton fields - plant tree seedlings in rows spaced between 8-15m and within rows at a spacing of 0.5m within the cotton farm. Line spacing can be single or double row spacing
- Establish bracheria grass as a pure stand or in alternating rows with fodder trees. Bracheria grass can also be established in rows between long rotation trees under alley intercropping
- After 6-7 years, cut the trees back to about 15cm to promote new growth
- Apply 1kg tin of manure per tree at the onset of the long rains each year
- Harvest and feed one part of tree fodder to every 3 parts of bracheria grass (or other grasses)
- Optimum feeding will require around 6kg of calliandra leaves per dairy cow per day

4. Boundary planting around cotton farms

Recommended species

- Seena siamea
- Combretum spp
- Grevillea robusta

Benefits

- Acts as a windbreak
- Increases biodiversity by creating habitats for birds and insects
- Provides demarcation for boundaries

No. of trees
33 - 50 per hectare

Guidance

- Establish high value trees on the farm boundaries at a line spacing of between 6-8m
- Apply 1kg tin of manure per tree at the onset of the long rains each year

5. Rotational woodlot fallows

Recommended species

- Sesbania
- Gliricidia Septum
- Leuceana Leucocephala
- Acacia albida
- Tephrosia vogelii

Benefits

- Creates soil organic matter
- Fixes nitrogen
- Produces wood fuel
- Conserves biodiversity

No. of trees
1000 per acre

Guidance

- Establish tree woodlots (mostly composed of fast growing nitrogen rich tree species) in rotation with cotton and other crops
- Trees should be spaced at a row and line scraping of 2 x 2m
- Cut the tree species after 3 - 5 years and replace them with cotton crop

6. Mango trees and cotton

Recommended mango varieties

- Kent
- Ngowe
- Sabine
- Pawpaw

Benefits

- Mango is successfully grown on a wide range of soils. The trees do well in sandy soils at the coastline as well as on loam, black cotton and even murram soils at other elevations
- It is a high value crop that provides significant additional income

No. of trees
40 per hectare

Guidance

- Establish grafted mango within cotton plots at a row spacing 20m and line spacing of 10m
- Farmers can also establish mango fruit orchards adjacent to cotton plots at a spacing of 10 x 12m
- Plant other crops within the mango orchards (for example cowpeas which is a vegetable and a nitrogen fixer)
- The essential prerequisites for good development of the trees are deep soils (at least 3m), appropriate rainfall (500 - 1000mm), good drainage, suitable altitude (0 - 1200m) and preferably a pH value of between 5.5. and 7.5.
  - Rainfall of 500 - 1000 mm at the right time of year is sufficient for successful cultivation
- Depending on cultivars and environmental conditions it takes 90 - 160 days after flowering for mangos to reach maturity

2.4.2. Compost systems

Compost, when properly managed, results in a high-quality soil amendment. Adding compost may increase the water holding capacity of the soil, helping farmers to produce a good crop even in years of low precipitation. Additionally, compost improves soil structure and stability, recycles nutrients, stabilizes volatile nitrogen, converts waste into resources and suppresses soil-borne diseases. The composting process destroys weed seeds and pathogenic microorganisms, while beneficial microorganisms grow and multiply in great numbers. Synthetic fertilizers can provide soluble nutrients for plant growth, but do not build the soils long-term biological reserves like compost.

Recommended options for include farm yard manure, compost and/or liquid manure.

The context analysis findings demonstrate that many farmers keep indigenous poultry, goats, sheep and local Zebu cows. This makes farm yard manure very feasible. The current challenge is poor management and application.

Liquid fertilizers

Part of the nutrients needed in the later growth stages of the crop can be provided by liquid manures like cow urine, biogas slurry, or fermented manures.
They are sprinkled on the soil, applied with irrigation water or diluted and sprayed as foliar fertilizer.
Liquid manures have the advantage that the nutrients are available almost instantly, thus they can be used to optimize nutrient supply.

2.4.3 Cover crops

Cover crops are usually creeping plants which cover the ground surface between rows of crops.

Cover crops will be an essential part of the regenerative design as they:

- Increase soil fertility and the organic matter content of the soil
- Protect the soil from rain, sun, and wind
- Reduce soil erosion
- Protect the fertile topsoil
- Prevent the silting of rivers and lakes
- Stop the soil surface from sealing
- Reduce the amount of precious rainwater that runs off
- Suppress weeds by smothering their growth and reducing the number of weed seeds, which in turn reduces the amount of labour needed for weeding.
- Cover crops should be planted soon after tillage or at the same time as sowing of the main crop, or after the main crop has established, to avoid competition for growth resources. Farmers can use a combination of mulch and living plants to keep the soil covered.

The context analysis revealed that soil in this area is characterized by poor structure and low vegetative cover, organic matter content and infiltration rate.

Cover crops will help to address these key issues.

Farmers will be advised to maintain year-round leguminous vegetative cover on 75 - 100% of all cultivated land. However, farmers should be mindful of competition with other crops, for instance cover crops that have a tendency to climb on the other plants should not be grown with cotton.

Farmers can plant cover crops in many ways. Here are some possibilities:

- **Intercropping:** Plant cover crops with the main crop
- **Relay cropping:** Plant cover crops with the main crop after 1st weeding
- **Sequential planting:** Plant cover crop after the main crop is harvested

Cover crops

Recommended species

- Pigeon pea
- Pulses
- Dolichos lablab
- Green grams

Benefits

- Enhances soil erosion control through protection from rain, sun and wind
- Leguminous crops increase the nitrogen content in the soil by fixing it from the air
- Improves soil structure, fertility and the organic matter content
- Enhances soil water conservation
- Provides additional habitat for biodiversity
- Provides a source of food (for example from beans)

Guidance

- Intercrop leguminous crops within cotton plots
- After harvesting the pods, cut back the cover crop and spread them as mulch in the cotton field
- Maintain a year-round vegetative cover on over 75% on the cotton crop

Mulching

Benefits

- Decomposes to increase soil organic matter
- Provides soil cover to prevent soil erosion, soil water retention
- Improves microbial activities
- Increases soil water retention

Guidance

- Spread crop residues in cotton plots: at least 50% of the productive area should be covered by a layer of organic matter (dead and decaying biomass such as mulch, grass leaves or branches) and/or nitrogen-fixing cover crops
- Increase mulch cover to 75% over time, depending on the availability of mulch materials
- Large pieces of crop residues should be cut into smaller pieces before application
- Crop mulches work best if a layer of 2.5 -10cm depth is evenly spread
- Mulch should be placed no closer than 15cm from the base of the cotton plants
- Crop residues, such as maize stalks, can be left on the ground after harvesting to act as mulch

Recommended species include pigeon pea, dolichos lablab and Lucerne. Pigeon pea and dolichos beans can also be used for human consumption. Lucerne is used for integrated pest management.

2.4.4. Crop Rotation

Continuous cultivation of the same crop, leads to deterioration of the soil due to depletion of natural resources, especially crop specific soil nutrients. Crop rotation is a systematic approach of growing different annual and herbaceous perennial crops in succession in the same field. The goal of crop rotation is to help manage organic soil fertility and also to avoid or reduce problems with diseases, pests and weeds.

Based on the context analysis results, crop rotation was not among common practices implemented. Farmers should rotate cotton crop with cereals and leguminous pulses and do not grow cotton in the same plot for more than 3 years.

Planting the same crop season after season encourages certain weeds, insects and diseases. Planting different crops breaks their life cycle and prevents them from multiplying. The more complex and long the rotation, the greater the benefits.

2.4.5. Minimum Tillage

The goal of minimum tillage is to reduce soil disturbance as much as possible. Soil disturbance should only occur for the following purposes:

- It is necessary to incorporate crop residues or green biomass from cover crops into soil to feed soil micro-organisms
- Control weeds
- Prepare the seed bed
- Break up compacted soil
- Develop drainage. Shallow cultivation tools must be used whenever possible.

The model farm will demonstrate a minimum tillage system where soil disturbance only occurs at time of planting.

As most farmers plough their farms two times prior to planting, the starting point would be to

1. Reduce ploughing to once whilst planting
2. Intensify adoption of cover crop
3. Then stop ploughing completely and dig only where seed will be planted

It is also important to consider the following:

- Use of direct seeding through crop residues
- Avoid burning crop residues
- Avoid incorporating crop residues into the soil spread them as mulch

2.4.6. Livestock integration and fodder production

The availability of fodder is one of the limiting factors in animal husbandry in Taita Taveta County. Poor access to balanced feed and fodder as well as poor feeding regimens makes cattle not reach their highest productivity potential. **This is in line with findings of the context analysis where most cows produce around 2 litres of milk per day against a national average of 7 litres a day and potential of over 18 litres a day.**

A combination of Calliandra a bracheria grass is recommended.

Calliandra improves milk production of both dairy cattle and goats. It can also be fed to other types of livestock such as sheep, rabbits and chicken. A cow needs to be fed with roughly 6kg of fresh leaves per day, a goat about 0.7kg. to harvest 6kg fresh leaves every day, you need to plant 500 calliandra trees at a spacing of 0.5m (1½ ft.), making 250m (800 ft) of hedge. This seems like a lot but a farm of 1 hectare (1½ acres) has over 400 metres (1280 ft) of external boundary, plus additional sites (along internal boundaries, along contours, around the homestead) where calliandra can be planted. Manure from this system is recycled and applied as farm yard manure or slurry for soil fertility improvement

Why is manure so important?

Manure provides essential nutrients needed for plant growth and production.

Key considerations and benefits:

- It improves soil properties such as structure.
- Both compost and farm yard manure is ideal.
- Manure production should be in sync with the crop production calendar.
- Preparation of manure should be timed to start early so that the ripe time coincides with the planting seasons or onset of the long rains.
- Manure need to be well prepared, stored and applied

2.4.7. Integration pest management (IPM)

Farmers will be advised to apply integrated pest management as a way of protecting cotton crop against pests. When incorporating IPM into their practices, farmers should follow this step-by-step approach:

1. **Monitor:** First, farmers should monitor their crops to check for pest attacks. This step will inform ongoing strategy and help the farmer to assess whether a solution is necessary or cost-effective.
2. **Biological:** The first response should be biological. This could be an organic input or the use of trap crops (see below for more details).
3. **Cultural/management:** This step refers to a change in management style to mitigate pest attacks, for instance weeding, ensuring the plants are spaced correctly, proper crop nutrient management, selection of the right varieties, correct post harvest management, etc.
4. **Chemical:** Chemical solutions should always be the very last resort. Whilst transitioning, farmers can first employ integrated soil fertility management (combining inorganic and organic means) and then move on to integrated pest management options

Guidance for IPM

- Establish trap crops to keep pests away from the cotton by offering a more attractive source of food, for example:
  - Lucerne (Medicago sativa L.).
  - Sunflower attracts the moths of African bollworm.
  - Pigeon peas (Cajanus cajan) trap Lepidopteran pests (caterpillars).
- Diseased plants are removed to maintain only healthy crops.
- Scout and monitor pest attacks.
- Control weeds (either manually or mechnically) to keep the fields clean.
- Introduce and conserve pollinators.

2.5 Cotton growing requirements and varieties

The context analysis has demonstrated that the climatic conditions in the region are well-suited to cotton production. Additionally, the crop is not attractive to elephants which will help to mitigate human-wildlife conflict.

Cotton Establishment

Recommended varieties

- HART 89M
- KSA81M
- Amiran Hybrid HA701
- Amiran Hybrid C570

Guidance

- At the onset of rains, plant either of the following at a depth of 3-5 cm:
  - 5 - 6 undelinted cotton seeds per hole (equivalent to 7kg of cotton seed per acre), or
  - 2 - 3 delinted cotton seeds per hole (equivalent to 4kg of cotton seed per acre)
- **Thinning** is recommended to avoid overcrowding of cotton seedlings in one hole
  - Where the spacing is 100cm between rows and 30cm between plants **(100x30)** leave **one plant per hole.**
  - Where the spacing is 100cm between rows and 60cm between plants **(100x60)** leave **two plants per hole**
- **Gapping** is also recommended where the germination rate is too low to avoid empty spaces in the farm
- Land preparation should follow contour lines, especially on hilly or sloped land
- The cotton plant population should be 1,349 per acre

Ideal climatic conditions

- High temperature (ideally 30°C)
- Long vegetation period
- Ample sunshine
- Dry climate
- Min. 500 mm rainfall or irrigation

Ideal soil conditions

- Deep soils
- Heavy clay soils, ideally black
- Cotton soils (vertisols)
- No water logging

Crop development

- Strong root growth in the first two weeks
- Natural bud shedding (only approx. 1/3 of flowers develop bolls)
- Plant compensates for damage through increased growth

Table 11: Cotton varieties applicable to farmers as part of the project

Cotton varieties			
Name	**Overview**	**Benefits**	**Region**
HART89M	• Self-pollinated variety	• Drought resistant • Heat tolerant • Long maturing • Has ability to regrow after dry spell	Recommended for altitude range of 1400m.a.s. It was originally targeted for mid-altitude, coastal and the semi-arid lowlands. • Lower eastern counties and the coast • Mukueni • Kitui • Machakos • Tharaka-Nithi, • Embu • Meru • Lamu • Taita Taveta • Laikipia • Wajir
KSA81M	• Self-pollinated variety • Medium maturing • Provides moderate yields (2000kg/ha) • Provides 38% gin outturn (GoT) • Registered by Crop Science Society of America (CSSA) • Takes 4-4.5 months to mature • Has acceptable fibre qualities	• Grows in arid areas with very low rainfall • Resistant to jassids (a type of pest) • Can withstand water logging, typical for black cotton soils	• Lower eastern counties and the coast • Isiolo • Kericho • Kisumu • Laikipia • Waijir • Machakos • Makueni • Embu • Tharaka-NIthi • Meru • Kitui • Lamu • Taita Taveta • Tana Delta
Amiran Hybrids HA701, C570	• Medium maturing • Provides moderate yields (2000kg/ha) • Provides 38% gin outturn (GoT)		Piloted in: • Busia • Siaya • Bungoma • Homa Bay • Migori • Barring • Market • Kisumu Suitable for: • Lower eastern counties and the coast • Isiolo • Kericho • Kisumu • Laikipia • Wajir • Machakos • Makueni • Embu • Tharaka-NIthi • Meru • Kitui • Lamu • Taita Taveta • Tana Delta

2.6 Spatial arrangement

Cotton model farms will involve establishment of long term trees in rows within the crop land and along the boundary (see figure 2, 3 and 4 below).

Key features of the design:

- **Plant trees along contours:** Trees will be planted along a contour as per the gradient of the farm in question - this will prevent soil erosion as well as acting as wind breaks.
- **Incorporation of hedgerows:** A hedgerow will be established in between rows of long term trees at a row spacing of 10m (see figure x). The hedgerows may consist of *Calliandra callothyrsus* or *Grilicidia sepium* species, trimmed at a height of 1m high. The cut foliage can be fed to livestock or used as mulch layer within the cotton field.
- **Ensure the cotton plant gets enough light:** Shade from trees can impact cotton production and yield. To this end, trees must be managed to ensure that the sun's rays reach the intended crop, especially in the morning. To optimize the amount of sunlight received, the orientation of rows should be in an east-west direction.
- **Incorporate diversity:** Although it is possible to have trees of only one species, incorporating different species is highly encouraged. In order to provide additional income, high value trees will be established. Fruit trees should be included so that farmers can sell fruit when the main crop is not cultivated. Early maturing trees are also important in this regard, as they can be harvested whilst other trees are being established.
- **Grass strips** consisting of natural grass or fodder grass such as *Bracharia* will be left to grow along the tree rows. This will facilitate enhanced water infiltration as well as prevent loss of soil nutrients through erosion.
- **Spacing of the cotton:** Cotton stems will be grown 10cm apart within a row (see figure x).
- **Incorporate cover crops:** A leguminous cover crop will be established which can then be used as fodder or as a food crop (e.g. black beans). Leguminous cover crops are useful in nitrogen fixation, which will improve soil fertility and therefore increase productivity. At the same time it prevents weed growth, soil erosion and water loss.
- **Application of manure:** Manure from the fodder systems will be recycled and applied to the soil as farm yard manure.

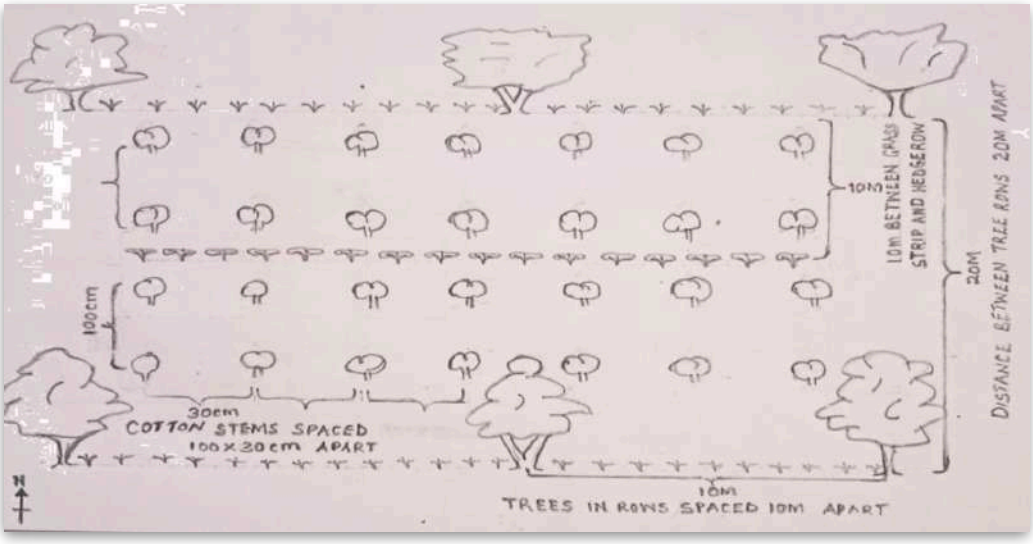


Figure 2: Aerial view of a regenerative agroforestry farm components

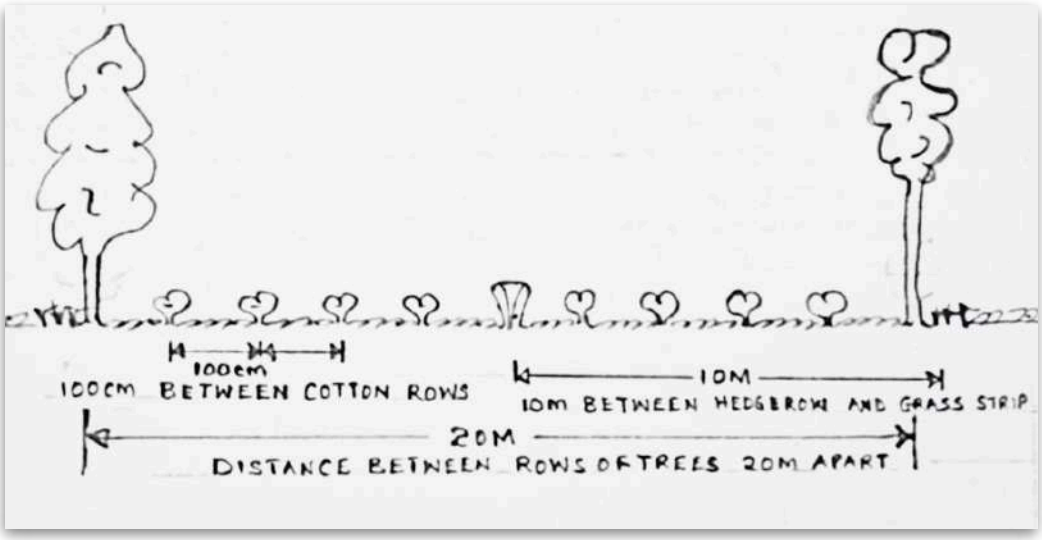


Figure 3: Cross Section view of cotton regenerative agroforestry farm

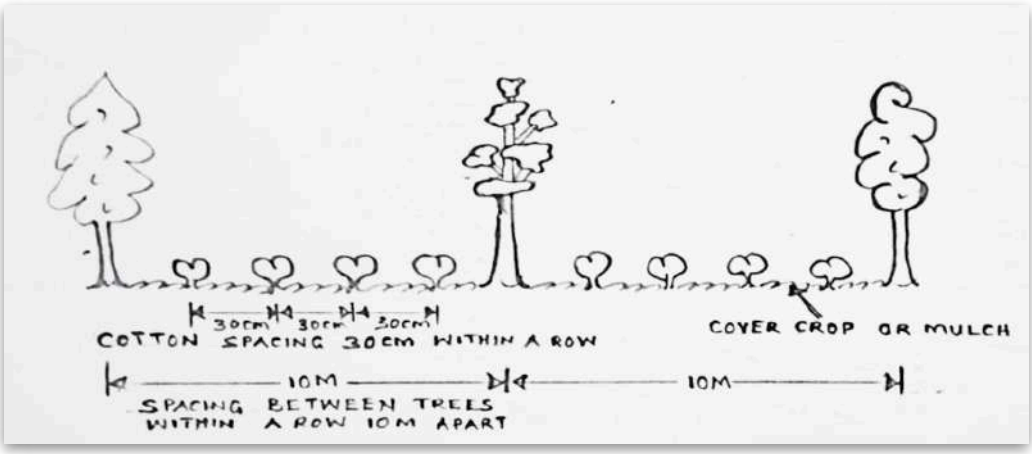


Figure 4: Cross section view of cotton farm with regenerative agroforestry

2.7 Species selection: Tree, cover and cash crops varieties

The choice of species for planting in regenerative agroforestry system will depend on:

- **The purpose of tree and cover crop planting.** The selected tree species and cover crop varieties must be able to fulfill the farmer's objective for planting them, for example shade provision, income, soil or water conservation and/or food production
- **The environment**, specifically climatic conditions, soil type and altitude
- The ability of the species and varieties to **establish and provide a wide range of services and products**, preferably for more than one purpose and with a high degree of profitability

Why are trees so important?

Trees are essential in restoring soil fertility over a long period of time through foliage. They control erosion and decrease wind speed that could be destructive to cotton plantation.

Table 12: The options for different tree species, including a description of their ecological features, mode of propagation and uses

Species	Ecology	Mode of propagation	Uses
Mangifera indica (Mango)	• *Mangifera indica* is a large evergreen exotic tree species growing to 20m tall with a dark green, umbrella-shaped crown. • The tree grows well in areas with an altitude of 0 - 1200 meters above sea level (m.a.s.l), mean annual temperature of 19 - 35 degrees celsius and mean annual rainfall of 500 - 2500mm.	The tree is propagated through seed. Grafting and budding are used for production of high-quality fruit trees.	The tree is used mainly for fruit production but provides other services and products, including soil conservation, shade, charcoal, firewood, timber, carvings, furniture, herbal medicine and fodder.
Senna siamea (Cassia tree, Msonobari, Mrabai)	• *Senna siamea* is an evergreen exotic tree species attaining a maximum height of 20m with a smooth pale-grey brown bark. • The species is common at the coast and can grow at an altitude of up to 1800 m.a.s.l. with average annual rainfall of between 500 - 2800 mm. • The species is poisonous to pigs.	The species is mainly established through seed. The tree can also be propagated through wildlings and coppices.	The tree is used mainly for fuelwood. It is also used for charcoal, timber, ornamental purposes, fodder and soil conservation.

Tamarindus indica (Tamarind, Mkwaju)	• *Tamarindus indica* is a slow-growing large evergreen indigenous tree species, growing up to 30m tall. The bole grows up to 2m diameter. • Tamarind grows at an altitude of 0 - 2000 m.a.s.l., with a mean annual rainfall of 500 - 1500mm and temperatures of 9.5 - 37 degrees Celsius.	Tamarind is propagated through seed.	As well as its edible fruit pulp, Tamarind has is commonly used for timber, medicine, firewood, charcoal, floor tiles and shade.
Moringa Oleifera (Drumstick tree, Mzunze)	• Moringa oleifera is a small to medium deciduous exotic tree species attaining a height of 12m and a diameter of 60cm. • The species does well at an altitude of 0 - 1000 m.a.s.l. and with mean annual rainfall of 500 - 1300mm.	Moringa is easily established by seed and cuttings. No seed pre-treatment is required.	Moringa is used as food, fodder, medicine, cooking oil and as a stimulant. It is also used in water purification and in industry for production of paints, lubricants and cosmetics.
Grevillea robusta (Silky oak, Mukima)	• Grevillea robusta is a semi-deciduous exotic tree species which grows to a height of 20m or more with a straight trunk, angular branches and oval leafy crown. • The species does well at an altitude of 200 - 2000 m.a.s.l. and with mean annual rainfall of 500 - 1700mm.	Grevillea is propagated through seed, wildlings and cuttings. However, Grevillea seed is difficult to collect as it is easily dispersed by wind. No pretreatment of seed is required.	Grevillea is used for timber, plywood, panelling, fuelwood, charcoal, furniture and fencing. It is also used as bee forage, shelterbelts, shade trees, mulch and for soil conservation.
Tectona grandis (Teak, Msaji, Mtiki)	• Tectona grandis is a large, deciduous exotic tree species reaching 35m in height in favourable conditions. • Teak grows best at an altitude of 0 -1200 m.a.s.l, with mean annual rainfall of 600 - 4000 mm and mean annual temperature of 14 - 36 degrees Celsius. • After 5 years, the tree can attain an average height of 13m. After 15 to 20 years, growth rate slows down. Thinning is recommended at 5, 10, 18 and 28 years.	The tree is propagated mainly through seed and can also be propagated vegetatively through grafting and cuttings.	The tree is used mainly for timber production and furniture. Other uses include fuelwood, charcoal, medicine, building poles, transmission poles and posts.

Gmelina arborea (Gmelina, Mwaborea)	• Gmelina arborea is a deciduous exotic tree species that attains a height of 30m, a diameter at breast height (DBH) of approximately 80cm and a clear bole of 6 - 9m. • Gmelina grows best at an altitude of 0 - 1400 m.a.s.l. and average annual rainfall of 750 - 1800 mm. The tree does well in fertile, well-drained loam soil.	Gmelina is mainly propagated through seed.	Gmelina is used mainly for timber. Other uses include pulp, fodder, particle board, dye and as forage for bees.
Calliandra calothyrsus (Callianda)	• Calliandra calothyrsus is a small, leguminous tree with characteristic pink flowers. It grows in a wide range of climatic and soil conditions, from sea level to the highlands. • Calliandra, being a leguminous species, has root nodules that fix nitrogen from the air. • Calliandra has a deep root system. When planted along soil conservation structures, it plays a significant role in holding the soil together. • If left to grow uncut, calliandra produces quality fuelwood.	-	Calliandra improves milk production of both dairy cattle and goats. It can also be fed to other types of livestock such as sheep, rabbits and chicken. A cow needs to be fed with roughly 6kg of fresh leaves per day, whilst a goat requires about 0.7kg. In order to harvest 6kg fresh leaves every day, 500 calliandra trees need to be planted at a spacing of 0.5m (1½ ft), creating 250m (800 ft) of hedge.
Gliricidia sepium (Mother of cocoa, Mexican lilac, quikstick)	• Gliricidia does well in a wide range of soil types but particularly flourishes on fertile soils. It tolerates acidic soils (pH 4.5–6.2), high clay content soils and poor, degraded, infertile soils under rain fed conditions. • A range of 15–30 degrees Celsius and 600–3500 mm of rainfall is best: from the semi-arid subtropics to the wet tropics. • The altitude requirement is 0–1600 m.a.s.l.	Gliricidia is best propagated from seed. Stem cuttings can also be used, but do not give very good establishment rates.	Enhances soil productivity, produces high-quality green manure and may contain as much as 4% nitrogen (N) in its leaves. This in turn, increases crop yields and improves nutrition for cattle. It is also a good source of bee forage for honey production and it controls striga weed.
Other tree species to consider: • Leuceana leucocephala • Papaws			
Source: KEFRI Capability map for growing high value tree species in the coast region of Kenya (2015)			

Table 13: The options for different cover crop species, including a description of their ecological features, mode of propagation and uses

Species	Ecology	Uses
Cajan cajan (pigeon pea)	• Pigeon pea (*Cajanus Cajan*) is a grain legume crop in the family Fabaceae. • It does well in temperates between 18 - 38 degrees Celsius, with an annual rainfall range of 600 - 1000mm, also flowering well at 1500 - 2000mm. Excessive rainfall can cause flowers to die and increase disease incidences. Dry weather is needed for harvesting. • It thrives well in soil at a pH of 5 - 7. It is very sensitive to high salinity and does not tolerate shallow and water logged soils. • The crop can be intercropped with other crops like maize, sorghum, cowpeas, beans, cassava, etc. • It is cultivated in the semi-arid tropics. In Kenya, pigeon pea is the third most widely grown pulse crop.	As a leguminous plant, pigeon pea increases soil fertility. It is also a source of food. Both the green and the dry pulses are consumed locally or exported in other countries like Tanzania, Malawi etc.
Lablab purpureus (Lablab dolchos)	• Lablab dolchos grows well at altitudes between 0 - 1,800m.a.s.l. • It is easily intercropped with cotton and cereals such as maize and sorghum. • Although susceptible to pests and diseases, lablab is drought tolerant.	As a cover crop, Lablab established well and provides cover for 3 months. It is a herbaceous leguminous crop with multiple uses. It is a source of food and fodder.

Why are leguminous plants so important?

Establishment of leguminous shrubs is essential in soil erosion control and nitrogen fixing.

Key benefits and considerations:

- They can be used for fodder especially during the dry season when other pasture is scarce.
- Where the farmer does not livestock, they may use the trimmed branches as mulch.
- The number of hedge rows to be planted is determined by the number of animals kept by the farmer. If the farm is large, then more rows may be established to cater for the livestock needs as per the number of animals kept.

Other considerations:

Machinery, tools, labour, and inputs

Based on the context analysis it is expected that farmers will continue using family and hired labour. The level of mechanization will also remain low as currently most of the production processes are done manually.

Functional group, plant type, succession, strata

The regenerative practices will be adopted in spatial arrangements where the selection of species, spacing and management are critical success factors (see figures x,x, and x). Some practices will be adopted on rotational manner (e.g. improved fallow). Each farm will have to develop a clear rotational plan to guide rotation of cotton, other crops and regenerative practices.

The Model Farm will demonstrate the above.

Potential livestock integration

Farmers in Taita Taveta County keep different types of livestock, mainly goats, poultry and local Zebu cows. The context analysis revealed challenges around feeding and manure management.

Along with the integration of fodder trees and pasture, capacity building on feed formulation and proper management and application of farm yard will be needed to enhance productivity and farmers livelihoods.

2.8 Implementation and management plan

2.8.1 Implementation plan

ACTIVITY	2022					2023									Resources Needed	Responsible
	A	S	O	N	D	J	F	M	A	M	J	J	A	S		
Development and approval of cotton establishment design															Finalised design	reNature
Preparation and sharing of lead farmer selection criteria															Stationery	reNature
Selection of lead farmers for Model Farms															Farmers pre-selection criteria	Labl
Sensitization of lead farmers and extension officers on basic skills for regenerative agroforestry in cotton															Stationery, transport and meals	reNature, Labl
On-site training and preparation of planting															Finance, spade, wheelbarrow, hoe, organic material	reNature, Labl
Preparation of cotton farm															Hoe, tractor, oxen	Farmer, reNature
Design and construction of soil erosion control structures															Hoe, a-frame, measuring tape, labor	Farmer, reNature
Sourcing for planting seeds (cotton, cover crop, pasture)															Finance, transport	Labl
Demarcation and digging cotton planting holes															Hoes, string, measuring tape	Farmer, reNature
Demarcation and digging of long term tree holes															Hoes, string, measuring tape, machete	Farmer, reNature

ACTIVITY	2022					2023									Resources Needed	Responsible
	A	S	O	N	D	J	F	M	A	M	J	J	A	S		
Application of manure in the planting hole															Wheelbarrow, spade, manure	Farmer, Labl
Procurement of recommended tree species (one foot high)															Finance, transport	Labl
Direct seeding of cotton															Cotton seeds, hoe, Labor	Farmer
Transplantation of tree seedlings															Hoe, manure, tree seedlings, Labor	Farmer
Thinning and gapping															Dibbler, labor	Farmer
Plant pasture grass - *Bracheria spp*															Bracharia seed, hoe, labor	Farmer
Weed main crop - cotton															Hoe, labor	Farmer
Plant and manage cover crop															Hoe, labor	Farmer
Pruning	To be done in the second or third year														Hand saw, pruning saw, machete	Farmer
Coppicing/ Pollarding	To be done in the third or fourth year														Hand saw, machete, axe, power chain saw	Farmer
Follow-up and technical backstopping															Finance, transport	reNature, Labl

2.8.2 Management plan

Recommended management practices	2022			2023									Details
	O	N	D	J	F	M	A	M	J	J	A	S	
Strengthening the extension system for cotton growers													Training lead farmers and extension service providers on best practices forregenerative cotton production.
Land preparation													Minimum tillage is recommended to reduce instances of erosion, however if tilling is needed, this should be done before the onset of the long rains.
Direct sowing of cotton seeds													Seeding holes are prepared at a spacing of 100cm between rows and 30 or 60cm between plants. Plant 1 - 2 seeds per hole.
Water harvesting and conservation													The farmer will establish structures for water harvesting on the farm. This will include run off, which will support cotton growth in the dry season. Mulching and cover crops will minimize loss of water through evaporation.
Thinning and gapping													This involves reducing the plant population to allow one plant per hole as per the recommended spacing. The thinned seedlings will be used to fill gaps in areas where there was poor germination.
Weed control													Weeding should be done whenever undesired plants grow in the cotton field. Mechanical weed control may be done at the early stages of the plant growth. However, mulching or cover crops can be used to suppress weeds.

Recommended management practices	2022			2023									Details
	O	N	D	J	F	M	A	M	J	J	A	S	
Preparation of manure and application, types include: • Farm yard manure • Compost manure • Plant tea													Manure should be applied during planting. 1kg tin of manure should be applied per planting hole. • Farm yard manure: This will be prepared by a farmer who has livestock such as cattle, goats and sheep. • Compost manure: This will be prepared by making a heap pile that contains plant residues and animal waste. • Plant tea: This will be prepared using leaves and animal waste from selected plant species. The extract will be applied as foliar spray.
Pest control													Integrated pest management is the best approach under regenerative agroforestry. Crop traps are planted to attract destructive pest away from the cotton plant.
Procurement of planting material and establish of permanent soil cover													• Mulching: This involves laying plant residues on the soil surface of the cotton field. It is necessary to reduce incidences of soil erosion, improve soil moisture retention and soil structure. • Cover crop: This involves planting a leguminous plant that is non-climbing such as cowpeas or soya beans. Whereas the cover crop protects the soil from erosion, it contributes to nitrogen fixing and weed control in the cotton farm.
Managing cover crops													This will involve controlling climbers so that they do not affect the main crop. For some, such as black beans, pods will be harvested in order to leave the plant in the field as mulch.

Recommended management practices	2022			2023									Details
	O	N	D	J	F	M	A	M	J	J	A	S	
Management and maintenance of soil erosion control structures													The registered farmer on the site will be required to make regular maintenance of the erosion control structure especially after heavy rainfall. This is through removal of silt deposit.
Cotton harvesting													This involves picking mature cotton bolls containing cotton strands.
Sourcing tree seedlings for the planting season													Recommended regenerative agroforestry tree species' seedlings are sourced ready for the planting season. Tree species are sourced to be grown as wind breaks, fodder or fruit.
Planting trees on the cotton farm													During land preparation, tree holes are planted within crop alleys and around the farm. Apply 1kg tin of manure per hole.
Pruning	To be implemented from the third year after tree were planted												As trees grow, the canopy needs to be managed which will ensure shading does not affect cotton crop performance.
Coppicing/ pollarding	To be implemented from the third year after tree were planted												As the cropping season comes to an end, trees are managed to reduce risk of damage to the intended crop. • Coppicing: Cutting down a tree close to the base to allow for re-sprouting. Used to harvest wood. • Pollarding: Cutting off the upper canopy of the tree to harvest wood and reduce shading.
Trimming	To be implemented from the second year after tree were planted												This is done to herbaceous shrubs planted within the cotton farm. Harvesting is done where the cut out branches are fed to livestock or layered on the soil surface as mulch

Recommended management practices	2022			2023									Details
	O	N	D	J	F	M	A	M	J	J	A	S	
Cut and carry	Fodder to be cut and used as mulch on the cotton farm or fed to livestock												Fodder species such as bracheria are grown within the cotton farm. The plant is then harvested through cut and carry to be fed to livestock and allow for regrowth.
Crop rotation or establishment of improved fallow	To be implemented at the end of the cotton crop season												At the end of the cotton crop season, the farm should be used to cultivate a different crop to break the disease or pest cycle associated with cotton. • Crop rotation: A different crop such as a grain is grown to reduce the risk of pest and/or disease accumulation. The rotation crop may be grow through relay (planted before cotton crop is cleared) or after the main crop has been cleared. • Tree fallows: After the cotton cropping season, leguminous trees are planted on the farm as a pure stand. This improves the soil health and protect it from erosion.

2.9 Key recommendations

Incorporating the proposed regenerative agriculture design into Labl's cotton supply has the potential to positively impact the lives of the local community, as well as enhancing the ecosystem. In order to secure the development of a resilient cotton value chain, Labl and its partners should follow this set of recommendations:

1

Invest in a regenerative Model Farm to act as a basis for capacity building

Invest in the establishment of a regenerative cotton model farm with the aim of serving as an inspirational and innovation tool for training farmers, staff and stakeholders.

- Regenerative practices are established and improved based on the recommended model.
- Seek partnerships with like-minded organizations to plan and execute the necessary trainings, including for instance reNature and local extension officers.
- Develop a functional training framework/curriculum to be used on the Model Farm.
- The Model Farm should incorporate livestock to demonstrate efficient farmyard manure management.

2

Invest in measures to restore soil health and productivity

- Ensure soil health is covered in capacity building sessions with farmers (please see section 2 for more details on different practices that support this).
- Support farmers to set up a demand driven seed and seedling supply system, for instance by creating links with seed vendors and suppliers and/or by establishing community-based seedling nurseries.
- Explore market incentives for adoption of agroforestry e.g certification or carbon finance instruments.
- Strengthen linkages with research institutions promoting regenerative and organic farming in Kenya e.g Organic Institute of Kenya and Baraka College.

3

Establish a functional cotton value chain

Cotton production will require certified and quality inputs (seeds), technical info on agronomic practices and specific management practices including post-harvest management and marketing services.

- Labl should conduct a stakeholder mapping of the cotton value chain to identify key actors and explore different partnership structures, for instance the public private partnership model.

4

Strengthen organizational capacity of farmers

As the basis of proper professional infrastructure, farmer groups and cooperatives should be supported to strengthen their leadership, management and extension service systems. Labl should support the development of local farmer organizations (e.g. cooperatives) to ensure the delivery of effective extension services. To this end, Labl could:

- Map and recruit existing farmer organizations.
- Set criteria to help groups/coops identify and recruit suitable farmers.
- Sensitize them to regenerative cotton and Labl's business venture as a whole.
- Support them to develop business/actions plans.
- Contract committed farmer organizations. Where farmers are not in groups, recruit them whilst also encouraging them to form or join existing groups.
- Carry out a (training) needs assessment.

- Focus on strengthening a farmer-centered extension services system, establishing a demand-driven capacity building framework.
- Provide a reliable market for the farmers' produce.
- Put in place demand-driven and sustainable instruments for access to inputs.

5 **Strengthen extension service systems**

Provide support to boost farm level cotton production by investing in extension services at the company and cotton out growers' level.

- Labl should strengthen the delivery of extension services by employing its own extension staff, with the view to support cotton cooperative societies to develop their own later down the line. This approach will ensure that support to farmers can be delivered on demand.

6 **Facilitate participation in the cotton value chain**

Develop a set of incentives to facilitate participation in the cotton value chain.

- Incentives could include training, assistance on input procurement support in the development of additional income through complementary crops.
- Labl needs to develop strategies and guidelines on effective sensitization and training.

7 **Enhance participation of young people in agricultural value chains**

Prioritize the inclusion of young people in engagement strategies.

- As part of the incentive scheme, promote and integrate low cost nature-based enterprises within or adjacent to cotton fields, based on the needs and priorities of young people. Enterprises should leverage technology, not require large pieces of land and have short payback periods.
- Explore the different roles young people could fulfil in cotton value chains, for instance management of digital platforms for monitoring plant health or capacity building, transport services, input supply, marketing, etc.

8 **Explore options to verify good practices by farmers**

It is important to consider different options to verify sustainable practices by farmers to ensure they have access to any relevant premiums.

- Explore the available options to verify sustainable agricultural practices (see Annex 1 for a comprehensive list).
- Incorporate monitoring and evaluation techniques on the Model Farms so environmental and socio-economic outcomes can be verified. Consider linking this data to ecosystem service credits where possible.
- Consider designing a voluntary environmental or sustainability certification program which is tied to financial incentives or premiums. This could enhance adoption of sustainable farming practices and at the same time enable them earn an extra income from the certified product market.

9 **Establish a long working relationship with key stakeholders**

In order to sustain the participation of farmers, a relationship with key stakeholders and value chain actors (for instance agro-input suppliers and Kenya Wildlife Service) must be established. This will build confidence among farmers to continuously invest in cotton production based on a guaranteed market.

Agro-input suppliers are important for the supply of inputs including seeds, farm equipment and tools.

Engagement with them will enable farmer organizations to enter in business agreements that can enhance access to inputs on affordable terms.

10 **Explore options to manage human-wildlife conflict**

Communities living adjacent to Tsavo National park face challenges when wildlife encroach onto their fields, destroying the little they have to support their livelihoods.

- In consultation with Kenya Wildlife Service, Labl should negotiate to find a lasting solution to the wildlife challenge among community members.
- This should also be a topic covered in capacity building sessions. Farmers must be aware that their choice of species selection can mitigate attacks from wildlife.

11 **Develop a strategic business roll-out plan**

When developing an ongoing business plan, Labl should always ensure that the following economic, social and environmental sustainability elements are taken into account:

Table 14: Economic, social and environmental sustainability considerations to be taken into account for business strategy

Economic sustainability	Social sustainability	Environmental sustainability
• Production of quality cotton crop and products • Adoption of good agronomic practices • Safety of actors in the value chain • Financial stability of the business at all levels • Supply chain efficiency • Risk management framework	• Sharing of best practices • Value workers welfare • Invest in training and capacity development • Health and safety of farmers and associated workers • Care of animals, livestock integration • Strengthening farmers organisations, management, governance, service provision systems and voice	• Environmental protection • Water conservation • Land and soil management • Care of nature and biodiversity • Decent work environment • Sustainable use of energy • Climate change adaptation and mitigation measures • Reduced use of chemicals

An ongoing business plan should include the following:

- Farmer recruitment process and engagement framework
- Farmer organisational models
- Extension models and farmer support services
- Government engagement
- Other key partnerships
- Regenerative cotton model

3. Conclusion

The context analysis has demonstrated that the integration of regenerative agriculture practices will greatly enhance the development of the cotton value chain in the region. Not only are the climatic conditions suitable for cotton production in Taita Taveta, but the assessment revealed that farmers have a real interest in growing it.

However, it must be acknowledged that the success of regenerative cotton depends on the acceptance and engagement of the farming community. Farmer awareness, level of education, attitude to risk, size of farms and other relevant factors must be considered and understood and incorporated into transformational capacity building to facilitate the transition.

To this end, support to potential growers must be at the forefront of all ongoing business strategies. Attention must be place on bridging capacity gaps by disseminating the right guidance through robust extension structures. The technical insights provided in this report will be vital in engaging farmers to incorporate the appropriate practices to ensure not only environmental, but economic outcomes. The design has the potential to facilitate optimum productivity, which will attract more private investment to further develop the value chain.

Functional markets will motivate more farmers to participate in cotton farming by demonstrating viable livelihood transformation.

The improvement of soil health will be key in achieving higher yields and income. This topic must be covered in capacity building sessions.

Using this replicable design, Labl should develop a (or several) model farm(s). This will provide the perfect platform to demonstrate best practices, where farmers learn in a practical and experiential setting. Once this implementation phase has taken place, farmers will have the tools to incorporate these practices in their own plots. A streamlined cotton input supply mechanism will heal the challenge of input quality and access farmers experience currently

Labl are embarking on a pioneering venture with great potential for huge impact, both environmentally and socio-economically. It is an initiative that will contribute to vital industrial development which forms a significant part of Kenya's Vision 2030. Realizing this transformational cotton value chain will take time, but will ultimately vastly improve the livelihoods of the local community and the local environment.

4. References

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Taita Taveta County Integrated Development Plan (2018 – 2022)

Annex 1 : Global Sustainable Cotton Initiatives

Table 15: An overview of global sustainable cotton initiatives, including regenerative and organic certifications.

Initiative	Overview
Regenerative Organic Certified (ROC)	In 2018, the Regenerative Organic Alliance created the Regenerative Organic Certification (ROC). ROC is a holistic, high-bar certification for food, fiber, and personal care products. The certification encompasses three pillars - soil health, animal welfare, and social fairness - all of which affect and impact each other. Regenerative Organic Cotton prohibits synthetic inputs like fertilizers, herbicides, and insecticides and prohibits the use of GMOs. ROC requires farmers to actively build soil health and organic matter on their land, conserve water, reduce soil disturbance, build habitats, and provide fair and comfortable working conditions. ROC addresses the full range of issues that plague conventional cotton, like intense water use, soil degradation, and unfair labor practices.
Organic Content Standard (OCS)	The Organic Content Standard (OCS) is a chain of custody standard that provides companies with a tool to verify that one or more specific input material is in a final product. It requires each organization along the supply chain to take sufficient steps to ensure that the integrity and identity of the input material is preserved.
Global Organic Textile Standard (GOTS)	The Global Organic Textile Standard (GOTS) is a processing standard for textiles made from organic fibers. It defines high-level environmental criteria along the entire organic textiles supply chain and requires compliance with social criteria as well.
Better Cotton Initiative (BCI)	Better Cotton Initiative sets out to improve the sustainability of mainstream cotton production. Growers must meet core environmental and social requirements for their cotton to qualify as Better Cotton. A continuous improvement is a key element of the Assurance Program.
Sustainable Cotton Project	The Sustainable Cotton Project works with California cotton growers to reduce the harmful impacts of pesticide use from cotton production on the air, water and soil in the region and to market the cotton they grow in the project as Cleaner Cotton
Cotton made in Africa	Cotton made in Africa is an initiative of the Aid by Trade Foundation (AbTF) that helps African smallholder cotton farmers to improve their living conditions. Growers must meet core environmental and social requirements for their cotton to qualify as CmiA.
Fairtrade	Fairtrade changes the way trade works through better prices, decent working conditions and a fairer deal for farmers. The Fairtrade standards require farmers to organize in democratic producer organizations and environmentally sound agricultural practices. It ensures the Fairtrade Minimum Price and Fairtrade Premium.

Field to Market	The Alliance for Sustainable Agriculture is a diverse, multi-stakeholder initiative working to catalyze opportunities across the agricultural value chain for continuous improvements in environmental outcomes. It provides a common framework for sustainability measurement that row crop farmers and the supply chain can use to better understand and assess performance at the field, local, state and national levels. Field to Market's programs helps the food and agricultural value chain benchmark sustainability performance, catalyze continuous improvement and enable brands and retailers to characterize the sustainability of key sourcing regions as well as measure and report out on progress against environmental goals.
ISCC	ISCC is applicable to all field crops, including cotton. ISCC ensures that crops are not produced on land with high biodiversity and high carbon stock. Good agricultural practices are applied to protect soil, water, and air, and that human, labor, and land rights are respected. Supply chain traceability is ensured. There are specific approaches to help smallholders. Non-GMO certification and verification of GHG emissions are optionally available.
myBMP	The myBMP (Best Management Practices) program is the Australian cotton industry's environmental and social standard. To achieve full certification, growers must comply with more than 325 checklists items across 10 modules including soil health, water management, natural assets, pest management, energy efficiency and worker health and safety.
REEL Cotton	The REEL Cotton Program is a three-year modular program for farmers with Sustainable Agricultural Practices (SAP) at its core. It has four key focus areas: • Agronomic training • Social mobility and engagement • Supply chain verification • Brand reputation
ABRAPA	The Brazilian Responsible Cotton program - ABR, is the union of cotton growers in favor of a more sustainable cotton production in Brazil, focused on the progressive evolution of good agricultural, social, environmental and economic practices.

Annex 2: The regenerative paradigm

A regenerative mindset considers the world to be built around reciprocal and co-evolutionary relationships, where humans, other living beings and ecosystems depend on and shape one another. The regenerative perspective believes that the interconnected social and environmental challenges we face can only be addressed by the restoration and rebalancing of these relationships - shifting from a model of extraction to regeneration.

The regenerative paradigm can guide our approach in cotton production systems in the following ways:

- **Nurture relationships within and across ecosystems** between people, land, water, animals and even microbial life in soil.
- **Prioritize soil health** by enhancing the biological structures that bacteria, fungi, and other soil microbes build underground which provide above-ground benefits in return. By feeding the soil, regenerative farmers feed their crops.
- **Reduce reliance on synthetic inputs,** such as herbicides, pesticides and chemical fertilizer, by opting for regenerative soil preservation techniques. Use of organic inputs will increase the number of beneficial insects and microorganisms, thereby supporting decomposition to unlock more nutrients for crops. In addition to the environmental benefits, a reduction in the use of toxic chemicals will have a beneficial impact on health, whilst also facilitating financial independence by releasing farmers from the recurring costs of synthetic inputs.
- **Nurture communities and reimagine economies** by bringing key social sustainability topics to the table. It essential for all workers associated with farming to be paid fairly and be involved in decision making. Any key stakeholder must also hold a deep appreciation for social and historical contexts, and take these into account in ongoing strategy.
- **Build resilience** by diversification of crops and the integration of livestock. For cotton, this could be any number of complementary crops, including cowpeas, soya beans, sorghum and maize. These practices will build resilience against climatic and economic shocks.
- **Circular thinking** in agriculture is an ecological concept based on the principle of optimisation of all biomass and residues from livestock and crop systems. Circular agriculture aims at closing the loop of materials to reduce resource use and pollution. Farmers can employ circularity by following the three principles below:
    1. Focus on the importance of benefiting from **natural processes** while limiting external (hazardous) inputs.
    2. Focus on **resource efficient** processes that promote an efficient cycling of nutrients, energy and water.
    3. Turn **waste streams** into **valuable inputs** for the food production chain.

Annex 3: Projected production volumes of cotton and other by-products (yields and prices)

Cotton production in Kenya was high in 1980s to early 1990s. Following the collapse of the ginnery industry, market became a challenge hence production dwindled. This was exacerbated by the importation of second hand clothes. Cotton production varies from one region to the other. It is also determined by the variety planted.

Assumptions for gross margin on 1 acre of cotton production

- Hole size- 0.5ft x 0.5ft
- Rotation at 1 year
- Sale price per kg of cotton @ KES 80
- Land preparation (oxen or tractor) @KES 3,000
- Digging planting hole @KES 2,400 per acre
- Labor planting @KES 300 per man-day
- Cotton price per kg @ KES 50
- Product: Cotton Lint

Table 16: Gross margin for cotton under regenerative practices

Item/activity			Year 1	Year 2	Year 3	Year 4
	Quantity	Unit cost	Total amount	Total amount	Total amount	Total amount
Cotton seed	6	80	480	-	480	-
Fertiliser (DAP 50kg)	1	5,500	5,500	5,500	5,500	5,500
Bean seeds	20	200	2,000	4,000	2,000	4,000
Harvesting bags	12	60	720	720	720	720
Manure (tons)	1	1,200	600	-	600	-
Sub-total			**9,300**	**10,820**	**9,300**	**10,220**

Table 17: Total costs associated with field operations over 4 years

Field operations			Year 1	Year 2	Year 3	Year 4
	Quantity	Unit cost	Total amount	Total amount	Total amount	Total amount
Land preparation (ploughing 1 acre)	1	3,000	3,000	3,000	3,000	3,000
Making holes	1	2,400	2,400	-	2,400	-
Planting cotton (Man-days)	4	200	800	-	800	-
Weeding (Man-days)	10	300	3,000	3,000	3,000	3,000
Harvesting cost	20	300	6,000	-	6,000	-
Planting beans as cover crop	6	300	1,800	-	1,800	-
Planting beans for crop rotation	10	300	-	3,000	-	3,000
Harvesting beans	10	300	3,000	3,000	3,000	3,000
Sub-total			**20,000**	**12,000**	**20,000**	**12,000**
Total			**29,300**	**22,820**	**29,300**	**22,220**

Table 18: Expected net income from cotton and beans harvested

Income			Year 1	Year 2	Year 3	Year 4
	Quantity	Unit cost	Total amount	Total amount	Total amount	Total amount
Cotton harvested and sold (kg)	800	52	40,000	-	60,000	-
Beans harvested (bags)	2	8,000	16,000	48,000	32,000	64,000
Total income			56,000	48,000	92,000	64,000
Total costs			29,300	22,220	29,300	22,220
Expected Net Income			**26,700**	**25,780**	**62,700**	**41,780**

Table 19: Cost estimation for establishing a regenerative cotton farm

Activities	Description	Frequency	Units	Unit cost (KES)	Total cost (KES)
Selection of lead farmers where demonstration sites will be set up	Identification of host farmer using predefined criteria	1	1	2,000	2,000
Sensitization of lead farmers and extension officers on basic skills on regenerative agroforestry in cotton	5 days training of lead farmers and extension officers	5	10	3,000	150,000
Onsite training and preparation for planting manure	Mobilizing material and making manure heap	1	10	2,500	25,000
Preparation of cotton farm	Clearing and tilling one acre of land	1	1	3,000	3,000
Design and construction of soil conservation structures	Establishment of soil conservation measures based on technical specifications	1	10	3,500	35,000
Source seeds	Source viable planting seed for cotton, cover crop, pasture	1	1	2,000	2,000
	Source viable planting seed for cover crop	1	1	2,000	2,000
	Source viable planting seed for pasture	1	1	1,000	1,000
Preparation of cotton planting holes	Demarcate and dig planting holes for direct seed sowing	1	1	2,000	2,000
Preparation of tree planting holes	Demarcate and dig long term tree holes	1	25	30	750
Application of manure in the planting hole	Labor for manure application into the cotton planting holes (man-days)	10	1	300	3,000
Procure recommended tree species	Source tree seedlings (1.5 feet tall)	1	25	30	750
Direct seeding of cotton	Labor for drilling cotton seed	1	10	300	3,000
Transplant tree seedlings	Labor for transplanting tree seedlings	1	1	300	300
Thinning and gapping	Labor for thinning and gapping	1	1	300	300
Planting pasture grass – Bracheria spp	Labor for planting fodder	1	1	300	300
Weeding main crop - cotton	Labor for weeding cotton farm	2	4	300	2,400
Plant and manage cover crop	Labor for planting cover crops	2	4	300	2,400
Follow up and technical backstopping	Technical advise on implementation of regenerative agroforestry practices	2	1	29,000	58,000
Crop rotation or establishment of improved fallow	Labor for establishment of another crop on the cotton farm after harvest	1	1	2,000	2,000
Subtotal 1					**295,200**

Materials and tools					
Activities	**Description**	**Frequency**	**Units**	**Unit cost (KES)**	**Total cost (KES)**
Cost of cotton seed	-	-	6	100	600
Cost of tree seedlings	-	-	25	20	500
Cost of fodder seed	-	-	1	1,000	1,000
Tools (Hoe, machetes, Spade)	-	-	6	400	2,400
Planting fertilizer	-	-	1	5,500	5,500
Cost of Gunny bags	-	-	30	70	2,100
Subtotal 2					**12,100**
Other costs					
Stationery	-	-	10	150	1,500
Communication	-	-	1	12,000	12,000
Subtotal 3					**13,500**
Total (1+2+3)					**320,800**

Annex 4: The link to Labl's value chain

Kenya cotton value chain

The Kenyan textile and apparel value chain consists of many different value chain actors illustrated in the figure below.

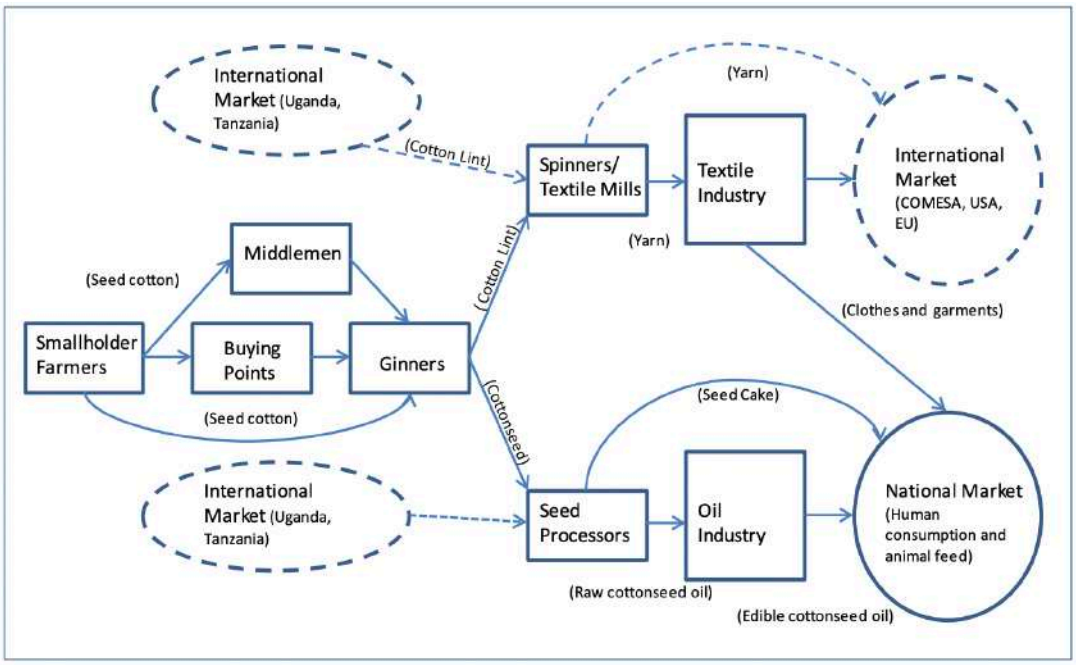

Figure 5: Simplification of Kenya's Cotton Value Chain

Source: Monroy L, Mulinge .W. Witiver.M (2012). Analysis of incentives and disincentives for cotton in Kenya. Technical notes, FAO, Rome.

The key value chain actors are:

- **Producers**: Cotton production is mostly conducted by smallholder farmers. In some cases, cotton farmers receive free seeds from the government, other farmers' source inputs from agro-input dealers or their local ginneries at a higher cost. Cotton is generally harvested and sorted manually. Thika textiles has provided some seeds for farmers in Taita Taveta.
- **Ginneries:** After harvest, cotton is sold to local ginneries that separate seed from fiber to produce cotton lint. The majority of ginneries purchase seed cotton directly from the farmer while other seed cotton is sourced through agents. Part of the ginned cotton seed is used for replanting and the remainder is crushed by oilseed processors to make seed cakes for animal feed and edible oil which has high demand.
- **Spinners:** After ginning, cotton lint is sent to yarn spinners (or integrated textile mills) for further processing.

Determinants of fiber quality

Fiber properties primarily depend on:

- **The variety of cotton:** This is the most important factor as it determines nearly of the quality parameters

- **Agro-climatic conditions:** Climatic conditions and management practices are critical for length parameters, maturity and strength. Fibre thickening is affected mainly by temperature and radiation. Micronaire (see definition below) correlates directly with the amount of photosynthesis observed 15-45 days after flowering.
- **Crop management practices:** Since the fibre is primarily cellulose, fluctuations in plant photosynthesis and carbohydrate production will affect fibre growth and development. Application of good agronomic practices and adoption of regenerative practices will provide a suitable environment for better cotton fibre quality.

Simple classifications for seed cotton quality

Kenya Fibre Crop Directorate has set two simple classifications for seed cotton. Grade A is of “superior quality” while Grade B is of “lower quality.” However, these differences are not well-defined. A lack of clear standards and training results in farmers struggling to sort accurately.

- Sorting is based on feel and appearance, considering factors like color, average fiber length, and degree of contamination.
- Grade A cotton earns almost twice the minimum price as Grade B.
- Low prices for Grade B cotton can exacerbate cycles of low returns that drive farmers away from cotton cultivation.
- Both dry weather and pests reduce cotton quality. The standards do not prescribe any environmental or climate-smart practices that could mitigate these effects.
- The Fibre Crop Regulations stipulate that inspectors and county governments should monitor cotton growing. It does not however provide any explanation on how this should be conducted.

Instrument based fibre quality determinations

The instruments based fibre quality measurements are performed by high volume, precision instruments. This method is commonly referred to as **"HVI" classification.** These instruments are used to measure, fibre length, fibre strength, fibre length uniformity, micronaire and color among others as described below:

1. **Fiber Length** is the average length of the longer one-half of the fibers (upper half mean length). Fiber length is largely determined by variety but the cotton plant's exposure to extreme temperatures, water stress, or nutrient deficiencies may shorten the length. Excessive cleaning and drying at the gin may also result in shorter fiber length. Fiber length affects yarn strength, yarn evenness, and the efficiency of the spinning process.
2. **Length Uniformity** affects yarn evenness and strength, and the efficiency of the spinning process. Cotton with a low uniformity index is likely to have a high percentage of short fibers. Such cotton may be difficult to process and is likely to produce low-quality yarn,
3. **Fiber Strength** is measured in grams per tex. A tex unit is equal to the weight in grams of 1,000 meters of fiber. Therefore, the strength reported is the force in grams required to break a bundle of fibers one tex unit in size.
4. **Micronaire** is a measure of fiber fineness and maturity. Micronaire measurements can be influenced during the growing period by environmental conditions such as moisture, temperature, sunlight, plant nutrients, and extremes in plant or boll population. Yarns made from finer fiber result in more fibers per cross-section, which in turn produces stronger yarns.
5. The **color** of cotton can be affected by rainfall, insects, fungi, and by staining through contact with soil, grass, or the cotton plant's leaf. Color also can be affected by excessive moisture and temperature levels while cotton is being stored, both before and after ginning. Color deterioration affects the ability of fibers to absorb and hold dyes and finishes.
6. **Trash** is a measure of the amount of non-lint materials in the cotton, such as leaf and bark from the cotton plant.
7. **Extraneous Matter** is any substance in the cotton other than fiber or leaf. Examples of extraneous matter are bark, grass, spindle twist, seed coat fragments, dust, and oil.