BASELINE ASSESSMENT OF THE COFFEE NURSERY SYSTEM IN KENYA

FINAL REPORT

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CHAPTER ONE

BACKGROUND INFORMATION

1.1 Introduction

The coffee sector in Kenya accounts for 2.2% of Gross Domestic Product (GDP) while directly and indirectly supporting livelihoods of over 6 million Kenyans and about 800,000 smallholder coffee farmers. The smallholder coffee farmers own approximately 85,000 hectares out of the approximately 110,000 hectares under coffee. While the production of coffee during Kenya's independence in 1963 was 43,778 Metric Tons (MT), it substantially increased to a high of 128,926 MT in 1987/1988. However, following the collapse of the International Coffee Agreement in 1989, the production of coffee went into a steady decline and coupled with other key challenges, production today is estimated at 42,000 MT. This has significantly reduced the income of small scale coffee farmers with the majority of them neglecting the crop.

At present, there are 5 commercial coffee varieties in Kenya: SL28, SL34, K7, Ruiru 11 and Batian. The SL varieties and the K7 have their origins in the 1930s, when the colonial British government funded the Scott Laboratories, which developed these varieties. The three are susceptible to the two major diseases of coffee namely Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR). Later in 1985, the first Kenyan variety that is resistant to the two diseases was released by the former Coffee Research Foundation (CRF), now Coffee Research Institute (CRI). This was followed by the release of Batian variety by the same institution in 2010.

In the recent years, land sub-division has resulted in continuous shrinking of agricultural land into small parcels. Consequently, some hitherto coffee farms have been lost or significantly reduced to small acreages carrying very few bushes. Considering that the bulk of Kenyan coffee is produced by small-scale farmers, it is absolutely critical that the farmer produces maximally per unit land area. This underscores the need to supply the farmers with coffee seedlings that are genetically pure and at their physiological optimum state to be planted. This baseline study seeks to characterize the current state of the coffee nursery system in Kenya and identify areas in which the sector could be strengthened.

1.1 Understanding the Partners

This initiative is jointly sponsored by a consortium of five likeminded international organizations namely: World Coffee Research (WCR), Kenya Coffee Platform (KCP), Global Coffee Platform (GCP), Solidaridad East and Central Africa and Rainforest Alliance. A brief profile of each of these organizations is provided below.

World Coffee Research (WCR) is a non-profit organization that was formed by the coffee industry in 2012 to grow, protect, and enhance supplies of quality coffee while improving the livelihoods of the families who produce it. The organization has been active in Kenya since 2015, starting with collaboration with Coffee Research Institute (CRI) on establishing a test site for an international multi location variety trial. In 2021-2025, WCR's strategic aim is to preserve origin diversity in the face of the climate crisis by accelerating innovation for coffee agriculture to enhance the productivity, profitability, and quality of coffee across major market segments in multiple, strategically targeted countries (https://worldcoffeeresearch.org).

Kenya Coffee Platform (KCP) is an inclusive County and National, multi-stakeholder and collaborative forum that seeks to provide a platform for coffee stakeholders both public and private, to freely interact, discuss, deliberate and address critical and pre-competitive issues affecting the coffee subsector. The platform serves as an inclusive forum facilitating the alignment of efforts so that they are all targeted at addressing the problems facing the coffee sub sector with the aim of improving the livelihoods of the coffee stakeholders and creating happy coffee people (https://www.sautiyakahawa.org).

The Global Coffee Platform is a multi-stakeholder membership association of coffee producers, traders, roasters, retailers, sustainability standards and civil society, governments and donors, united under a common vision to work collectively towards a thriving, sustainable coffee sector for generations to come. Established in 2016, GCP seeks to enhance farmers' prosperity with profitability of coffee production, improved livelihoods and well-being, and conservation of nature. Together with its

members and Country Platforms in coffee producing countries, GCP strives to increase the demand and supply of sustainably produced coffee in order to ensure diversity and viability in the coffee sector. With a farmer-oriented approach, GCP seeks to address the most critical sustainability challenges and contribute to greater collective impact on the livelihoods and natural environments of coffee farming communities (https://www.globalcoffeeplatform.org/about-gcp/).

Solidaridad is a non-governmental organization (NGO) that strives to understand the signs of modern times, seeking to be a Civil Society Organization (CSO) with its own place and role in society, while simultaneously interacting with Governments and markets. The organization envisions a world in which total production and consumption will be achieved in a sustainable manner with minimal interference with the mother nature, thus taking care of the current and future generations. Solidaridad embraces public-private and people partnerships (PPPP) to ensure inclusivity when testing innovations and addressing existing challenges, thus ensuring speedy but sustainable change and unmatched success in all endeavors. Globally, Solidaridad works around coffee and other 12 commodities / sectors (http://www.solidaridadnetwork.org).

The Rainforest Alliance is an international non-profit organization working at the intersection of business, agriculture and forests to make responsible business the new normal. It is an alliance of farmers, forest communities, companies and consumers committed to creating a world where people and nature thrive in harmony. Together with its allies, the Rainforest Alliance strives to protect forests, improve the livelihoods and rights of farmers and forest communities, and help them mitigate and adapt to the climate crisis (https://www.rainforest-alliance.org/about/). The Alliance works with over 400,000 certified coffee producers, mainly smallholders, in Latin America, East Africa, and Asia. It connects the farmers with responsible markets and trains them on climate-smart and regenerative growing practices that boost their yields and incomes.

The five institutions are working closely with the Coffee Research Institute in Ruiru which is charged with the sole mandate of "promoting research into and investigating

all issues relating to coffee and other agricultural and commercial systems as are associated with coffee and on matters ancillary thereto". Coffee Research Institute is therefore expected to play more than a backstopping role in safeguarding the quality of coffee planting materials distributed to coffee farmers in Kenya.

1.2 The Baseline Assessment Study

The consortium sought to undertake an assessment study on the coffee nursery system in Kenya. The study was intended to unveil information and provide reliable data on coffee planting materials in 20 coffee growing counties comprising of 16 traditional and 4 emerging coffee growing counties.

1.2.1 Baseline Study Objectives

The overall objective of this baseline study was to undertake an in-depth analysis of the quality, genetic purity, application of Good Agricultural Practices (GAPs) and the capacity for nurseries and seed lots that provide Arabica seedlings in Kenya.

The specific objectives of the baseline study were to:

1. Estimate the demand and supply dynamics of coffee planting materials in Kenya.
2. Understand the expectations and challenges prioritized by nursery operators in Kenya.
3. Identify the available opportunities that can be exploited by coffee nursery operators in Kenya.
4. Determine the key innovations that are desirable to coffee nursery operators in Kenya.
5. Determine the purity of the varieties currently being distributed in Kenya
6. Evaluate the economic and production sustainability of the coffee nurseries in Kenya.
7. Document the types of agroforestry and shade trees propagated in these nurseries.
8. Assess the level of extension support available to nursery operators in Kenya.
9. Analyse the major stakeholders in the Arabica coffee seed sector.

1.2.2 Baseline Study Hypotheses

The assessment study was guided by the following hypotheses:

1. The dynamics of demand and supply of coffee planting materials in Kenya can be established.
2. The nursery operators in Kenya have prioritized their expectations and challenges.
3. The available opportunities that can be exploited by coffee nursery operators in Kenya are identifiable.
4. The key innovations that are desirable to coffee nursery operators in Kenya are identifiable and justifiable.
5. The purity of the varieties currently being distributed in Kenya is measurable.
6. The economic and production sustainability of the coffee nurseries in Kenya is measurable.
7. The types of agroforestry and shade trees grown in these nurseries are identifiable.
8. The capacity of extension support available to nursery operators in Kenya can be determined.
9. The major stakeholders in the Arabica coffee seed sector in Kenya are identifiable.

CHAPTER TWO

LITERATURE REVIEW

2.1 Coffee Production in Kenya

In Kenya, coffee is the third leading export crop after horticulture and tea. However, coffee production in Kenya has been in a tumbling trend from 128,000 tons realized in 1987 to the current production which oscillates around 40,000 tons. More than 99% of Kenyan coffee is of Arabica type with the remaining less than 1% being Robusta. Kenyan coffee is currently being produced in 30 out of the total 47 counties (Figure 1). However, only about 20 counties are the traditional coffee growing counties while the others have embraced coffee farming in the recent decades due to cultural shift and enhanced adoption campaigns by different stakeholders.

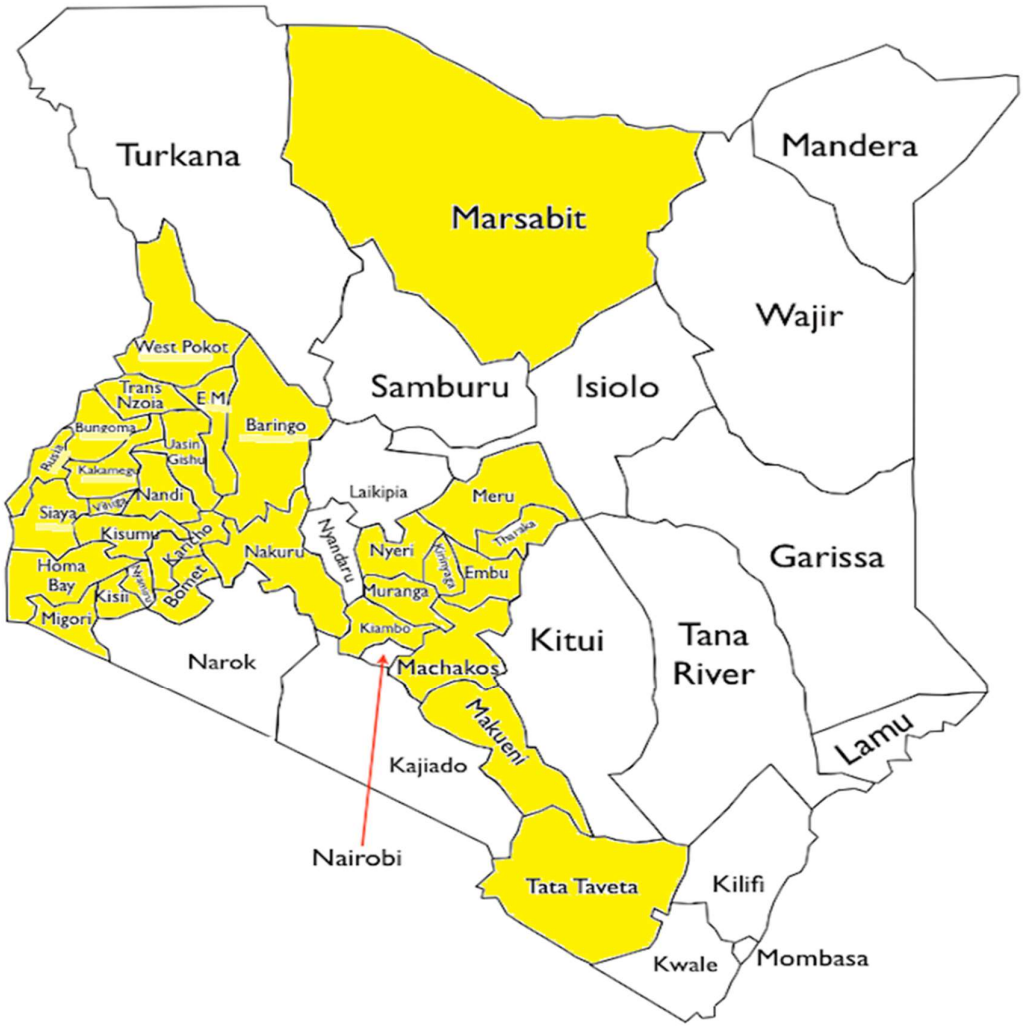

Figure 1: Coffee growing counties in Kenya

2.2 Challenges Facing Coffee Production in Kenya

Coffee growers are also faced by climate change related challenges, including extreme temperatures, harsh winds, limited or poor distributed rainfall and emergence of new pests and diseases. Since coffee can only be grown in a certain temperature range, it is highly vulnerable to the impacts of climate change. Global heating is forcing some farmers to move to higher elevations or out of the business altogether. Rising temperatures contribute to the proliferation of *Hemileia vastatrix*, the fungus that causes coffee rust, and several destructive insect pests including the coffee berry borer, coffee thrips and scales. On the other hand, low temperatures create a conducive environment for the fungus *Colletotrichum kahawae*, the causal agent of CBD (Figure 2). However, coffee farmers can enhance their resilience by planting resistant varieties and mitigating the climate change effects by adopting climate smart technologies which include growing coffee under some levels of shade (https://www.rainforest-alliance.org/insights/rainforest-alliance-certified-coffee/).

Figure 2: Severe Coffee Berry Disease on resistant Ruiru 11 coffee cultivar. This may be attributed to climate change effects, seed contamination or probably development of new and more voracious isolates of *Colletotrichum kahawae*, the causal pathogen of CBD.

2.3 Kenyan Coffee Varieties

The actual coffee breeding work in Kenya started in 1971 after the outbreak of Coffee Berry Disease (CBD) and Leaf Rust in the late 1960s. Traditional varieties released in 1930's (SL28, SL34 and K7) were mere selections and are all susceptible to the two major coffee diseases in Kenya. In 1985, the first disease resistant hybrid cultivar, Ruiru 11, was released. Further research and development culminated to the release of another disease resistant variety named Batian in 2010. Other varieties grown in Kenya include French Mission and Blue Mountain although the two are rarely propagated in Kenyan nurseries.

Due to the rising incidences of CBD and leaf rust in farmers' fields, production of the traditional varieties is almost becoming untenable and most farmers are now adopting the resistant varieties namely Ruiru 11 and Batian, though at varying preference levels. Ruiru 11 is a composite cultivar comprising of 66 hybrid sibs. The cultivar has a compact growth allowing farmers to intensify production per unit land but its sensitive to water stress unless grafted on traditional varieties. It also possesses good quality attributes comparable to the traditional varieties. On the other hand, Batian is a true-breeding tall statured and deep rooted cultivar with good tolerance to water stress but appears to be sensitive to acidic soils. It is also high yielding with excellent bean and cup quality. Both Ruiru 11 and Batian comes into production earlier (1½years) than the traditional varieties (2 years), hence earlier realization of benefits to the farmers. Due to their resistance to both CBD and CLR, the two varieties are recommended for all coffee growing areas in Kenya.

2.4 Coffee Propagation Methods

Coffee can be propagated from seeds (sexual propagation) or vegetative by use of cuttings, grafting and tissue culture. Sexual propagation brings about some variability due to exchange of gametes which takes place at fertilization during the process of seed production. This occurs even in true breeding varieties such as Batian and the traditional varieties if necessary control measures are not put in place. For this reason, production of certified coffee seeds in Kenya is exclusively done by Coffee Research Institute. Unfortunately, there could be some unscrupulous nursery operators who

harvest coffee seeds directly from their farms or obtain the seeds from other uncertified sources. Such a malpractice may end up contaminating the quality of coffee planting materials supplied to farmers and could be one of the causes of rising incidences of CBD and leaf rust infections being reported in some farmers' fields on resistant varieties as shown in Figure 2. This study was therefore important and very timely.

Being an F1 hybrid, seed production in Ruiru 11 goes through a highly specialized technical process. For this reason, there is only one Ruiru 11 seed garden in Kenya that is located at Coffee Research Centre in Ruiru unlike for the true breeding varieties (Batian and the traditional varieties) whose seed gardens are decentralized in other CRI centres in Kenya. Owing to the technical challenges associated with production of Ruiru 11 seed, its propagation can only be supplemented through vegetative propagation. The most tenable vegetative propagation method that has become very popular in Ruiru 11 is grafting which is also done to improve the root system of this compact cultivar. However, just like the seeds whose source should be certified, the source of clonal scions is equally important. Use of low quality scions would also contaminate the quality of planting materials being distributed to farmers.

CHAPTER THREE

IMPACT STUDY METHODOLOGY

3.1 Scope of Study

The baseline study covered a total of twenty (20) counties in Kenya comprising of sixteen (16) main (traditional) coffee growing counties and four (4) emerging coffee growing counties (Table 1).

3.2 The General Methodology Approach

The methodology for this study included both direct and indirect data collection, analysis and cross referencing and formulating recommendations thematically and as area/county specific. The whole exercise was undertaken under strict adherence to the COVID19 guidelines and restrictions issued by the Government of Kenya under the Ministry of Health and the Ministry of Interior.

3.3 Stepwise Methodology Approach

The consultancy team employed the following step-wise methodology during the study to ensure adequate data collection from all the relevant stakeholders:

1. Review of global best practices and new innovations in coffee nursery operations, emerging trends, technologies and practices – this provided a framework for comparison and a bench mark to measure the baseline status.
2. Review of existing relevant secondary information and reports related to the coffee nursery sector including coffee production trends, coffee production seasons, adopted coffee management practices, coffee varieties grown and how the farmers are organized.
3. Review of previous related coffee programme level documents and reports to clearly understand the objectives and needs of the nursery beneficiaries and to provide basis on which the performance of the nursery sector was measured.
4. Field visits in the main coffee growing counties in Kenya for data collection, observations and triangulation. This formed part of the primary baseline data collection on performance of the nursery sector in Kenya. The data collection was at three levels:
    a) Key Informant Interviews with selected relevant institutions
    b) Household survey at nursery level

c) Community level participatory meetings and focused group discussions

d) Non-interactive observations and photography recording of relevant features as guided by the Field Observation Checklist (FOC). Morphological appearance of the coffee seedlings was assessed and compared with known coffee descriptors. The nurseries with "suspect" seedlings were noted for subsequent sample collection for genetic fingerprinting to verify their genetic purity and quality.

5. Data analysis and verification of analysed data.

3.4 Sampling Procedure and Sample Size

The study applied multistage stratified sampling to select the nurseries to be sampled. The first stage involved purposive sampling of the coffee growing counties in Kenya. This was followed by simple random sampling to select the nurseries to be sampled from every County. This was a slight departure from the proposed methodology where the nurseries were to be clustered into three groups based on their sizes. The clustering was to be based on the data obtained from County Departments of Agriculture but it proved difficult to obtain reliable data from most of the County offices. Simple random sampling was therefore applied based on the leads provided by other relevant offices and stakeholders in the sampled counties including Cooperative Societies/Unions, local administration, NGOs and other development partners. Simple random sampling was therefore preferred because all possible samples in each County were equally likely to occur.

The sample size for the entire study was estimated using the formula of Cochran (1963) as applied by Wambua et al. (2019) as follows:

$$n_o = \frac{Z^2 pq}{e^2} \quad \text{..... (1)}$$

Where: n_0 = required sample size

Z = t value at 95% confidence level from normal table (1.96)

p = probability that respondent has characteristic being measured

q = probability that respondent has no characteristic being measured (1-p)

e = 5% level of significance

The study assumed that 50% of the respondents had the characteristic being measured. The proportion of 50% was used because it indicates the maximum variability in a population, and therefore results in a more conservative sample size i.e., the sample size may be larger than the actual sample size that would have been used if the true variability of the population was known. The targeted sample size was therefore calculated as follows:

$$n_o = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384$$

However, preliminary information indicated that there are about 250 active coffee nurseries in Kenya. The sample size was therefore adjusted using the equation recommended by Cochran (1963) for small size finite population correction as follows:

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}} \quad \text{..... (2)}$$

$$n = \frac{384}{1 + \frac{(384 - 1)}{250}} = \text{ 152 coffee nurseries}$$

Considering that 20 Counties were being sampled, this sample size would have translated to a sample of 7 - 8 nurseries per county which was hypothesized to be a good representative sample of the entire number (population) of nurseries in each County. However, since the suitability of coffee production varies with agro-ecological zones, some Counties have larger coffee growing areas than others. Therefore, probability proportional to size sampling criteria was considered during the study culminating with a final sample size of 132 coffee nurseries (Table 1).

Table 1: Counties sampled for baseline coffee nursery assessment

S/No.	Region	County	County Coffee Growing Status	Computed Sample Size	Achieved Sample Size
1	Eastern	Machakos	Traditional	5	2
2		Embu	Traditional	7	4
3		Tharaka Nithi	Traditional	7	3
4		Meru	Traditional	8	8
5	Central	Kiambu	Traditional	7	7
6		Murang'a	Traditional	6	2
7		Kirinyaga	Traditional	12	18
8		Nyeri	Traditional	8	8
9	Rift Valley	Nakuru	Traditional	8	2
10		Kericho	Traditional	8	7
11		Nandi	Traditional	8	6
12		Baringo	Traditional	8	10
13		Elgeyo Marakwet	Emerging	8	9
14		Uasin Gishu	Emerging	6	2
15		West Pokot	Emerging	4	2
16	Western	Trans Nzoia	Traditional	8	8
17		Bungoma	Traditional	8	9
18	Nyanza	Kisii	Traditional	12	16
19		Nyamira	Traditional	8	4
20		Homabay	Emerging	6	5
Total Sample Size				**152**	**132**

3.5 Data Collection Tools

The primary data was collected using well-structured questionnaires which were developed in consultation with the project team and pre-tested before the actual data collection process commenced. The questionnaires were designed to contain useful indicators for effective characterization of coffee nursery systems in Kenya.

A set of three questionnaires were used as outlined below:

1. **Household Questionnaire** (Annex II)– Used to assess and collect information on the general characteristics of the sampled nurseries. This questionnaire covered the administrative, production (technical), economic, institutional and other cross cutting issues.
2. **Key Informant Interview (KII) Guide** (Annex III) – Used to interview key personnel in selected institutions that were hypothesized to be holding vital relevant information, both current and archival, about the coffee nursery sector.

3. **Focus Group Discussion (FGD) Guide** (Annex IV) – Used to gather information from small groups (8 – 12 participants) particularly small-scale and estate coffee farmers gathered together. The FGD guide contain broad questions that were designed to elicit responses and generate discussion among the participants. The group participants were encouraged to give their perceptions, attitudes, beliefs, opinions or ideas relevant to the study topic.

In addition, a **Field Observation Checklist** (FOC) (Annex V) was developed to guide the enumerators on the type of non-interactive data they were expected to capture through observations and taking photos where possible.

3.6 Accuracy and Reliability of Data Collection Tools

A pilot study was conducted with a small sample of four (4) nurseries drawn from Kiambu County to assess the effectiveness of the questionnaire. Content analysis was done by taking a sample of the questions from each section of the questionnaire and comparing it with the anticipated outcome. The questionnaires were then revised accordingly.

3.7 Selection of Key Informant Interviewees and Focus Group Discussants

Individuals and institutions that were hypothesized to hold vital information (both current and archival) about the study were selected using purposive method. These formed part of Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Selection of these groups took into consideration their specific predetermined roles and influence in their locations or areas of jurisdiction.

3.8 Recruitment and training of the survey team

The key consideration in the recruitment of the enumerators was their adequate level of knowledge on coffee related aspects and adequate geographical understanding of the targeted area. Therefore, local enumerators were used in all the focal areas. In addition, selection of enumerators considered the candidate's level of education; fluency in the target local language, experience in undertaking similar tasks, gender inclusivity and availability of the candidate during the period of data collection. Training of the enumerators was done on-site in every county by a member of the consultancy

team. During the training, the survey team was taken through the study objectives, approaches, fieldwork procedures and processes. The training also covered study timelines, communication protocol, data quality control, modalities for handling field challenges and logistical issues. A detailed review and mocking of the study tools was also undertaken practically in one of the nurseries. The data collection process in all the counties was conducted under close supervision of the consultancy team who also conducted the key informant interviews and focus group discussions.

3.9 Data Analysis

The online generated data was downloaded and cleaned before analysis. Inadequate questionnaires were discarded after which the preliminary analysis was done using Statistical Package for Social Sciences (SPSS) software. Further cleaning was done during preliminary analysis before final analysis was carried out. Qualitative data was analysed through content and narrative analysis. Quantitative data hypothesized to influence project impact was analysed using descriptive statistical tools of percentages, means and correlations. The results are presented in frequency tables, pie charts and graphs.

CHAPTER FOUR

RESULTS AND DISCUSSION

The Consultancy team was cognizant of the major regulatory role played by the County Departments of Agriculture under the County Governments and the Coffee Directorate and therefore continuously consulted the two institutions during the study. At this point, the consultant sought to know the number of active nurseries in the area and understand the existing policies and regulations that govern the operation of coffee nurseries in Kenya. However, it became evident that the Coffee Directorate was no longer keenly following the regulation of coffee nurseries since the mandate was moved to the County Governments. On the other hand, it emerged that most of the County Governments had no packaged information about the coffee nurseries in their area. Therefore, there was no reliable data on the coffee nursery status in almost all the sampled counties.

4.1 Trend of Coffee Production in the Sampled Counties

Although the main objective of this study was to assess the coffee nursery systems in Kenya, it is obvious that coffee nurseries are usually sustained by the existing demand of the coffee planting materials in a given area. It was therefore logical to assess the trend of coffee production in the sampled areas. The data generated from the Key Informant Interviews (KII) conducted in the sampled Counties indicated that the coffee production trend has been increasing in the last three years as rated by 79% of the respondents (Figure 3). However, 17% of the respondents were of the opinion that coffee production is decreasing while 4% reported that the trend has been inconsistent.

Further interrogation revealed four factors that are limiting coffee expansion in the sampled area. Lack of quality coffee planting materials was rated as the second most important factor limiting coffee expansion in the sampled areas after poor prices (Figure 3). This is an indication that with the current improvement of coffee prices being experienced nationally, the demand of coffee planting materials is liable to increase significantly, hence the need for the coffee nurseries to be adequately prepared. This observation was backed by 67% of the KII respondents who also

anticipate a marked increase in the demand of coffee planting materials in the coming years.

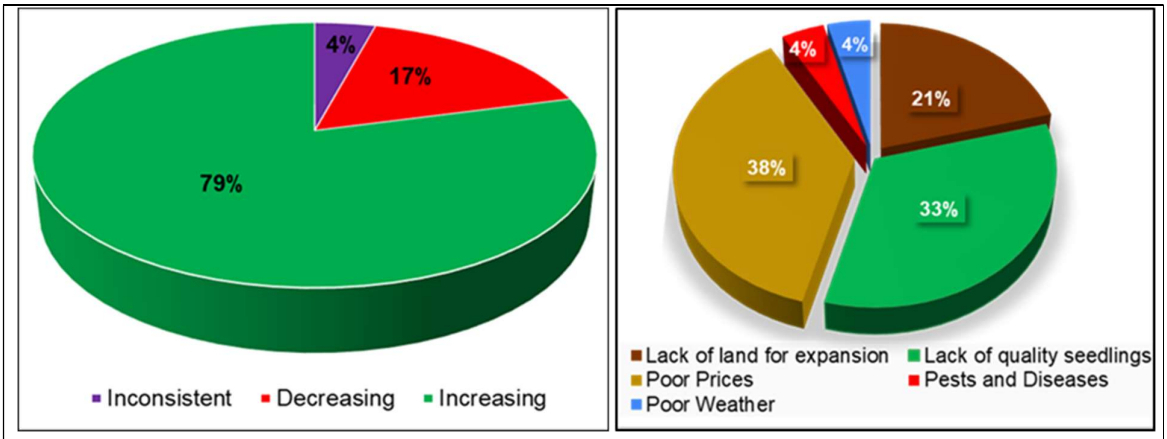

Figure 3: Trend of coffee production in the last three years (left) and factors limiting coffee farming expansion (right) in the sampled Counties. The current positive shift in coffee prices being experienced nationally may attract more farmers into coffee farming hence increase the demand for coffee planting materials.

4.2 Coffee Cultivar Preference in the Sampled Areas

In order to document variety preference in the sampled areas, we sought to know the most demanded variety in the sampled nurseries and also among farmers in the area. The two parameters showed a similar trend mainly because most of the sampled nurseries supplied the seedlings to the nearby farmers with a few instances of long distant clients. Analysis of demand of the coffee planting materials in the sampled areas showed that Ruiru 11 is currently the most desired cultivar in Kenya (Figure 4). Since some farmers have higher preference for the grafted type of Ruiru 11 than the conventional type (from seed) and vice versa, it was important to separate the demand of the two types. It emerged that the conventional type of Ruiru 11 attracted the highest demand from the farmers as it was the most demanded at nursery level and also within the sampled areas. Batian was the second most demanded variety at nursery level but its demand in the sampled areas matched that of grafted Ruiru 11 (Figure 4). Their almost equal demand among the farmers in the sampled areas may be attributed to their more or less similar desirable characteristics. They are both resistant to the major diseases of coffee in Kenya (CBD and Leaf Rust) and the grafting aspect in Ruiru 11 gives it a more extensive root system similar to that of Batian.

Among the traditional varieties that are susceptible to CBD and Leaf Rust, the variety K7 is currently the most demanded followed by SL28 (Figure 4). The former is attracting the highest demand in the West of Rift Valley especially towards Mt. Elgon in Bungoma County while the latter is more desired in the East of Rift Valley especially in the upper Eastern region (Embu, Meru and Tharaka Nithi) and some parts of Central Kenya. We observed that the SL28 is becoming popular among a new crop of farmers who are practicing single tree system. The single tree system wave has been influenced by one popular farmer in Embu who has been advocating for the system with claims that SL28 attains 100 kg of cherry per tree under that system. Undocumented information obtained from the nursery owners and from some farmers in the sampled areas showed that there is a lot of unfounded myths about the Kenyan coffee varieties that need to be addressed from a reliable source. There is therefore need for sensitization and training about coffee varieties in Kenya.

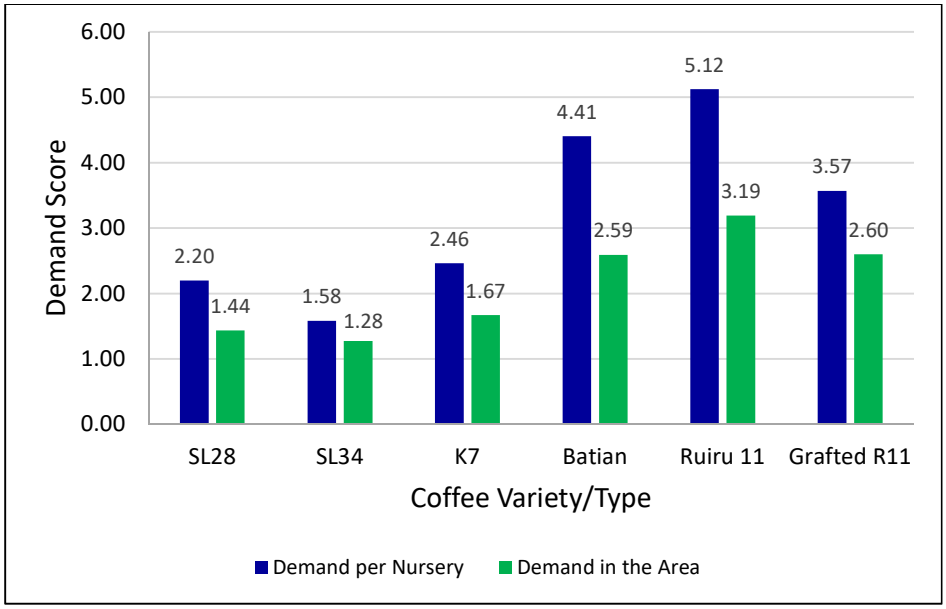

Figure 4: Comparative demand of coffee varieties in the sampled areas

We further assessed the proportion of coffee types being propagated by the sampled nurseries in order to understand whether the supply was geared towards meeting the demand. Our analysis showed that, although Ruiru 11 is currently the most demanded coffee variety in Kenya, it is not the most propagated variety among the sampled nurseries. Ruiru 11 accounted for a total of 40% (15% of seeded type and 25% of

grafted type) while Batian accounted for 45% of all the seedlings currently being propagated in the sampled nurseries (Figure 5). The remaining 15% is taken by the traditional varieties which are mainly propagated to supply rootstocks for Ruiru 11 grafting.

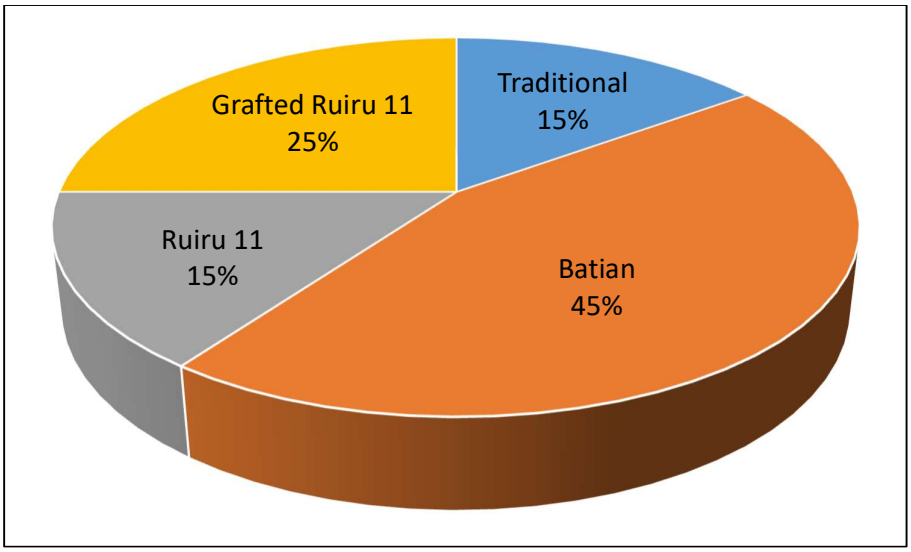

Figure 5: Proportion of Kenyan coffee cultivars propagated in the sampled nurseries

An interesting observation was that we did not encounter any single nursery with dead stock of Ruiru 11 seedlings of whichever type. However, there were many instances of overgrown Batian seedlings in numerous nurseries that had failed to secure buyers (Figure 6). This was a confirmation of the demand trends of coffee seedlings as earlier reported in this section. Considering the fact that Batian coffee was doing very well in some regions like in Kirinyaga, Uasin Gishu and Trans-Nzoia County, there is need for enhanced sensitization of the attributes and agronomic requirements of this variety among farmers. Such an effort was reported to have born fruits in West Pokot County where the Chairman of Pokot FCS acknowledged that many of his farmers had adopted the variety after being trained by CRI staff from Kitale Centre.

Figure 6: Some of the observed cases of overgrown Batian seedlings in the sampled nurseries. This was a common challenge in many Counties including Nyeri (upper left), Kirinyaga (lower left), Kisii (upper right) and Trans-Nzoia (lower right). It would be logical for such seedlings to be converted to the desired Ruiru 11 through grafting, subject to availability of scions and grafting skills. However, the affected respondents were not aware that Batian has a similar stature as the traditional varieties and would equally serve as a good rootstock.

Further analysis showed that only 13.6% of all the sampled coffee nurseries were able to fully meet their seedling orders received from potential buyers (farmers) as shown in Table 2. The remaining 86.4% who failed to meet their orders clarified that it's mainly Ruiru 11 orders that were not met. Ironically, some among them had overgrown Batian seedlings in their nurseries that were not moving. A detailed analysis of orders met showed that 53% of the respondents met less than 50% of their orders. An interesting observation was that most of those who met over 50% their orders reported that they

achieved so through grafting. In addition, advertising the nursery and its accessibility were found to have significant impact in improving the sales of the less desired varieties (Figure 7).

Figure 7: A nursery manager in Trans-Nzoia County displaying overgrown Batian seedlings (left) that are due for disposal despite the fact that there is a lot of coffee expansion taking place in the area. At the centre is a neighbouring nursery that is almost empty after selling over 80% of their Batian seedlings. Interestingly, the two nurseries are about 20 km apart but the latter maintains an open gate policy and has put a signpost (right) along the road advertising the nursery. The former is situated in a 20-acre coffee estate but no signpost along the road. This indicates the need for the nursery operators to advertise their business.

We further sought to find out the main reason that prevented majority (86.4%) of the nurseries from meeting their orders. Out of the 114 nurseries, majority (53.5%) stated that they lacked the most desired variety which was Ruiru 11, while 21.9% felt that the demand was high than their supply. The 21.9% majorly included those who were practicing grafting. A significant proportion (16.7%) of the respondents felt that lack of seeds was the major challenge hindering them from meeting their orders. These were majorly those who were not practicing grafting. Only 7.9% of the respondents acknowledged to have a low seedling production capacity (Table 2). Interestingly, lack of grafting scions was not cited as a major hindrance among those who had perfected grafting yet it was evident that the number of clonal gardens was not commensurate with the number of grafted seedlings. This was an indication that most nurseries were harvesting their scions from uncertified sources.

Table 2: Percent of orders met by the sampled nurseries

Last Season Orders	Frequency	Percentage	Remarks
Orders met	18	13.6	Only Ruiru 11 orders were not met
Orders not met	114	86.4	
Percent of orders met	**Frequency**	**Percentage**	**Remarks**
0 - 25%	39	29.5	The nurseries that met over 50% of their orders achieved so through grafting
26 - 50%	31	23.5	
51 - 75%	31	23.5	
76 - 99%	13	9.8	
100%	18	13.6	
Reason for not meeting orders	**Frequency**	**Percentage**	**Remarks**
Lack of the most desired variety	61	53.5	The most desired and demanded variety whose seeds are lacking is Ruiru 11
High demand than supply	25	21.9	
Lack of seeds for propagation	19	16.7	
Low production capacity	9	7.9	

A total of 2,815,547 coffee seedlings were distributed in the last season of April/May 2021 by 103 out of the 132 sampled nurseries. On average, only 60% of the orders were met in that season. By extrapolation, considering that there are about 250 coffee nurseries in Kenya, it is estimated that approximately 6,833,852 seedlings were distributed to coffee farmers in Kenya against the demand of approximately 11,325,575 seedlings. Since it's mainly Ruiru 11 orders that were not met, it can therefore be estimated that the current national demand for this variety is approximately **4,491,723** seedlings. This is the demand that need to be addressed by improving Ruiru 11 seed production and enhancing grafting capacity in the nurseries.

4.3 Challenges Faced by Coffee Nursery Operators

Apart from the challenges analysed in Table 2 above, the study sought to clearly unpack all the challenges that are currently being faced by the coffee nursery operators as these would inform on the potential areas for intervention. The respondents were requested to give three major challenges that they were facing in the coffee nursery business after which the prioritized challenges were ranked according to their percentage occurrence (Figure 8). Since each respondent was required to name only three biggest challenges, all the challenges featured in Figure 8 are therefore considered major (as per respondents' perception) but have been ranked for the purposes of prioritization. The most common challenge which was

highly significant was found to be lack of desired coffee seeds (19.7%) which was majorly the Ruiru 11 seed. This was followed by lack of technical skills (11.6%) both for the general nursery management as well as grafting skills. Other major challenges included unpredictable demand, pests and diseases (Figure 9), lack of irrigation capacity, lack of basic inputs, high cost of production and inadequate funds (Figure 8). Irrigation capacity was compounded to lack of reliable source of water to lack of irrigation equipment such as water pumps, storage tanks and pipes. On the other hand, the basic inputs included good quality soils, manure, river sand and recommended potting bags.

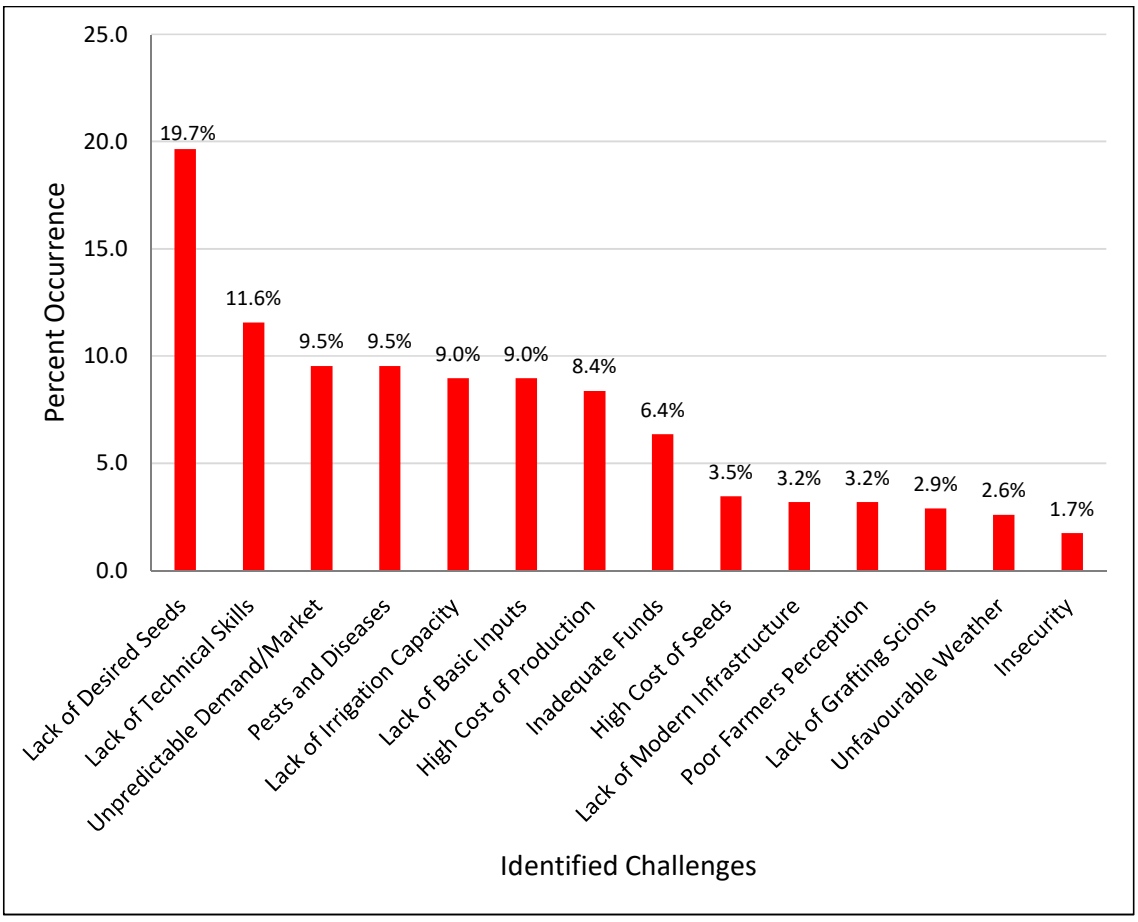

Figure 8: Major challenges identified by the nursery operators

Figure 9: Coffee nursery diseases and pests. Damping-off disease affecting coffee seedlings at germination stage (left) and young coffee seedlings affected by Leaf Rust disease in the nursery (centre). Damping-off disease is caused by soil-borne fungi and is predisposed by too much watering, poor drainage or use of infected germination medium. Leaf Rust mainly affects the traditional varieties and demands frequent spraying with fungicides. It may also infect Batian seedlings but at a lesser threshold. Scales (on the right) are among the common coffee nursery pests. Other major pests include giant loopers and leaf miners.

Other major challenges that are oppressing a relatively fewer nursery operators include high cost of seeds, lack of modern infrastructure, poor perception of farmers, lack of grafting scions, unfavourable weather and insecurity. These challenges are discussed in some other section(s) of this report. However, a quick check from Coffee Research Institute confirmed that 1 kg of Batian and Ruiru 11 seeds is sold at Kshs 7,500 (approximately USD 68) while the same quantity of the traditional varieties (SL28, SL34 and K7) is sold at Kshs 3,000 (approximately USD 27). These costs may be oppressive to many nursery operators as they are incurred at a very early stage of production and there is a high risk of losing the seeds if required propagation requirements are not observed. The high cost of seeds also contributes significantly to the cost of production considering that most of the nurseries achieved 3000 – 3500 seedlings from a Kg of seeds (see table 4).

From the results presented in Figure 8 above, it emerged that lack of desired coffee seeds (Ruiru 11 seeds) was the major challenge curtailing adequate production of the most desired coffee variety in Kenya. This is probably because Ruiru 11 is an F1 hybrid

and therefore requires a specialized way of certified seed production unlike the true breeding varieties whose seeds can be picked directly from the mother parent. However, there are other vegetative methods that can be used to propagate Ruiru 11 namely use of cuttings and grafting. Among the two, grafted seedlings are more popular among the farmers. We therefore sought to find out the percentage of nurseries that were practicing grafting as well as the challenges associated with it.

The results indicated that 38.6% of the sampled coffee nurseries were practicing grafting. Among those who are not practicing grafting, majority (53.1%) claimed that there was no demand for grafted seedlings in their area (Table 3). These are majorly the Counties in the West of Rift that are marked in red in Figure 10. The low demand of grafted Ruiru 11 seedlings in these Counties is attributed to lack of adequate sensitization among the farmers considering that most farmers in these areas were not traditionally coffee farmers. Another significant proportion (32.1%) of those who are not practicing grafting reported that they lacked grafting skills while 14.8% lacked scions for grafting (Table 3). These two challenges must be very genuine and should be among the major considerations for urgent intervention especially in the West of Rift regions.

Table 3: Grafting capacity among the sampled nurseries

Practicing Grafting	**Frequency**	**Percentage**
Yes	51	38.6
No	81	61.4
Reasons for not Grafting	**Frequency**	**Percentage**
Lack of grafting skills	26	32.1
Lack of scions	12	14.8
No demand	43	53.1
Source of Scions	**Frequency**	**Percentage**
Coffee Research Institute	20	39.2
Own Farm	28	54.9
Other Farmers	3	5.9

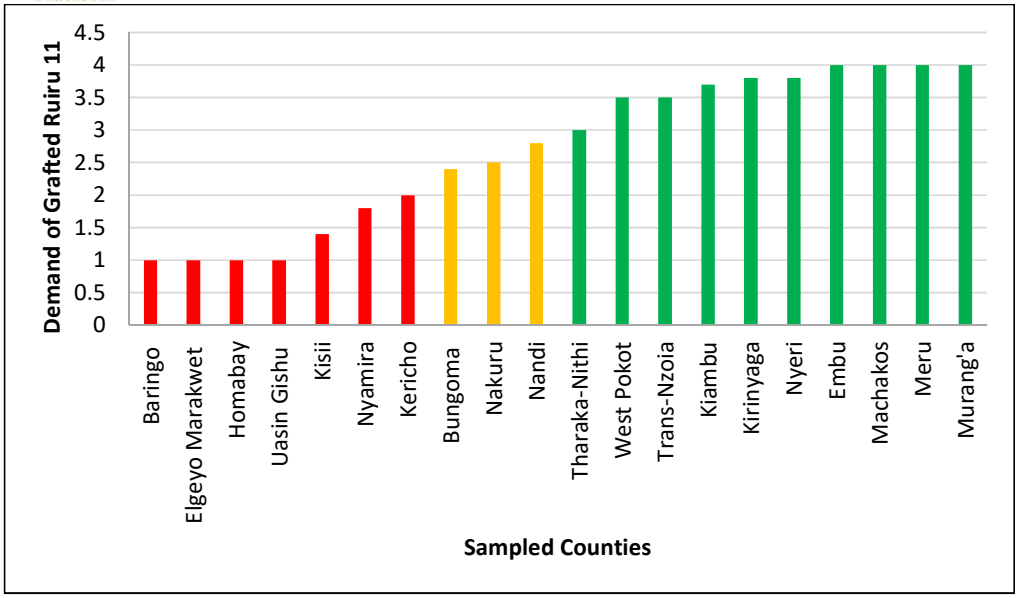

Figure 10: Demand of grafted Ruiru 11 coffee in the sampled counties. The red colour represents low demand; yellow represents moderate; green represents high demand.

There was evidence of graft failure in most of the sampled nurseries and this was seen as one of the major contributors of high production cost since the failed seedlings had to be re-grafted (Figure 11).

Figure 11: Grafting exercise taking place in one of the biggest nurseries in Kiambu County (left) and a bunch of seedlings in the same nursery whose graft union failed (right). The failed seedlings have been sorted awaiting re-grafting which significantly increases the cost of production. This confirms the need for training on grafting skills in Kenyan nurseries.

A further interrogation of those who were practicing grafting revealed that majority (60.8%) were obtaining scions either from their own farms or from other farmers but it was not possible to know which proportion of these scions were obtained from certified clonal gardens. Some of the respondents had established their own clonal gardens while some were sourcing their scions from their Ruiru 11 coffee farms with little or no selection of desirable qualities as explained by one of the respondents. A quick check with the Coffee Breeding Unit of the Coffee Research Institute confirmed that there are very few certified Ruiru 11 clonal gardens in farmers' fields in Kenya. Some of the clonal gardens that were observed in the sampled areas were poorly managed (Figure 12). Only 39.2% claimed that they were sourcing scions from Coffee Research Institute. This data may not be accurate because apparently some respondents gave false information for fear of being victimized.

Figure 12: Samples of Ruiru 11 clonal gardens in the sampled areas. The clonal trees are not properly bent to enable them to produce orthotropic shoots suitable for harvesting the scions. The gardens are also small and cannot supply the required number of scions for their own nurseries. Again, there were no records to confirm that the clonal seedlings used to establish the clonal gardens were certified (sourced from CRI).

4.4 Quality of the Coffee Varieties Being Distributed in Kenya

As a rule of nature, human beings respond to challenges by looking for all possible strategies through which the feasible solutions can be realized regardless of whether these solutions are sustainable or not. We hypothesized that lack of desired coffee seeds may have pushed some nursery operators to devise other means of getting the seeds. Our discussion with some of the key stakeholders in the coffee sector confirmed our worries as 13% of them rated the quality of coffee planting materials being distributed in Kenya as low and 58% rating the quality as moderate. Some

expressed concern over the source of coffee seeds being propagated in some nurseries in Kenya. Apparently, all the sampled nursery operators were aware that CRI is the sole source of certified coffee seeds in Kenya. Despite this, 4.5% of the respondents reported that they preferred sourcing the seeds from their own farms (2.3%), cooperative societies (0.8%), NGOs (0.8%) while 1% had no preference (Table 4). The rest (95.5%) preferred sourcing the seeds from CRI as they were assured of quality. Those who preferred other sources justified their preference with seed availability.

Further interrogation revealed that 79.5% of the sampled nurseries sourced their last batch of coffee seeds from Coffee Research Institute (Table 4). The remaining 20.5% obtained their seeds from cooperative societies (12.9%), non-governmental organizations (3%), millers and marketers (2.3%), own farms (1.5%) and private companies (0.8%). The actual source of these seeds could not be verified since CRI is the sole source of certified coffee seeds in Kenya. One of the sampled nurseries who sourced Batian seeds through a certain coffee marketing company reported that the company claimed to have sourced the seed from CRI on their behalf. However, these claims were unfounded because the supplied seeds were not in the usual packaging used for CRI seeds. This was a clear evidence of unscrupulous distribution of coffee seeds that if not curtailed will have serious quality repercussions in future.

The study further established that 65.9% of the sampled nurseries did not receive any kind of follow-up from their seed supplier after acquisition of the seeds (Table 4). These include those who sourced the seeds from CRI. Out of the 105 nurseries that sourced their last batch of seeds from CRI, only 33 nurseries (31%) received technical follow-up from CRI officers. This may have contributed to the highly variable output of coffee seedlings achieved by various nursery operators from 1 kg of coffee seeds as shown in Table 4. Information obtained from the Coffee Breeding Unit of CRI in Ruiru indicated that 1 kg of coffee seeds contains between 3,500 and 4,000 seeds with a guaranteed purity of 99% and germination percentage of 90%. The nurseries are therefore expected to obtain between 3,150 and 3,600 seedlings from 1 kg of coffee seeds. However, only 47% of the sampled nurseries were producing within this range.

Table 4: Source of seed propagated by the sampled nurseries

Last Seed Source	Frequency	Percentage
Coffee Research Institute	105	79.5
Cooperative Society	17	12.9
Non-Governmental Organization	4	3.0
Millers & Marketers	3	2.3
Own Farm	2	1.5
Private Companies	1	0.8
Preferred Seed Source	**Frequency**	**Percentage**
Coffee Research Institute	126	95.5
Own Farm	3	2.3
Cooperative Society	1	0.8
Non-Governmental Organization	1	0.8
Not Sure	1	0.8
After Sale Follow-up	**Frequency**	**Percentage**
No Follow-up	87	65.9
Follow-up	45	34.1
Achieved Seedlings per Kg of Seed	**Frequency**	**Percentage**
<2000	17	12.9
2001 - 2500	14	10.6
2501 - 3000	39	29.5
3001 - 3500	48	36.4
3501 - 4000	14	10.6

Most of the sampled nurseries do not have the standard propagator for germinating the coffee seeds and are using very crude methods in some make-shift “propagators” resulting in very low germination percentage (Figure 13). This observation is a confirmation of the earlier reported findings that lack of technical skills is one the major challenges limiting effective production of coffee seedlings in most of the coffee nurseries. This can be effectively addressed through capacity building.

Figure 13: Some of the crude methods being used by some of the sampled nurseries to germinate coffee seeds. They include application of banana leaves as mulch inside a propagator (upper left); sowing the seeds directly on soil and covering with banana leaves as mulch without a propagator (upper center); using raised grass shade over poorly prepared seedbed (upper right) or covering propagators with a black shade-net instead of polythene sheeting. Such methods result in low or no germination of the seeds (lower right).

4.5 Production Capacity of the Sampled Coffee Nurseries

Analysis of the production capacity of the sampled nurseries showed that none of the Counties had their nurseries producing at full capacity. It emerged that the nurseries in 12 out of the 20 sampled Counties were producing below 50% of their production capacity (painted red in Figure 14) while the nurseries in two other Counties (Nakuru and Meru) were utilizing slightly more than half of their production capacity. The nurseries in the remaining 6 Counties were producing at between 63 and 70% of their production capacity. The best performing nurseries were in Embu County utilizing an average of 70% of their production capacity while the worst performing were in Homabay County utilizing an average of 10% of their production capacity (Figure 14).

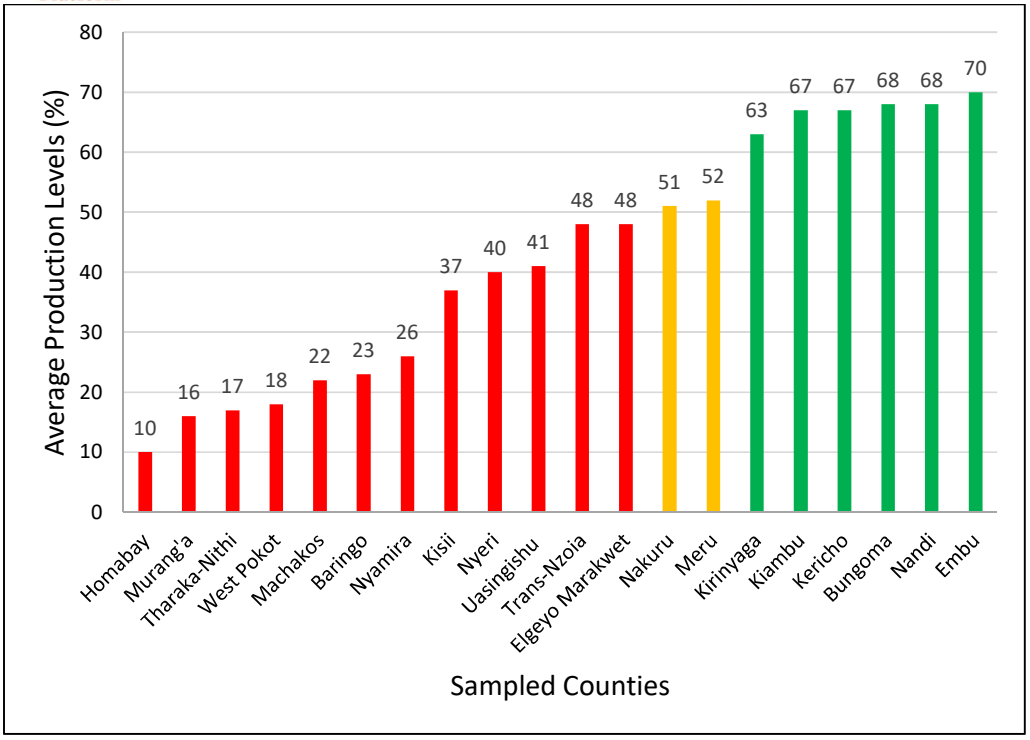

Figure 14: Utilization of available nursery production capacity in the sampled Counties

This study observed that most of the nurseries in Embu County are private nurseries but the county has very few nurseries. Only one out of the 5 sampled nurseries in Homabay County was active. The other four nurseries did not have even a single coffee seedling. Other Counties with some empty nurseries include Baringo, Elgeyo Marakwet, Kericho, Kiambu, Kisii, Nandi, Nyamira, Nyeri and West Pokot. The situation is dire in Homabay, Murang'a, Machakos and West Pokot where very few nurseries are available and have little or no seedlings. Urgent intervention is necessary in these Counties.

Further analysis of the production capacity of the sampled nurseries showed that 22% of the nurseries were operating below or at 20% of their production capacity while 25% were utilising 21 and 40% of their production capacity. Nineteen percent (19%) of the nurseries were utilizing 41 – 60% of their potential capacity while 15% were utilizing between 61 – 80% of their potential. Only 19% of the nurseries were producing at 81 – 100% of their potential capacity (Figure 15). The latter reported that they apply strict planning of their production seasons including timely acquisition of inputs especially

the coffee seeds. They also embark in active marketing of their coffee seedlings and most of them had adopted grafting to compensate for inadequate Ruiru 11 seeds. The nurseries that were performing dismally cited some production challenges most of which are documented in section 4.3 of this report.

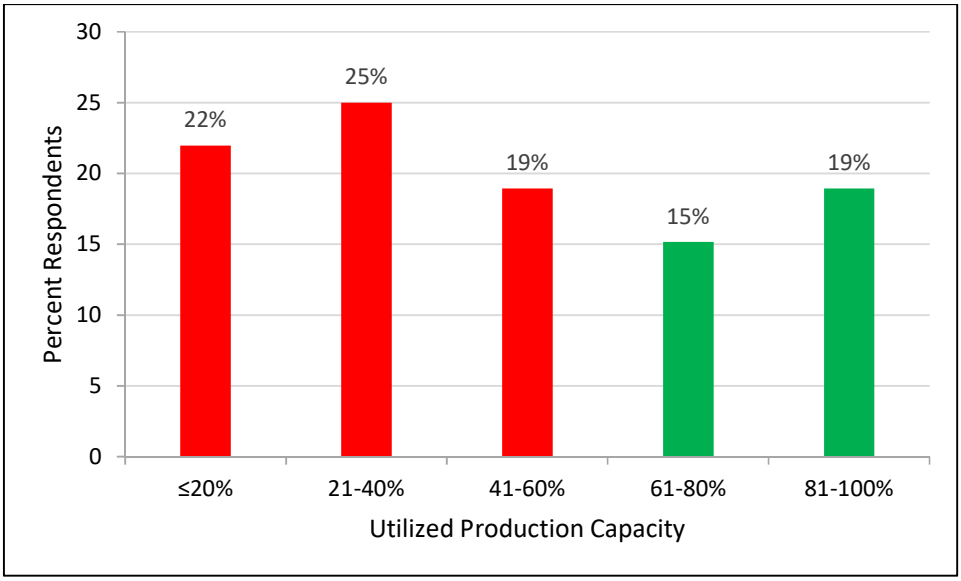

Figure 15: Utilization of the available production capacities of the sampled nurseries

Ironically, some nurseries have very good infrastructure and adequate area for expansion (Figure 16) but they were found to have little or no seedlings citing lack of Ruiru 11 seeds. Such nurseries should be identified and earmarked as the recommended seedling distribution centres, supported adequately with necessary training and extension services and prioritized during seed distribution. Ruiru 11 clonal gardens should also be established near such nurseries and a reliable group of personnel be equipped with grafting skills. Such an initiative would ensure adequate vegetative supplementation in the supply of the highly demanded Ruiru 11 seedlings.

Figure 16: Nurseries with good but underutilized infrastructure. The one on the left was recently upgraded under sponsorship of Solidaridad through the FOSEK project while the one on the right is an individual investment.

4.6 Economic Sustainability of the Kenyan Coffee Nurseries

The sampled nurseries were requested to provide data on their estimated cost of production, the number of seedlings sold in the last season, available seedlings in the nursery to be sold in the next season and their set price of coffee seedlings. This data was used to estimate the economic sustainability of the sampled nurseries. The results showed that 7.9% of the nurseries were making losses while the rest were making normal to super normal profits as shown in Figure 17. This shows that the nursery business can be lucrative if well managed. This was confirmed by many cooperative societies who reported that the nursery business is the one that covers some of their operational costs. They, however, expressed the need for sustainable solutions to mitigate the many challenges they are currently facing in the coffee nursery business as discussed earlier under section 4.3 of this report.

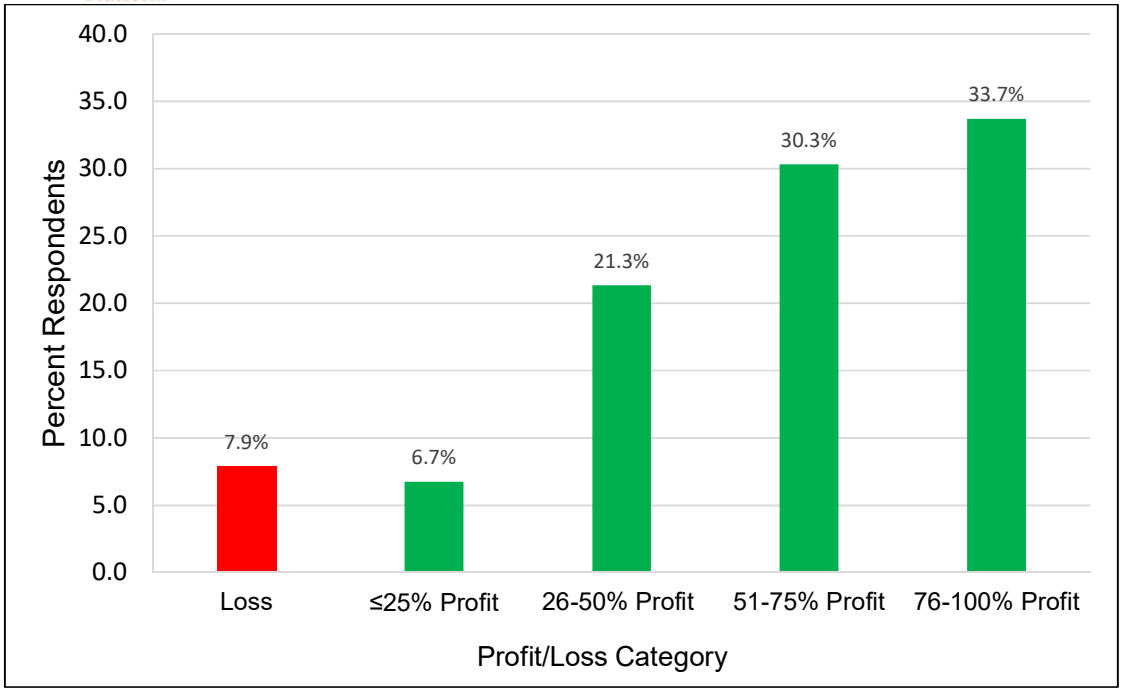

Figure 17: Economic status of the sampled nurseries

4.7 Key Infrastructure or Resources Desired by Coffee Nursery Operators

The study sought to document the key infrastructure and/or resources desired by coffee nursery operators in the sampled counties which by extension would be the same desires for all the coffee nurseries in Kenya. The findings indicated that 48% of the respondents desired to have modern nursery structures which mainly constituted the recommended quality of tilder nets erected on permanent metallic posts. This was a genuine concern especially in areas that were prone to hailstones which caused massive damage not only to the seedlings but also damaged the low quality nets and sometimes brought down the entire shade. A few nurseries had already benefited from such modern structures from some development partners mainly the European Union under the Coffee Productivity Project (CPP) and Solidaridad. It was observed that the quality of seedlings that were being propagated under modern structures were of relatively better quality compared to those propagated in the open or under makeshift structures (Figure 18). The latter were found to be prone to hailstone damage and some fungal diseases especially the brown eye spot disease (Figure 19).

Figure 18: Comparative quality of seedlings propagated in the open (left) and those propagated under modern nursery structures (right). The nursery on the left was constructed for a cooperative society in Bungoma County by Solidaridad through the Food Security through Improved Resilience of Small Scale Farmers in Ethiopia and Kenya (FOSEK) project.

Figure 19: Coffee seedlings affected by brown eye spot disease. The fungal disease causes severe leaf defoliation if no control measures are taken. Brown eye blight is more severe in nurseries that are not shaded with good quality tilder nets.

Another significant proportion (19%) of the respondents desired irrigation facilities particularly reliable sources of water, water pumps, storage tanks and irrigation pipes. These requirements would therefore vary from one nursery to the other depending on the nursery location and distance from the nearby source of water. Therefore, such desires can only be considered on a case by case basis. Provision of biodegradable potting bags was also prioritized by 13% of the respondents. The study established that, following the ban of polythene materials in Kenya by the National Environment

Management Authority (NEMA), it has become quite difficult for most of the ordinary nurseries to acquire the recommended biodegradable potting bags. Apart from availability, most of the respondents complained of the high cost of these biodegradable potting bags. In addition, it was reported that most of the available biodegradable potting bags were of questionable quality and were not serving for a long period as desired for slow growing seedlings such as coffee. Most of the nurseries are now using any type of potting materials available while some nurseries in Kisii County opted to do direct planting due to lack of potting bags (Figure 20).

Figure 20: Coffee seedlings directly seeded on soil at some nurseries in Kisii. This practice is rampant in Kisii County occasioned by many reasons including lack of potting bags, lack of adequate capacity building and lack of funds. Farmers in this County also have a habit of establishing coffee farms using seedlings gathered from other coffee farms.

The issue of security also featured as a priority to 10% of the sampled nurseries who desired good fences around their nurseries to keep away potential thieves and other intruders. Some reported having encountered losses from theft and avoided establishing their nurseries in areas that are easily accessible since they considered such areas to be less secure. Modern propagation technologies were also desired by

7% of the sampled nurseries mainly the big nurseries. The desired technologies included propagation greenhouses with raised propagation beds, misters and drip irrigation system. This would ensure faster growth of quality seedlings hence higher returns. A few nurseries were found to have installed some of these technologies (Figure 21). Other desired technologies included hot frames to be used for rooting cuttings and germinating seeds. Soilless media was also desired as an alternative to soil since it was becoming difficult to get a reliable source of good quality soil. Finally, a small percentage (3%) of the respondents expressed the need for passable roads for enhanced access of their nurseries by potential clients (Figure 22).

Figure 21: The manager of Sakami Estate displaying installed high pressure drip irrigation system (left). On the right are some vegetable greenhouses established to support the coffee nursery enterprise during low seasons. The greenhouses were installed by an NGO called "We Effect" for some Coffee Cooperative Societies in Kisii. Interestingly, the beneficiaries have never tried the greenhouses on coffee citing lack of adequate Ruiru 11 seeds which is the most desired variety in the area. Such a facility can be very useful for grafting but the beneficiaries are not enlightened on this hence the need for capacity building.

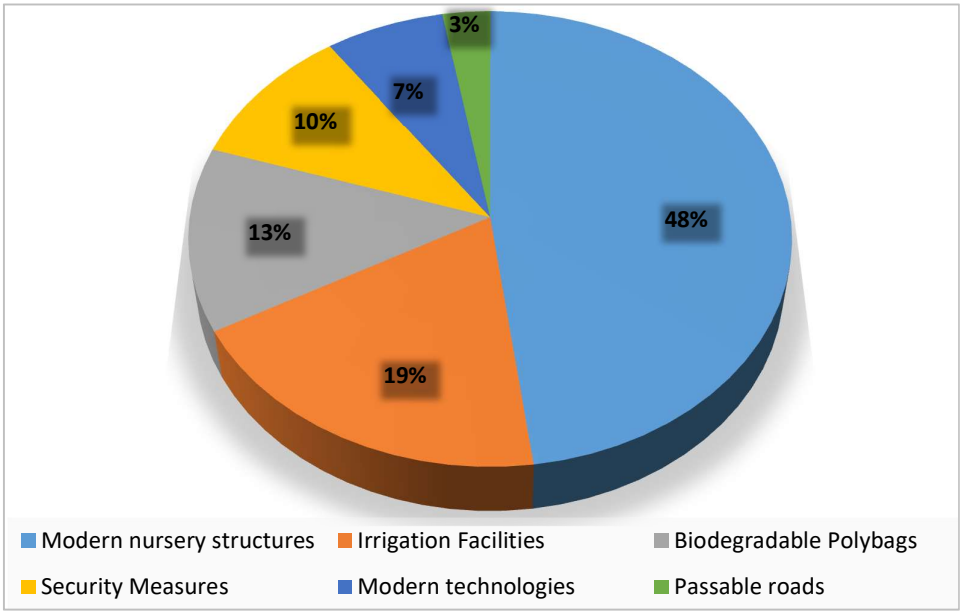

Figure 22: Infrastructure and resources desired by the coffee nursery operators

Having analysed the capacity, key challenges, the needs and intervention gaps among the sampled nurseries, it was our firm believe that similar dynamics would be found in all the coffee nurseries in Kenya. That notwithstanding, we sought the opinion of the nursery operators and other relevant stakeholders on what strategies would be necessary to be put in place to improve the coffee nursery sector in Kenya. The results indicated that the most effective strategy as hypothesized by 26.7% of the respondents would be capacity building of the nursery owners on both technical and administrative aspects of the nursery. Improving the seed supply to the nurseries would also unlock the untapped potential of some coffee nurseries as suggested by 24.3% of the respondents. It was evident that the nurseries that followed the recommended propagation practices and used quality seeds were highly successful. A good example is Underit Youth Group Nursery in Tinderet, Nandi County (Figure 23).

Figure 23: A well-managed coffee nursery owned by Underit Youth Group in Tinderet, Nandi County. It's among the best performing nurseries in Kenya where all activities are carried out professionally and the nursery is self-sustaining and earning high profits. The nursery was established through the support of the European Union under the Coffee Productivity Project in 2015 and has been expanding since then. This is a good indication of what can be achieved through capacity building.

Approximately 16% of the respondents believed that there was need for subsidized production while 12.8% called for enhanced monitoring and regulation of the nurseries to weed out scoundrel nurseries. Apparently the County Governments in most of the sampled Counties were doing very minimal in nursery monitoring and regulation. The hands off role of the regulator was blamed for the increasing number of rogue nurseries which could be the major distributors of poor quality planting materials. Sensitization of the farmers was also suggested by 8% of the respondents. They felt

that coffee farmers should be sensitized on the different attributes of different coffee varieties to enable them make informed decisions. Other suggested strategies included availing of good quality potting bags, decentralization of clonal gardens in the main coffee growing areas and diversification within the nurseries to ensure sustainability (Figure 24).

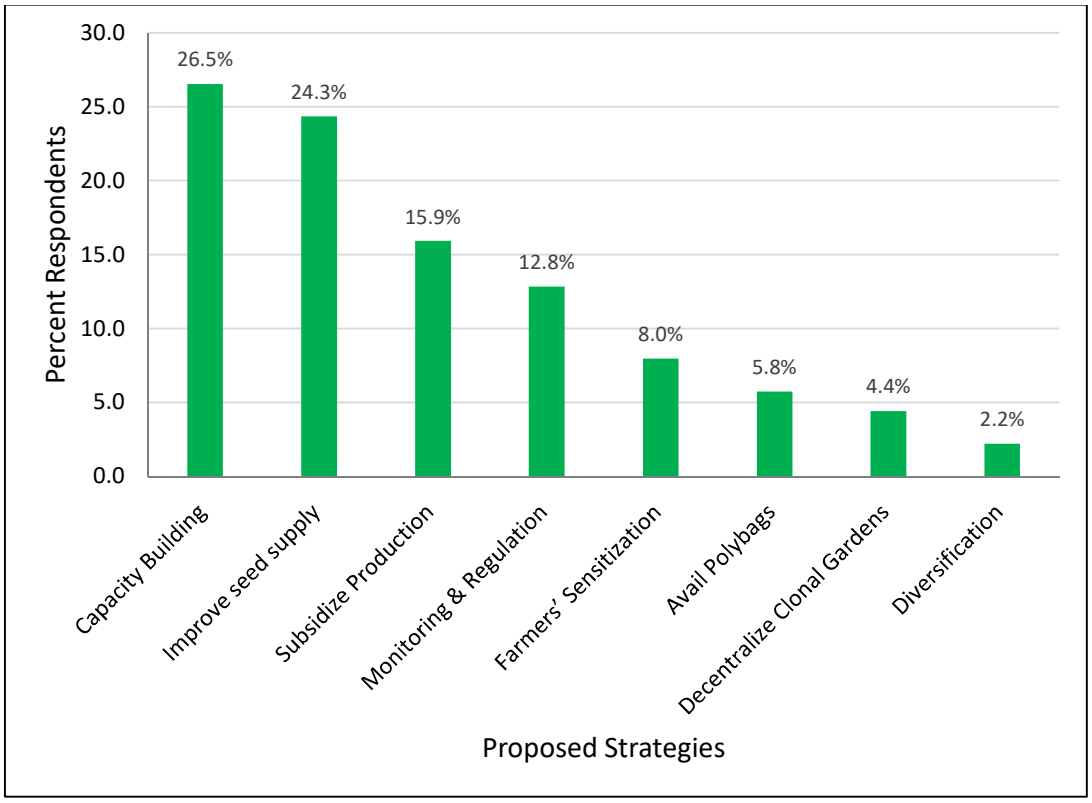

Figure 24: Prioritized strategies to improve the Kenyan coffee nursery sector

4.8 Diversification in Coffee Nurseries

One of the proposals by the nursery owners as a possible strategy to improve the coffee nursery sector in Kenya is diversification into propagation of seedlings for other crops like fruit trees, shade trees, forest trees and ornamental trees. This is in line with the Kenyan Government call for planting trees to attain the desired forest cover of 10% as required by the Kenyan constitution. This study established that some of the nurseries had already diversified into other seedlings (Table 5) either by default (lack of adequate coffee seeds) or by design. Non-coffee seedlings that were being propagated included: assorted fruit trees (avocado, macadamia, mangoes, citrus,

pawpaw, tree tomato, passion fruits, apples, tissue culture bananas); agroforestry trees (*Grevillea robusta*, *Cordia africana*); forest trees (Cypress, Eucalyptus); ornamental trees (Podocarpus, bottle brush) and flowers (Figure 25). Some nurseries were also propagating vegetables (cabbage, spinach, kales, tomatoes). One nursery in Embu County had also diversified into propagation of khat (miraa) seedlings. However, some reported that it was difficult to sell other seedlings if coffee seedlings were not available since the other seedlings are mostly sold to impromptu buyers.

Table 5: Total number of other seedlings found in the sampled nurseries

Fruit Trees			**Agro-forestry Trees**		
1.	Macadamia	116,806	1.	Grevillea	88,319
2.	Avocado	94,710	2.	*Cordia africana*	902
3.	Passion fruits	20,100	3.	Nandi flame	200
4.	Citrus fruits	2,050	**Forest Trees**		
5.	Apples	1,000	1.	Eucalyptus	51,470
6.	Tree tomato	1,650	2.	Cypress	41,000
7.	TC bananas	650	**Ornamental Trees**		
8.	Pawpaw	110	1.	Podocarpus	300
9.	Mango	150	2.	Bottle brush	600

Figure 25: Some of the non-coffee seedlings being propagated in some of the sampled nurseries. They include fruit trees like passion fruits (left), ornamental trees such as Podocarpus (centre) and flowers (right). Most of these nurseries used to be purely coffee nurseries but have now embraced propagation of other seedlings to ensure their sustainability.

Out of the 132 nurseries that were sampled, 84 (63.6%) of them had not diversified at all as they were propagating coffee seedlings only (Figure 26). The rest had diversified into different types of seedlings. Some had diversified into propagation of fruit trees only (12.2%) while others were propagating assortment of agro-forestry and fruit trees (8.3%) or assortment of agro-forestry and forest trees (12.9%). A few nurseries are also propagating ornamental trees (1.5%) and assorted vegetables (1.5%). Most of these nurseries reported that they opted to diversify to enhance their sustainability when coffee seeds are not available. The highest level of diversification was observed at Afri-Link Nursery located in Trans-Nzoia County near Trans-Nzoia-Uasin Gishu border. This nursery was established through the support of the European Union under the Coffee Productivity Project in 2014/15. It was one of the main nurseries supplying coffee seedlings to Uasin Gishu County which has very few functional coffee nurseries but was forced to diversify into other seedlings due to low demand of Batian seedlings and lack of adequate seeds for the desired Ruiru 11 variety (Figure 27).

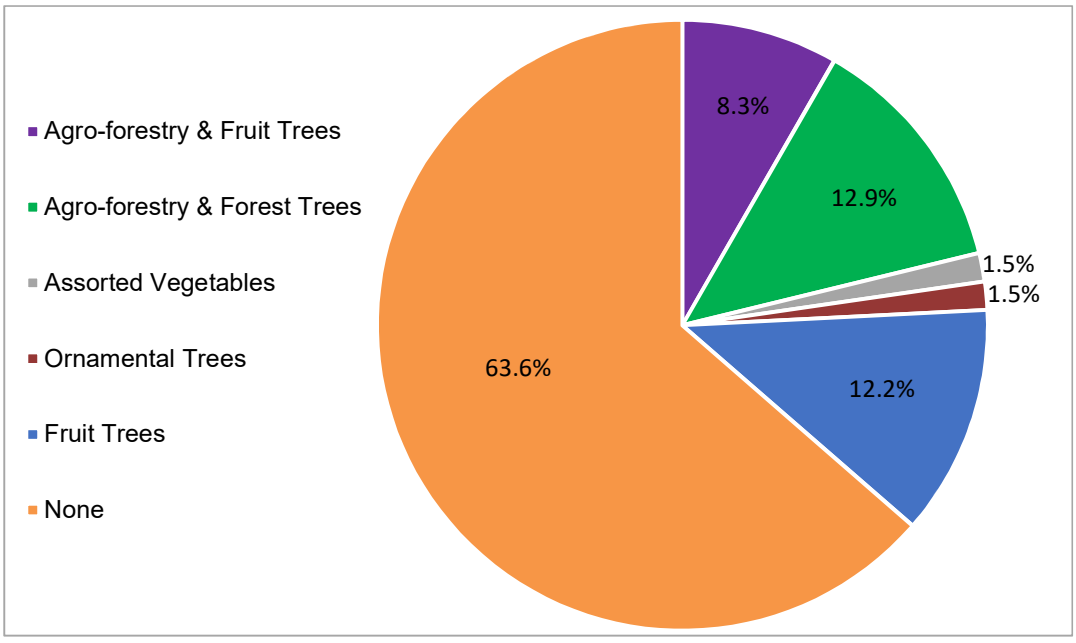

Figure 26: Levels of diversification in the sampled nurseries

Figure 27: Diversification at Afri-Link Nursery in Trans-Nzoia. The nursery was established through the Coffee Productivity Project in 2014/2015 but has since diversified into other crops due to lack of adequate coffee seeds for the most desired variety, Ruiru 11. The nursery is currently producing over 20 different types of seedlings including fruit trees, agro-forestry trees and ornamental trees.

Majority (84%) of the KII respondents rated the adoption of shaded coffee in the sampled Counties as moderate with only 16% rating the adoption as low. However, physical observation of the farmers' fields painted a slightly different picture. Farmers in the East of Rift (Central and Eastern Regions) appeared to have adopted moderate levels of coffee shading compared to the West of Rift where the levels of coffee shading are critically low (Figure 28). There is need to sensitize the farmers in these regions on the role of shade in coffee plantations considering the rising incidences of coffee leaf rust fungus infection and some heat loving pests such as the coffee berry borer, coffee thrips, scales and mealy bugs. The most preferred shade tree in the sampled counties was *Grevillea robusta* with a preference rating of 50%, followed by macadamia with a preference rating of 26%. Others included *Cordia* spp (12%), *Sesbania* spp (6%) and banana (6%) as illustrated in Figure 29.

Figure 28: Coffee under partial shade in Kiambu County

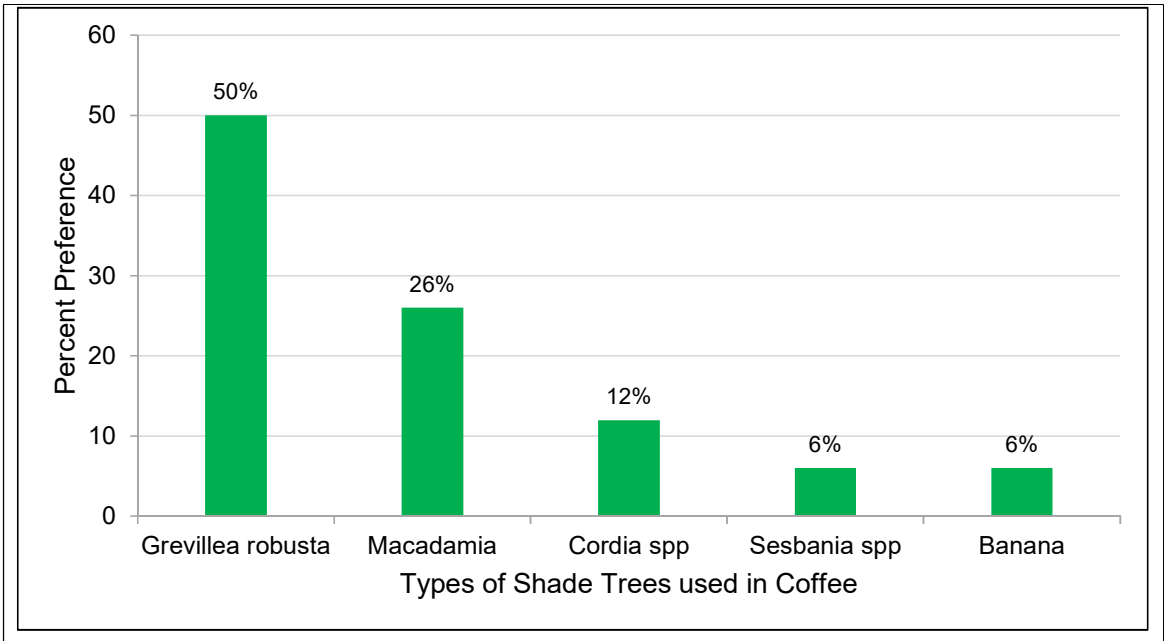

Figure 29: Preference rating of some of the shade trees used in Kenyan Coffee. Although macadamia is known as a high value industrial tree, its preference as a shade tree in coffee is still far below *Grevillea robusta*. This may be attributed to the high cost of acquiring macadamia seedlings and may be the prolific nature of *G. robusta*.

4.9 Accessibility of Extension Support by Coffee Nursery Operators

Apart from the low follow-up on supplied seeds reported in section 4.3 of this report, most of the respondents complained of low or lack of extension support on coffee related issues and particularly the coffee nursery aspects. This concern was also raised by 75% of the KII respondents who rated availability of extension services on coffee propagation as limited or unavailable. Among the sampled nurseries, only 33.3% obtained extension support from CRI (Figure 30). This was attributed to lack of adequate funding by the government to enable CRI officers to adequately discharge its mandate. The institution has only 5 centres (Ruiru, Mariene, Kisii, Koru, Kitale and Namwela) distributed in only 5 counties (Kiambu, Meru, Kisii, Nandi, Kitale and Bungoma) out of the 33 coffee growing counties in Kenya. The County governments were also found to be less supportive in terms of provision of coffee farming extension services despite Agriculture being a devolved function. Only 19.7% of the sampled coffee nurseries were receiving extension support from the County Departments of Agriculture. Some cooperative societies have employed their own agronomists and therefore 17.4% of the sampled nurseries reported to be receiving extension support from their own agronomists.

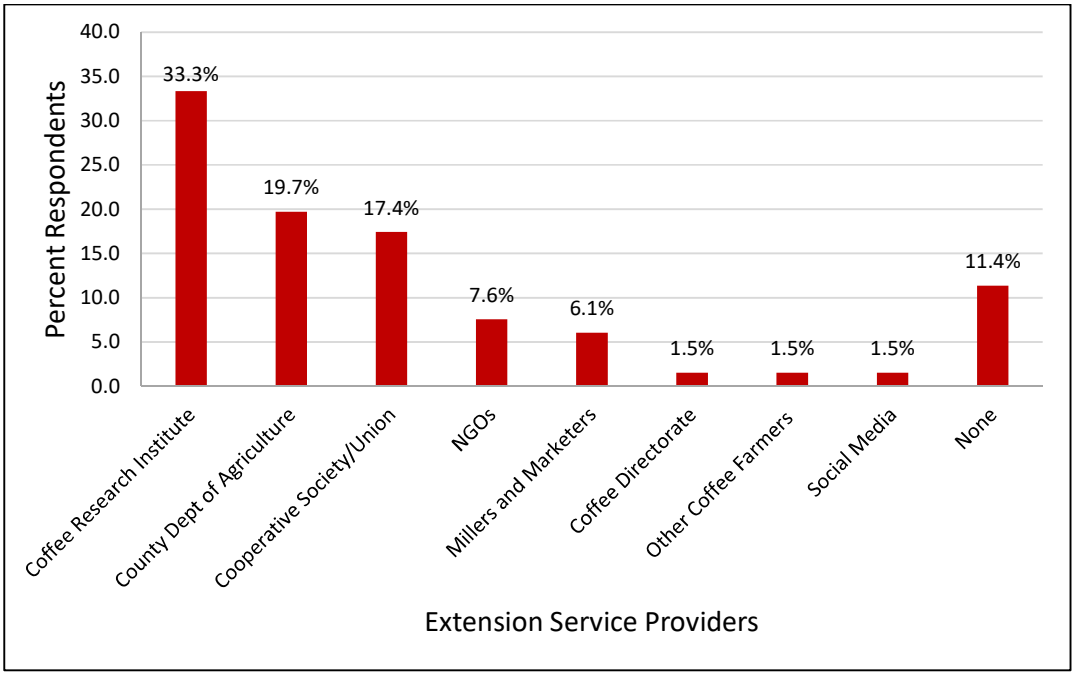

Figure 30: Extension service providers accessible by the nursery operators

Non-Governmental Organizations particularly Solidaridad were also found to play a significant role in the coffee nursery sector. The NGOs were reported to be the main source of extension services to 7.6% of the sampled nurseries. The most active NGO is Solidaridad which was found to be actively involved in coffee production in all the regions that were covered and had even assisted in establishment and rehabilitation of many coffee nurseries (Figure 31). Millers and marketers particularly Coffee Management Services (CMS) and Tropical Farm Management were also offering extension services to 6.1% of the sampled nurseries. However, the millers and marketers are employing a “give and take” approach and are therefore only supporting the cooperatives that sells coffee through them. Other nurseries obtained extension support from the Coffee Directorate (1.5%), other coffee farmers (1.5%) and social media (1.5%). Sadly, 11.4% of the respondents reported that they are not able to access any form of extension support (Figure 30).

Figure 31: Rehabilitated Kibirigwi FCS Coffee Nursery. Rehabilitation was sponsored by Solidaridad through the FOSEK project. The beneficiary reported that Solidaridad had also assisted them greatly in terms of provision of extension services.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study successfully undertook an in-depth analysis of the coffee nursery systems in Kenya using an adequate representative sample of 20 (16 traditional and 4 emerging) coffee growing counties. The study unveiled reliable information on the current status of coffee nurseries in Kenya. The challenges faced by coffee nursery operators and their current and future desires were uncovered. The production capacity of most of the coffee nurseries was found to be below average and the level of adoption of good nursery practices need to be improved. The demand for planting materials of the traditional varieties and that of Batian cultivar was found to be low but that of Ruiru 11 cultivar was found to be overwhelming. The study also revealed that the quality and purity of coffee planting materials currently being supplied to coffee farmers in Kenya need to be improved.

5.2 Recommendations

There is need to urgently fix the demand and quality gaps that were identified by devising effective ways of enhancing the adoption of good nursery practices among the coffee nursery operators in Kenya. Most urgently, it will be prudent to carry out genetic fingerprinting of the available coffee seedlings from some selected nurseries in order to conclusively estimate the level of genetic purity of the coffee seedlings being planted in Kenya. Consequently, effective measures should be put in place to control any further genetic contamination of the coffee planting materials.

5.3 Proposed Interventions

Based on the findings of this study, some immediate and future interventions are proposed to increase the efficiency of the coffee nursery system in Kenya as discussed under this section.

5.3.1 Capacity Building on Coffee Nursery Management

There is need for continuous training of coffee nursery operators on all aspects of coffee nursery management to enhance their efficiency, improve quality and quantity

of seedlings and minimize losses. The training curriculum should include varietal attributes, proper channels of acquiring certified seeds, nursery site selection, construction of different nursery structures and their recommended specifications, record keeping and planning, propagation requirements, care and tending of young seedlings, grafting skills, nursery marketing among other aspects. There should be an extension programme to ensure continuous training and retooling on all the above mentioned practices and any other emerging training needs.

5.3.2 Improved Production of Ruiru 11 Coffee Seed

Since Ruiru 11 is an F1 hybrid, the process of fertilization for quality seed production requires manual emasculation of the "female" parents and subsequent manual pollination using pre-harvested pollen from selected "male" parents. This process is not only tasking but also less effective compared to natural fertilization which takes place with or without the pollinating agents hence the low production of Ruiru 11 seed. The reduced budgetary allocation to CRI by the government has also denied the institution adequate resources needed for the Ruiru 11 seed production. In addition, the changing weather pattern has disrupted the normal seed garden calendar that ensured regular production of Ruiru 11 seed. There is urgent need to increase Ruiru 11 seed supply and this can be achieved through the following strategies:

a) Enhanced budgetary allocation to CRI for Ruiru 11 seed production.
b) Construction of movable rainout shelters in the Ruiru 11 seed gardens.
c) Training and maintenance of a reliable team of skilled seed garden workers to ensure increased seed production efficiency

5.3.3 Promotion of Grafting Especially in the West of Rift

This study established that grafting is less popular in the West of Rift as compared to the East of Rift. This was attributed to lack of adequate information about the technology, lack of adequate grafting skills and lack of reliable source of certified scions. This therefore calls for enhanced extension support towards the region to sensitize the farmers on the agronomic benefits of grafting and also to equip the nursery workers with requisite grafting skills. This can be combined with top-working

sessions for those willing to convert their existing coffee bushes from traditional to improved varieties.

5.3.4 Decentralization of Ruiru 11 Clonal Gardens

Considering the current high demand of Ruiru 11 seedlings and the technical challenge associated with its seed production, there is need for the nursery operators to embrace other propagation methods. Grafted Ruiru 11 seedlings have become popular among many coffee farmers but the grafting process is highly constrained by lack of certified scions. There is need to decentralize Ruiru 11 clonal gardens from CRI stations to selected cooperative societies and train them on proper management of the clonal trees for sustainable supply of Ruiru 11 scions.

5.3.5 Sensitization of Farmers about the Varietal Differences and Attributes

This study found out that there is an extension gap in the Kenyan coffee sector and consequently, there is a lot of unsubstantiated information that is circulating among the farmers about the attributes and agronomic potential and suitability of the existing coffee varieties. The improved Batian cultivar which was released in 2010 has suffered the biggest blow among many farmers who have been made to believe that the variety is not suitable in some of the coffee growing areas. This trend which is fast spreading can only be reversed through extension. The coffee farmers need to be trained about the attributes and specific agronomic requirements of different coffee varieties in Kenya. Improved adoption of Batian will go a long way in reducing the pressure on production of Ruiru 11 seed. There is therefore need for an enhanced budgetary allocation particularly to CRI and other relevant institutions to offer adequate extension services to coffee farmers.

5.3.6 Promotion of Modern Technologies in the Nursery Sector

Apart from grafting, there are other desirable modern technologies that should be embraced in the coffee nurseries for enhanced seedling production efficiency and to cut down the cost of production. One such technology is the use of greenhouse as a nursery structure. This will enhance security of seedlings and also reduce the incidences of pests and diseases. The high temperatures in the greenhouse will also

ensure faster growth of the coffee seedlings especially in the cooler high altitude areas. The greenhouse will also promote faster healing of the graft union in grafted seedlings and proper hardening of the seedlings before they are released to the farmers. In addition, the greenhouse can be fitted with other necessary technologies including misting and drip irrigation systems to cut down the labour used for irrigation of seedlings. Use of good quality tilder nets is also desirable for the healthy growth of seedlings. The nursery owners should strive to use different types of nets (based on the percent light penetration) for different stages of the seedlings.

5.3.7 Diversification in Coffee Nurseries

Although 36.4% of the sampled nurseries were found to have diversified into production of other seedlings apart from coffee, the diversification appeared to be unplanned and the variety of seedlings being propagated was low. There is need to sensitize the nursery operators on the importance of diversification into other non-coffee seedlings to cushion them during low seasons and to ensure economic sustainability. Nurseries can diversify into other high value crops grown in the locality especially fruit trees. They can also propagate agro-forest trees that are recommended for coffee shading such as *Grevillea robusta*, *Cordia africana*, *Sesbania sesban* among others.

5.3.8 Promotion of Shaded Coffee Especially in the West of Rift

Coffee is a shade-tolerant plant and is mainly grown under shade trees in complex agroforestry systems. Coffee is a shade-loving plant and the shade trees reduce the stress of coffee by ameliorating adverse climatic conditions and nutritional imbalances. Trees contribute to control of soil erosion and to the carbon sequestration. Coffee agroforestry also has many benefits in the economy as it supports other household needs such as timber. Shaded coffee therefore has many benefits and should be promoted among all farmers. However, it is a known fact that adoption of shaded coffee is generally low in Kenya. This study further observed a relatively lower adoption of shaded coffee in the West of Rift as compared to the East of Rift. Therefore, there is need for enhanced promotion of shaded coffee in Kenya with more emphasis to the West of Rift.

5.3.9 Enhanced Monitoring and Regulation of Coffee Nurseries

One of the improvement strategies that was proposed by the nursery operators is enhanced monitoring and regulation of coffee nurseries. This used to be the mandate of the former Coffee Board of Kenya (now Coffee Directorate) before promulgation of the current constitution which made agriculture to be a devolved function. The responsibility was hence taken by the County Government and domiciled in the County Departments of Agriculture. However, this study noted that there is laxity in delivering this task which has resulted in mushrooming of many unlicensed and unscrupulous nurseries whose quality of planting materials is doubtful. Such nurseries should be weeded out to ensure quality and purity of seedlings and only licensed nurseries should be allowed to operate. There is need for the relevant stakeholders particularly CRI, County Governments and Coffee Directorate, to develop stringent measures that should be implemented to ensure effective monitoring and regulation of the coffee nursery sector.

5.3.10 Characterization of *Colletotrichum kahawae* Isolates in Kenya

Coffee Berry Disease (CBD) caused by the fungus *Colletotrichum kahawae*, is the most important disease of coffee in Kenya. Although there are no confirmed races of *C. kahawae*, several studies have revealed significant genetic diversity among different isolates of this pathogen. A good understanding of the genetic diversity existing within this pathogen is desirable not only in the development of new resistant varieties but also in checking the current resistant cultivars against possible resistance breakdown. In the recent past, some cases of CBD infection have been reported in Batian and Ruiru 11 cultivars which are considered resistant against the disease. There is therefore need to characterize the genetic diversity existing among *C. kahawae* isolates in Kenya and assess the pathogen by genotype interaction. This will assist in unmasking the cause of CBD cases being reported on resistant cultivars. High genetic diversity within the pathogen and significant pathogen by cultivar interaction would send a risk signal for some resistance erosion in the resistant cultivars. If otherwise, then the infection cases being reported would be attributed to

either seed contamination or climate change effects. This characterization will therefore be useful in informing policy decisions.

5.3.11 Characterization of *Hemileia vastatrix* Races in Kenya

Coffee leaf rust (CLR), caused by the fungus *Hemileia vastatrix*, is among the most important diseases affecting coffee all over the world. In Kenya, it is the second most important disease after CBD. Over time, new rust pathogenic races able to infect hitherto resistant coffee genotypes have been registered. Currently, more than 49 races of the pathogen have been characterized all over the world, some of which are able to infect derivatives of Timor Hybrid (HDT), which is a major source of resistance in Kenyan cultivars. The most recent characterization of *H. vastatrix* races in Kenya was done 11 years ago (Gichuru *et al*., 2012) and it revealed a total of six new races (III, XVII, XXIII, XXXVI, XLI and XLII), three new virulence genes (v1, v7, v8) and possibly a fourth virulence gene, the v9 which was not fully confirmed. Since then, cases of CLR infection continue to be reported in resistant varieties indicating a high possibility of additional *H. vastatrix* races in Kenya. There is need to undertake a similar characterization to ascertain this speculation. If there will be no new races that are virulent against the resistant cultivars, then the infection cases being reported would be attributed to either seed contamination or climate change effects. This characterization will therefore be useful in informing policy decisions.

5.3.12 Development of More Coffee Varieties

As a long term strategy, further selection and breeding work should be fast-tracked to develop more commercial varieties with desirable attributes as guided by the current grower and market preferences. For instance, the best performing Ruiru 11 sibs which were identified by Gichimu et al. (2013) should be advanced through marker assisted selfing to change them from F1 hybrids to true-breeding varieties. This would be another breakthrough that would ease the pressure in production of Ruiru 11 seeds. However, the breeding process should ensure that the hybrid vigour is maintained and the resistant genes remains functional.

ANNEXES

Annex I: Locational Description of the Sampled Nurseries

S/No.	Nursery	Affiliated FCS/Union	Region	County	Sub-County	Ward	GPS Location
1.	Kilimo - Marigat		Rift Valley	Baringo	Marigat	Marigat	0.4733N, 36.0050E
2.	Kilimo - Sogon		Rift Valley	Baringo	Baringo Central	Ewalel chap chap	0.5583N, 35.8172E
3.	Kapkawa	Kapkawa FCS	Rift Valley	Baringo	Baringo Central	Ewolelel chap chap	0.5539N, 35.7917E
4.	Tugen Hills	Tugen Hills FCS	Rift Valley	Baringo	Baringo North	Kabartonjo	0.5924N, 35.7748E
5.	Tenges FCS	Tenges FCS	Rift Valley	Baringo	Baringo Central	Tenges	0.3144N, 35.8030E
6.	Ketlogoi Nursery		Rift Valley	Baringo	Baringo Central	Sacho	0.4274N, 35.7981E
7.	Kongmet Nursery		Rift Valley	Baringo	Baringo Central	Ewalel chap chap	0.4818N, 35.7500E
8.	Kituro FCS	Kituro FCS	Rift Valley	Baringo	Baringo Central	Kewal chap chap	0.4818N, 35.7800E
9.	Rotich Dennis		Rift Valley	Baringo	Baringo Central	Ewalel chap chap	0.4874N, 35.7570E
10.	Joram Tree Nurseries		Rift Valley	Baringo	Ravine	Ravine	0.1922N, 35.7300E
11.	Simiyu		Western	Bungoma	Bungoma North	Naitiri/kabuyefwe	0.7906N, 34.8752E
12.	Coffee Research Institute - Namwela		Western	Bungoma	Sirisia	Namwela West	0.7553N, 34.5580E
13.	Kikai FCS Nursery	Kikai FCS	Western	Bungoma	Sirisia	Namwela	0.7850N, 34.5628E
14.	Menu FCS Nursery	Menu FCS	Western	Bungoma	Sirisia	Namwela	0.7744N, 34.5390E
15.	Kimabole FCS	Kimabole FCS	Western	Bungoma	Cheptais	Cheskaki	0.7823N, 34.5209E
16.	Kimama FCS	Kimama FCS	Western	Bungoma	Cheptais	Cheskaki	0.8071N, 34.5155E
17.	Mayekwe FCS Nursery	Mayekwe FCS	Western	Bungoma	Bungma West	Lwandanyi	0.8083N, 34.4229E
18.	Kibisi FCS Nursery	Kibisi FCS	Western	Bungoma	Kapchai	Mukuyuni	0.7889N, 34.6497E
19.	Chepkube FCS Nursery	Chepkube FCS	Western	Bungoma	Cheptais	Cheptais	0.8305N, 34.4436E
20.	Simit FCS Nursery	Simit FCS	Rift Valley	Elgeyo marakwet	Keiyo south	Soy North	0.3768N, 35.6005E
21.	Kapkosom Lead Farmers Group	Kormut FCS	Rift Valley	Elgeyo marakwet	Keiyo south	Soi South	0.3768N, 35.6006E

22.	Kormut FCS	Kormut FCS	Rift Valley	Elgeyo marakwet	Keiyo South	Soy South	0.2121N, 35.6710E
23.	Rural Ambassadors SGH	Kormut FCS	Rift Valley	Elgeyo marakwet	Keiyo south	Soy south	0.2131N, 35.6693E
24.	Kocholwo	Kocholwo FCS	Rift Valley	Elgeyo marakwet	Keiyo south	Soy south	0.2271N, 35.6610E
25.	James Bogong		Rift Valley	Elgeyo marakwet	Keiyo south	Soy South	0.2243N, 35.6528E
26.	Engut estate		Rift Valley	Elgeyo marakwet	Keiyo south	Soy South	0.2243N, 35.6529E
27.	Kolongei		Rift Valley	Elgeyo marakwet	Keiyo south	Soy south	0.2184N, 35.6359E
28.	Peter Kangogo		Rift Valley	Elgeyo marakwet	Keiyo North	Tambach	0.6301N, 35.5269E
29.	Ngano's Nursery		Eastern	Embu	Embu North	Nginda	-0.4444S, 37.4446E
30.	Wamugendi Nursery		Eastern	Embu	Embu North	Gaturi North	-0.4317S, 37.4973E
31.	Green View Nursery		Eastern	Embu	Manyatta	Nginda	-0.4297S, 37.4434E
32.	Kanja Coffee Factory nursery	Kagaari North FCS Ltd	Eastern	Embu	Embu East	Kagaari North ward	-0.3803S, 37.5309E
33.	Pala Factory	Pala FCS	Nyanza	Homabay	Kabondo	Misambi	-0.4307S, 34.9725E
34.	Paddy Ahenda		Nyanza	Homabay	Rachuonyo East	Kabondo East	-0.4693S, 34.9209E
35.	Kabondo Factory	Kabondo FCS	Nyanza	Homabay	Rachuonyo East	Kabondo East	-0.4583S, 34.9267E
36.	Jobolo Peelers		Nyanza	Homabay	Rachuonyo East	Kabondo East	-0.4430S, 34.9110E
37.	Ogera Factory	Ogera FCS	Nyanza	Homabay	Rachuonyo East	Kojwaj	-0.4876S, 34.8280E
38.	Coffee Research Institute - Koru	N/A	Rift Valley	Kericho	Kipkelion	Kunyak	-0.1354S, 35.2810E
39.	Kipkelion Coffee Mill Nursery	Kipkelion District Co-op Union	Rift Valley	Kericho	Kipkelion west	Chilchila	-0.2019S, 35.3494E
40.	Tech-gaa FCS Nursery	Tech-gaa FCS	Rift Valley	Kericho	Kipkelion	Chilchila	-0.1405S, 35.3649E
41.	SEEWO Farm		Rift Valley	Kericho	Belgut	Kapsuser	-0.3443S, 35.2341E

42.	Kichawir FCS	Kichawir FCS	Rift Valley	Kericho	Londiani	Chepseon	-0.2301S, 35.4141E
43.	Kipsinende FCS	Kipsinende FCS	Rift Valley	Kericho	Kipkelion west	Chilchila	-0.1665S, 35.3571E
44.	Sorwot FCS	Sorwot FCS	Rift Valley	Kericho	Kipkelion west	Chilchila	-0.2274S, 35.3567E
45.	Coffee Research Institute - Ruiru		Central	Kiambu	Juja	Murera	-1.0913S, 36.9030E
46.	Ruiru Mills		Central	Kiambu	Juja	Murera	-1.1029S, 36.9181E
47.	Ting'ang'a Coffee Estate Nursery		Central	Kiambu	Kiambu	Ting'ang'a	-1.1270S, 36.7987E
48.	Doondu Coffee Estate		Central	Kiambu	Kiambu	Ting'ang'a	-1.1176S, 36.8766E
49.	Emerald Nursery		Central	Kiambu	Juja	Juja	-1.0919S, 37.0060E
50.	Kenya Nut Company		Central	Kiambu	Thika	Thika Township	-1.0142S, 37.0503E
51.	Kanjuu/Gituto	Kanjuu FCS	Central	Kirinyaga	Kirinyaga East	Njukiini	-0.5420S, 37.4554E
52.	Kiangundu Nursery	Mutira FCS	Central	Kirinyaga	Kirinyaga Central	Kanyekini	-0.5524S, 37.2623E
53.	Kibirigwi FCS Nursery	Kibirigwi FCS	Central	Kirinyaga	Kirinyaga West	Kiine East	-0.5235S, 37.1798E
54.	Kabingara nursery	Karithathi FCS Ltd	Central	Kirinyaga	Gichugu	Ngariama	-0.4123S, 37.3889E
55.	Mirichi Nursery	Mirichi FCS Ltd	Central	Kirinyaga	Kirinyaga East	Njukiini	-0.5168S, 37.3727E
56.	Kianyaga nursery	Baragwi FCS Ltd	Central	Kirinyaga	Kirinyaga East	Baragwi	-0.4947S, 37.3569E
57.	Mitondo Factory	Mwirua FCS Ltd	Central	Kirinyaga	Kirinyaga West	Mukure	-0.5477S, 37.2166E
58.	Rwamuthambi Factory Nursery	Mwirua FCS Ltd	Central	Kirinyaga	Kirinyaga West	Kiine	-0.6092S, 37.2433E
59.	Kiangikinyi nursery		Central	Kirinyaga	kirinyaga west	Mukure	-0.5202S, 37.2081E
60.	Getuya Factory Coffee Nursery	Mwirua FCS Ltd	Central	Kirinyaga	Kirinyaga West	Mukure	-0.5286S, 37.2254E
61.	Kariaini Coffee factory nursery	Mwirua FCS Ltd	Central	Kirinyaga	Kirinyaga West	Mukure	-0.5061S, 37.2161E
62.	Gathambi Coffee factory nursery	Mwirua FCS Ltd	Central	Kirinyaga	Kirinyaga West	Mukure	-0.4685S, 37.2094E
63.	Kabonge coffee & Tree nursery		Central	Kirinyaga	Kirinyaga West	Mukure	-0.4844S, 37.2154E
64.	Kiri coffee factory nursery	Ngiriambu FCS Ltd	Central	Kirinyaga	Kirinyaga East	Njukiini	-0.4859S, 37.3867E

65.	Kainamui Coffee Factory Nursery	New Ngariama FCS Ltd	Central	Kirinyaga	Kirinyaga East	Ngariama	-0.4305S, 37.3960E
66.	Karimikui	Rungeto FCS Ltd	Central	Kirinyaga	Kirinyaga East	Ngariama	-0.4428S, 37.4044E
67.	Kii Coffee Factory Nursery	Rungeto FCS Ltd	Central	Kirinyaga	Kirinyaga East	Ngariama	-0.4497S, 37.4273E
68.	Kiangoi coffee factory nursery	Rungeto FCS	Central	Kirinyaga	Kirinyaga East	Ngariama	-0.4585S, 37.4134E
69.	Gusii Cooperative Union	Gusii union	Nyanza	Kisii	Kisii central	Kisii central	-0.6820S, 34.7768E
70.	Nyaguta FCS	Nyaguta FCS	Nyanza	Kisii	Nyaribari Chache	Kiogoro	-0.7411S, 34.8094E
71.	Nyaturubo FCS	Nyaturubo FCS	Nyanza	Kisii	Keumbu	Birongo	-0.7567S, 34.8462E
72.	Nyosia FCS Nursery	Nyosia FCS	Nyanza	Kisii	Nyaribari Chache	Bobaracho	-0.7108S, 34.8229E
73.	Nyamache FCS	Nyamache FCS	Nyanza	Kisii	Nyamache	Massive East	-0.8551S, 34.8236E
74.	Magena FCS	Magena FCS	Nyanza	Kisii	Kenyanya	Boochi Borabu	-0.9006S, 34.7964E
75.	Mogonga FCS	Mogonga FCS	Nyanza	Kisii	Nyamache	Basi Masige	-0.8602S, 34.7638E
76.	Enkorongo Factory	Mogonga FCS	Nyanza	Kisii	Nyamache	BasiMasige West	-0.8276S, 34.7467E
77.	Nyamosongo main Factory	Nyamosongo FCS	Nyanza	Kisii	Bobasi	Sameta Mokwerero	-0.7668S,34.7537E
78.	Marani Main	Marani FCS	Nyanza	Kisii	Marani	Marani	-0.5815S, 34.8012E
79.	Kiomooncha	Kiomooncha FCS	Nyanza	Kisii	Marani	Marani	-0.5557S, 34.7766E
80.	Nyambunde Factory	Nyambunde FCS	Nyanza	Kisii	Sameta	Bassibointangare Mukwerero	-0.7851S, 34.8019E
81.	Gakero Main Factory	Gakero FCS	Nyanza	Kisii	Bomachoge Chache	Majoge Chache	-0.7668S, 34.7573E
82.	Gesebe Factory	Gesebe FCS	Nyanza	Kisii	Kisii South	Riana	-0.6514S, 34.6683E
83.	Nyamarambe	Nyamarambe FCS	Nyanza	Kisii	South Mugirango	Bogetenga	-0.7948S, 34.6420E
84.	Orienyo Factory	Riasuta FCS	Nyanza	Kisii	Nyamarambe	Chitago	-0.9501S, 34.6674E
85.	Lower Eastern Coffee Mills		Eastern	Machakos	Machakos	Machakos Central	-1.5235S, 37.2582E
86.	Muisuni FCS Nursery	Muisuni FCS	Eastern	Machakos	Kangundo	Central	-1.3158S, 37.3705E
87.	Kiangua FCS	Kiangua FCS	Eastern	Meru	Imenti South	Igoji West	-0.1950S, 37.6132E
88.	Kigari FCS	Kigari FCS Ltd	Eastern	Meru	Imenti South	Igoji West	-0.1792S, 37.6273E

89.	Mitine FCS	Mitine FCS Ltd	Eastern	Meru	Imenti South	Igoji East	-0.1840S, 37.6732E
90.	Kathera FCS	Kathera FCS Ltd	Eastern	Meru	Imenti South	Nkuene	-0.0677S, 37.6609E
91.	Coffee Research Institute - Mariene		Eastern	Meru	Meru Central	Abothuguchi Central	-0.0691S, 37.6604E
92.	Ntongoro Nursery	Nthimbiri FCS Ltd	Eastern	Meru	Imenti North	Ntima West	0.0596N, 37.6432E
93.	Katheri Coffee Nursery	Katheri FCS Ltd	Eastern	Meru	Imenti Central	Abothuguchi West	0.0161N, 37.6288E
94.	Meru Union Nursery	Meru Central Co-op Union	Eastern	Meru	Imenti North	Municipality	0.0473N, 37.6567E
95.	Ikundu Farm Nursery	Muranga Farmers Coop Union	Central	Murang'a	Maragua	Nginda	-0.7653S, 37.1516E
96.	Karurumo FCS Nursery	Karurumo FCS	Central	Murang'a	Murang'a South	Nginda	-0.7845S; 37.0473E
97.	Marumi FCS		Central	Murang'a	Maragua	Marumi	-0.8033S, 36.9740E
98.	Solai Coffee Traders		Rift Valley	Nakuru	Subukia	Kabazi	-0.1124S, 36.1057E
99.	Mutungati FCS	Mutungati FCS	Rift Valley	Nakuru	Bahati	Bahati	-0.1525S, 36.1343E
100.	Chepsangor Hills Coffee Nursery		Rift Valley	Nandi	Tinderet	Kapsimotwa	0.0568N, 35.1842E
101.	Underit Youth Group		Rift Valley	Nandi	Tinderet	Kapsimotwa	0.0532N, 35.1486E
102.	Kapsaos Toretmot CGCS	Kapsaos Toretmot CGCS	Rift Valley	Nandi	Aldai	Koyo/Ndurio	0.0255N, 35.0778E
103.	Kapkiyai Multipurpose FCS	Kapkiyai Multipurpose FCS	Rift Valley	Nandi	Tinderet	Songhor/Soba ward	0.5963N, 35.9765E
104.	Kibukwo FCS	Kibukwo FCS	Rift Valley	Nandi	Tinderet	Songhor/Soba	0.0442N, 35.2734E
105.	Kabunyeria FCS	Kabunyeria FCS	Rift Valley	Nandi	Tinderet	Songhor/Soba	0.0435N, 35.2751E
106.	Girango Factory	Girango FCS	Nyanza	Nyamira	Masaba	Gachuba	-0.7097S, 34.8664E
107.	Gesonso Factory	Gedo FCS	Nyanza	Nyamira	Manga	Manga	-0.6462S, 34.8485E
108.	Kemera	Kemera FCS	Nyanza	Nyamira	Manga	Kemera	-0.6645S, 34.8371E
109.	Motanya Mitenya		Nyanza	Nyamira	Nyamira South	Nyamaiya	-0.5489S, 34.9219E
110.	Dedan Kimathi University Nursery		Central	Nyeri	Nyeri Central	Rware	-0.4049S, 36.9683E
111.	Miiri Factory	Iriaini FCS	Central	Nyeri	Mathira East	Iriaini	-0.4833S, 37.1647E

112.	Gikanda FCS Nursery	Gikanda FCS	Central	Nyeri	Mathira East	Iriaini	-0.5029S, 37.1544E
113.	New Tekangu FCS Nursery	New Tekangu FCS	Central	Nyeri	Mathira East	Kirimukuyu	-0.5056S, 37.0998E
114.	Thiriku FCS Nursery	Thiriku FCS	Central	Nyeri	Tetu	Wamagana	-0.4886S, 36.9156E
115.	Kiandu Coffee Factory Nursery		Central	Nyeri	Tetu	Wamagana	-0.4907S, 36.9671E
116.	Gura Nursery	Othaya FCS	Central	Nyeri	Nyeri South	Gura	-0.5114S, 36.9752E
117.	Gacatha FCS	Gacatha FCS	Central	Nyeri	Tetu	Wamagana	-0.4895S, 36.9437E
118.	Jemuka Nursery		Eastern	Tharaka-Nithi	Chuka	Mugwe	-0.3421S, 37.6364E
119.	Nthirani Coffee Factory Nursery	Kirubia FCS Ltd	Eastern	Tharaka-Nithi	Meru South	Mugwe	-0.3391S, 37.6320E
120.	Ndogo coffee factory nursery	Ndagani FCS Ltd	Eastern	Tharaka-Njuki	Meru South	Karingani	-0.3131S, 37.6667E
121.	Machungwa Coffee Nursery		Rift Valley	Trans-Nzoia	Kiminini	Waitaluk	0.9927N, 35.0712E
122.	Central Nursery		Rift Valley	Trans-Nzoia	Saboti	Matisi	1.0161N, 34.9958E
123.	Sakami Coffee Nursery		Rift Valley	Trans-Nzoia	Saboti	Nabiswa	0.8881N, 34.8608E
124.	Chepkaitit Estate Nursery		Rift Valley	Trans-Nzoia	Cherangani	Geta	1.0086N, 35.2803E
125.	Lunyu Integrated Tech. Transfer Centre		Rift Valley	Trans-Nzoia	Kwanza	Kwanza	1.1641N, 35.0000E
126.	CRI Kitale		Rift Valley	Trans-Nzoia	Kiminini	Matisi	0.9803N, 35.0133E
127.	Afri-link Nursery		Rift Valley	Trans-Nzoia	Trans-Nzoia East	Motosiet	0.9235N, 35.1324E
128.	Koa Nursery		Rift Valley	Trans-Nzoia	Saboti	Kinyoro	0.9498N, 34.9055E
129.	Chebororwa ATC		Rift Valley	Uasin Gishu	Moiben	Moiben	0.9273N, 35.3854E
130.	Kibano Nursery		Rift Valley	Uasin Gishu	Kapseret	Kapseret	0.4595N, 35.2437E
131.	Pokot FCS Nursery	Pokot FCS	Rift Valley	West Pokot	West Pokot	West Pokot	1.2320N, 35.0638E
132.	Kena Group Coffee Nursery		Rift Valley	West Pokot	Pokot South	Tabach	1.2870N, 35.3457E

Annex II: Household Survey Questionnaire

Introduction and Consent: Hello. My name is [ ]. We are conducting a Baseline Study on the coffee nursery system in Kenya on behalf of Kenya Coffee Platform (KCP) and its partners. I humbly request for your voluntary participation in this interview which will take about 20 minutes. Please answer the questions as honestly and objectively as possible. The information will be treated with utmost confidentiality.

Enumerator's name ...……...……
Enumerator's Phone Number …….

Nursery Location

GPS: Latitude ……..…… Longitude ……...……
Region …… County …… Sub-County ….……

Name of the Nursery / Nursery holder (optional) ...……...……
Year of Registration …….. Reg. Number …….
Affiliated Cooperative Society...……

Nursery characteristics

1. How many years have you been undertaking coffee nursery business? ……..
2. Do you keep records of your nursery operations? YES [ ] NO [ ]
3. How many seedlings can you produce in a year at full capacity? ……
4. Number of coffee seedlings currently in the nursery (all stages) …….
5. Number of coffee seedlings sold in the last season (April/May 2021) ……
6. Did you meet your orders for last season? YES [ ] NO [ ]
7. If No to 6 above, why?
   - [ ] High demand and supply
   - [ ] Lack of the most desired variety
   - [ ] Low production capacity
   - [ ] Lack of seeds for propagation
   - [ ] Other (Specify) ……
8. 8. What percentage of your orders did you meet? ……..
9. Percentage of coffee varieties propagated
   - SL28……
   - SL34 ……
   - K7……
   - Batian …….
   - Ruiru 11 ……..
   - Grafted Ruiru 11 ……..
10. Which is the most demanded coffee variety from your coffee nursery? Rank them in order of preference starting from 1(the least) to 6 (the best)
    - SL28……
    - SL34 ……
    - K7……

- Batian …….
- Ruiru 11 …….
- Grafted Ruiru 11 ……..

11. How would you rate the demand of the following coffee seedlings in this area?
    - Traditional Varieties: Very High [ ] High [ ] Moderate [ ] Low [ ]
    - Batian: Very High [ ] High [ ] Moderate [ ] Low [ ]
    - Ruiru 11: Very High [ ] High [ ] Moderate [ ] Low [ ]
    - Grafted Ruiru 11: Very High [ ] High [ ] Moderate [ ] Low [ ]
12. When did you acquire your last batch of coffee seeds? ……..
13. Where did you get your last batch of coffee seeds from?
    [ ] Coffee Research Institute
    [ ] Cooperative Society
    [ ] County Government
    [ ] Non-Governmental Organization
    [ ] Millers & Marketers
    [ ] Own farm
    [ ] Other farmers
    [ ] Others (specify)
14. How long did it take you to acquire your last batch of seeds from the date of request?
    …….
15. Who is your most preferred source of coffee seeds?
    [ ] Coffee Research Institute
    [ ] Cooperative Society
    [ ] County Government
    [ ] Non-Governmental Organization
    [ ] Millers & Marketers
    [ ] Own farm
    [ ] Other farmers
    [ ] Others (specify)
16. Why do you prefer the source you mentioned in number 10 above?
    [ ] Good Quality
    [ ] Availability
    [ ] Cheap
    [ ] Other (Specify) ……..
17. Do you receive after sale follow-up from your seed supplier? YES [ ] NO [ ]
18. How many seedlings do you achieve from one kilogram of coffee seeds?
    [ ] < 2000
    [ ] 2000 - 2500
    [ ] 2501 - 3000
    [ ] 3001 - 3500
    [ ] 3501 - 4000
19. Do you produce grafted seedlings? YES [ ] NO [ ]

20. If NO to number 19 above, why?
    1 = No demand
    2 = Lack of scions
    3 = Lack of grafting skills
    4 = Others (specify)…….
21. If YES to number 19, where did you obtain the scions from?
    [ ] Coffee Research Institute
    [ ] Cooperative Society
    [ ] County Government
    [ ] Non-Governmental Organization
    [ ] Millers & Marketers
    [ ] Own farm
    [ ] Other farmers
    [ ] Others (specify)
22. Average cost of labour per month (Kshs)…….
23. Average cost of inputs per year (Kshs) ..……...
24. Average overhead costs (water, electricity, repairs) (Kshs) …….
25. Current price of traditional variety seedling (Kshs) …….
26. Current price of Batian seedling (Kshs) …….
27. Current price of Ruiru 11 seedling (Kshs) …….
28. Current price of grafted Ruiru 11 seedling (Kshs…….
29. Where do you get coffee related extension services from?
    [ ] None
    [ ] Coffee Research Institute
    [ ] Cooperative Society
    [ ] County Department of Agriculture
    [ ] Non-Governmental Organization
    [ ] Others (specify)…….
30. Rank the three major challenges that you face in the coffee nursery business
    1 = ……..……..…….
    2 = ……..……..…….
    3 = ……..……..…….
31. What strategies do you think should be put in place to improve the coffee nursery sector in Kenya?

……..……
……..
32. Kindly identify the key resources and/or infrastructural developments that you need to improve the production efficiency of your coffee nursery

……..……
……..
33. Apart from coffee, what other seedlings do you propagate?

……..……

……..

34. Kindly provide any other information that you believe would help in improving the coffee nursery sector in Kenya.

……..……

……..

35. How many non-coffee seedlings of each type do you currently have?

……..……

……..

36. Is your nursery registered? YES [ ] NO [ ]

37. Year of Registration? ……..

38. Registration Number? …….

39. License Expiry Date ……

THANK YOU FOR TAKING YOUR TIME TO GIVE YOUR INPUT

Annex III: Key Informant Interview Guide

Hello. My name is [ ]. We are conducting a Baseline Study on the coffee nursery system in Kenya on behalf of Kenya Coffee Platform and its partners. You have been identified as one of the key stakeholders in the coffee nursery sector and I humbly request for your voluntary participation in this interview which will take about 20 minutes. The study aims at determining the challenges and opportunities associated with the coffee nursery sector in Kenya with a view of identifying the key areas of improvement. Please answer the questions as honestly and objectively as possible. The information will be treated with utmost confidentiality.

1. Name of the KII organization (optional) ……
2. Position of the respondent in the Institution / Organization ……...
3. What role do you (or does your organization) play in the coffee value chain?
   - [ ] Research
   - [ ] Regulator
   - [ ] Development Partner
   - [ ] Miller
   - [ ] Trader / Marketing Agent
   - [ ] Financier
   - [ ]Other (Specify)……..
4. How long have you been involved in coffee related activities?
   ……
5. How is the trend of coffee production in the area in the last 3 years?
   - [ ] Increasing
   - [ ] Decreasing
   - [ ] No change
   - [ ] Inconsistent
6. Kindly identify the major biotic/ abiotic factors affecting coffee production in the area.
   - [ ] Pests and Diseases
   - [ ] High Temperatures
   - [ ] Low Temperatures
   - [ ] Low Rainfall
   - [ ] Unpredictable Rainfall Patterns
   - [ ] Hailstorms
   - [ ] Poor Soils / Low Fertility
   - [ ] Other (Specify) …….
7. Kindly identify the major factor limiting coffee farming expansion in the area
   - [ ] Lack of quality planting materials
   - [ ] Pests and Diseases
   - [ ] Poor Weather
   - [ ] Poor Prices
   - [ ] Lack of land for expansion
   - [ ] Other (Specify) …….
8. How do you foresee the demand of coffee planting materials in the area / in Kenya in the next 3 years?
   - Demand will have increased [ ]

Demand will have decreased [ ]
No Change [ ]

9. How would you rate the availability of information/data related to coffee planting materials among farmers and other stakeholders in the area/ in Kenya?
   Not Available [ ]
   Limited [ ]
   Adequate [ ]
10. How would you describe the quality of coffee planting materials available in the area/ in Kenya?
   High [ ] Moderate [ ] Low [ ]
11. How is the current demand of seeds/seedlings for the following varieties?
   - Traditional Varieties: Very High [ ] High [ ] Moderate [ ] Low [ ]
   - Batian: Very High [ ] High [ ] Moderate [ ] Low [ ]
   - Ruiru 11: Very High [ ] High [ ] Moderate [ ] Low [ ]
   - Grafted Ruiru 11: Very High [ ] High [ ] Moderate [ ] Low [ ]
12. What innovations do you think should be prioritized to improve the coffee nursery sector in the area / in Kenya?
   ……
   ……
13. What innovations do you think need to be put in place to address the acute shortage of Ruiru 11 coffee seeds in Kenya?
14. What innovations do you think need to be put in place to address the acute shortage of grafted Ruiru 11 coffee seedlings in Kenya?
   ……
   ……
15. Please rate the level of adoption of shaded coffee in the area
   High [ ] Moderate [ ] Low [ ]
16. Which is the most preferred shade tree in the area?
   ……
   ……
17. How would you rate the availability of the preferred shade tree seedlings in the area?
   High [ ] Moderate [ ] Low [ ]
18. Kindly provide any other information you believe would help in improving the coffee nursery sector in Kenya.
   ……
   ……

THANK YOU FOR TAKING YOUR TIME TO GIVE YOUR INPUT

Annex IV: Focus Group Discussion Guide

Each group should have a maximum of 12 (need to follow the regulations of COVID 19) discussants and minimum of 6. The groups should be mixed (at least 33% of either gender).

Introduction and Consent: Hello. My name is [ ]. We are conducting a Baseline Study on the coffee nursery system in Kenya on behalf of Kenya Coffee Platform and its partners. We humbly request for your voluntary participation in this interview which will take about 20 minutes. Please answer the questions as honestly and objectively as possible. The information will be treated with utmost confidentiality. Are you willing to participate? (Allow 3 minutes for those not willing to participate for whatever reason to leave the group).

Record the number mobilized _____ Number interviewed _____

1. Name of the focus group (optional) ……
2. Locality: Region…..……. County…… Sub County…..……
3. Which are the best income generating cash crops in this area? Rank them in order of priority starting from 1(the best) to 6 (the least)

Cash Crop	**1**	**2**	**3**	**4**	**5**	**6**
Coffee						
Macadamia						
Avocado						
Bananas						
Horticulture						
Miraa						
Food Crops / Cereals						
Other (specify) ……						

4. What are the major factors limiting coffee farming expansion in the area? Rank them in order of priority starting from 1(the best) to 5 (the least)

Cash Crop	**1**	**2**	**3**	**4**	**5**	**6**
Lack of quality planting materials						
Poor Prices						
Pests and Diseases						
Poor Weather						
Lack of land for expansion						
Lack of interest						
Low extension support						
Other (specify) ……						

5. Which is the most preferred coffee variety in the area? Rank them in order of preference starting from 1(the best) to 5 (the least)

Coffee Variety	**1**	**2**	**3**	**4**	**5**
SL28					
SL34					
K7					
Ruiru 11					
Batian					

6. What is the major source of coffee seedlings in this area?
   1 = Coffee Research Institute
   2 = Cooperative Society
   3 = Private nurseries
   4 = Non-Governmental organization (specify)…….
   5 = Others (specify)…….
7. What is the most trusted source of coffee seedlings in this area?
   1 = Coffee Research Institute
   2 = Cooperative Society
   3 = Private nurseries
   4 = Non-Governmental organization (specify)…….
   5 = Others (specify)…….
8. How would you rate the demand of the following coffee seedlings in this area?
   - SL28: High [ ] Moderate [ ] Low [ ]
   - SL34: High [ ] Moderate [ ] Low [ ]
   - K7: High [ ] Moderate [ ] Low [ ]
   - Batian: High [ ] Moderate [ ] Low [ ]
   - Ruiru 11: High [ ] Moderate [ ] Low [ ]
   - Grafted Ruiru 11: High [ ] Moderate [ ] Low [ ]
9. How would you rate the general quality of coffee seedlings available in this area?
   High [ ] Moderate [ ] Low [ ]
10. What innovations do you think need to be put in place to address the acute shortage of grafted Ruiru 11 coffee seedlings in your area?
    ……
    ……
11. What strategies do you think should be put in place to improve the coffee nursery sector in the area?
    ……
    ……
12. Kindly identify the key infrastructural developments needed by coffee nursery operators in the area/ in Kenya
    ……
    ……
13. Kindly provide any other information that you believe would help in improving the coffee nursery sector in Kenya.
    ……
    ……

THANK YOU FOR TAKING YOUR TIME TO GIVE YOUR INPUT

Annex V: Field Observation Checklist

The following non-interactive observations will be captured using photos:

Coffee Nursery Structures

1. Available nursery structures
    i) Propagators
    ii) Lath houses
    iii) Shade structures (natural or artificial)
    iv) Greenhouses and their level of automation if any
    v) Hardening structures
    vi) Nursery store
2. Available fixed assets e.g. tractors, irrigation facilities
3. Source of water e.g. piped water, river, water pan, dam etc.
4. Signage and labelling
5. Security measures

Technical Aspects

6. Diversification (Other trees propagated)
7. General appearance of the seedlings
    i) Healthy looking?
    ii) Disease infected
    iii) Pest infested
    iv) Water stressed?
    v) Nutrient deficient?
8. Topography
9. Security
10. Accessibility

Infrastructural and Developmental Indicators

11. Road Network
12. Government funded supportive projects e.g. dams, water pans
13. Donor funded supportive projects e.g. dams, water pans, water tanks
14. Community based self-help supportive projects e.g. dams, water pans, water tanks
15. Piped irrigation water
16. Connectivity to power

Other Indicators

17. General activities in the area
18. Condition of the coffee fields

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