INFUENCE OF LAND USE PRACTICES ON DOMINANT TREE SPECIES DIVERSITY, RICHNESS, EVENNESS, AND ABUNDANCE IN UGENYA SUB-COUNTY, KENYA

BY

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DECLARATION

Declaration by student

I hereby declare that this Thesis is my original work and that it has never been presented for award of any degree in any other University.

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DEDICATION

To my father Mr. Oduor Joab Opiyo and to the late teacher; Mr. Greggory Ochieng' for the love of the tree species.

ABSTRACT

Change in Land use practices are important indicators of socio-cultural and economic advancement. The common practices for example, rapid human settlement development and unsustainable livestock farming affect distribution of the dominant trees, conversely, Influence of the change in practices on the tree species diversity Richness, Evenness, and abundance is understood. Farm-forestry is contributing to the restoration of trees. However, information relating the 10% Farm-forestry and tree species diversity Richness, Evenness, and abundance is contradicting. Palatable tree organs are unsustainably harvested for forage supplement. Even so, proof about the Influence of stocking rate on the tree species diversity Richness, Evenness, and abundance was attracting varied qualitative justifications in the literature. Therefore, the aim of the study was to assess the Influence of land use practices on dominant tree species diversity, Richness, Evenness, and abundance. The specific objectives of this research were; to analyze Influence of human settlement on the species diversity, Richness, Evenness, and abundance to evaluate the Influence of farm-forestry on the species diversity, Richness, Evenness, and abundance and; to assess the Influence of livestock farming on the species diversity, Richness, Evenness, and abundance. Out of 33,565 households, using Fisher's formula, a sample size of 384 household heads was recruited for questionnaire administration between December 18th 2021 and February 24th of 2022. Descriptive cross-sectional survey design and Systematic random sampling was used. Primary data sources included; questionnaires, Focused Group Discussions, key informants, observation, measurement, and photography. Secondary data was extracted from; Geographical text books, publications, and print media. The Tree species that had a Diameter at Breast Height of ≥ 5.0 inches were enumerated and their diversity, richness, evenness, and abundance measured using Shannon Wiener's Diversity index. Palatability tests were performed, and tree forage preference measured using Manly's alpha/Chesson's index. Qualitative data on specific objectives which had mean scores were compared using the Independent Two-sample t test. The written and verbal information were categorized and analyzed theme wise. The Hubbert's Bubble pattern of depletion theoretical model was used. Quantitative data was processed by Microsoft Excel and analyzed using the *R Statistics version 4.1.3*. The null hypothesis was rejected, the multiple Coefficient of Determination ($R^{2)}$ showed that 67.6%, 57.2%, 48.4%, and 45.6% of the variations in the species Diversity, Richness, Evenness, and Abundance respectively could significantly be explained by the joint variation in the values of independent variables. The result revealed an average Shannon Wiener's diversity index (*H*) of M = 1.58, SD = 0.24 compared to a possible maximum of H = 4.5. A significant estimate of 52% of the sampled Dominant trees were established through planting. From the 27 tree species studied, an average richness (M= 6.00, SD = 2.41) and an abundance of (M = 36, SD = 2.46) per acre was reported. At approximately 13% *Eucalyptus SPP* was the highest ranked followed by *Markhamia lutea* at nearly 12%. A significant round figure of 59% of the species richness was composed of the indigenous trees. Species evenness was (M = .71, SD = 0.04), however, the enumerated 2510 trees with an average age of (M = 9.22, SD = 4.42) years, and *DBH* of (M = 6.83, SD = 1.99), the exotic trees registered a higher abundance of about 56%. It was therefore concluded that the studied Land Use Practices significantly influenced the dominant tree species diversity, richness, evenness, and abundance. To mitigate the low tree species diversity, richness, evenness, and abundance, it is crucial to sensitize the stakeholders on the ecological functions and benefits of diversifying the tree species establishments.

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LIST OF ABBREVIATIONS

COVID 19	Coronavirus Disease 2019
DBH	Diameter at Breast Height
DRC	Diameter at Root Collar
FAO	Food and Agriculture Organization
FGDs	Focused Group Discussions
GOK	Government of Kenya
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
KEFRI	Kenya Forestry Research Institute
KNBS	Kenya National Bureau of Statistics
MEF	Ministry of Environment and Forestry
MoALF	Ministry of Agriculture Livestock and Fisheries
NACOSTI	National Commission for Science Technology and Innovation
SCADP	Siaya County Annual Development Plan
SD	Standard Deviation
SMEs	Small and Medium sized Enterprises
TLU H^{-1}	Tropical Livestock Unit per Hectare
TLUH^{-1}Year^{-1}	Tropical Livestock Unit per Hectare per Annum.
UNECE	The United Nations Economic Commission for Europe
UN	United Nations
UNEP	United Nations Environment Program

WORKING DEFINITION OF TERMS

Agroforestry: - Cultivation of trees, crops, and livestock in agricultural systems, it is a branch of agriculture.

Dendrophobia:- A strong dislike or fear of trees.

Dominant Tree Species: - Trees whose crowns are higher compared to the overall level of the canopy which receive sunlight both from above and as well as from the sides and have a Diameter of ≥ 5.0 inches at Breast Height. For this study they are made-up of a list of 27 tree species proposed by Kokwaro, 1994, Oloo et al., 2013, and Oloo, 2013 as the most dominant in Siaya county.

Ethnobotany: - The study of how people from a given culture and region make use of native plant species.

Farm-Forestry: - Measured in percentage on-farm tree cover. Programs (the percentage proportion of farm size in acres occupied by trees) associated with the promotion of commercial tree growing by farmers on their own land, for example the 10% Farm-forestry policy in Kenya. Other attributes are; Age of tree species, mean DBH, Mode of tree species establishment, tree species varieties, Tree phobia (Dendrophobia), Choice, and preference.

Household Size: - Refers to the number of persons in a private household for the last one year.

Human Settlement: - Measured in Residential unit area. Is a location where Human societies live. It refers to the complexity of human characteristics; all the social materials, organizations, spiritual and geo-cultural factors sustaining it. The qualitative and quantitative attributes are; Land ownership by size, Household's education level, Housing classification, Land tenure system, Gender, and Culture/Beliefs.

Land Use Practices: - The purpose for which land cover is committed, for example Human Settlement, Farm-Forestry, and Livestock Farming.

Livestock Farming: - Measured as stocking rate ($TLUH^{-1}$). The domestication of animals (in this case the grazers/browsers) in an agricultural setting for provision of labor and other produce commodities like meat, milk, eggs, leather, wool, and fur. Other measurable attributes are; the rate of forage (tree fodder) harvesting, animal breeds, feeding method, livestock farming system, livestock composition, forage (tree fodder) palatability, and preference.

Shannon-Wiener Index of Diversity: - Used to describe the uncertainty and disorder of individual species, there are two elements in Shannon-Wiener diversity index: the species richness and evenness.

Species Abundance: - The number of individual (dominant trees) per species.

Species Diversity: - The number of varied (in this case the dominant tree) species that are represented in a particular community.

Species Evenness: - How close in numbers each (dominant tree) species in a community is. Also known relative abundance.

Species Richness: - The number of (dominant tree) species within a defined geographical space.

Subtropical Moist Bio Zone Vegetation: - Refers to plants which grow in areas with warm to hot and moist climate. Located South of the tropic of Cancer and North of the tropic of Capricorn.

Symbionts: - Organisms living in a mutually beneficial relationship

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Zomer et al., (2016) approximated that over 60% of the global habitable land surface has been modified by humans, with around 11 - 30% of the land left for tree species. About 30% of the natives have valid land ownership, leaving out an approximate 60% of arable land to subjective use and degrading practices, which affect the spatial distribution of the tree species (The World Bank, 2019). The raw timber or wood harvesting has risen by 45% above the global average and is contributing to tree diversity loss because timber preference depends on tree species and function (UN, 2019). On a wide world scale, over 43% of the farms are found in a rural area and are identified by the presence of tree species which makes such areas most potential for conservation research (Food and Agriculture Organization [FAO], & United Nations Environmental Program [UNEP], 2020). The report continues to provide warning on a total of 20,334 dominant tree species which are included in IUCN's Red list of threatened species, of which 8056 dominant tree species are in the globe's critical and endangered species list (International Union for Conservation of Nature [IUCN], 2021). Low-intensity land use sustained many human societies together with the majority of their diverse indigenous plant species for thousands of years (Borges, et al., 2021). The contemporary ecological challenges including the tree cover decline have resulted basically from the recent increase in changes in landscape use intensification and expansion (Erle, 2021). The studies on the global land use dynamics are relevant as far as the distribution of the tree species is concerned. The studies addressed a significant contribution of land use change and magnitude on the forest ecosystems. However, these studies failed to reveal whether the remaining 40% of the forest patches had a complete representation of the species diversity, richness, evenness, and abundance.

The diversity loss has been orchestrated by the rapid advancement in scientific discoveries, industrialization, and land use intensification. The industrial pollutants are known to negatively impact biodiversity in general, (United Nations [UN], 2016). Change in tree species biological adaptation, climate change, species invasion, and colonization have been cited among the possible factors contributing to tree species richness and diversity, Richness, Evenness, and abundance down trend (The World Bank [WB], 2016). Of the greatest concern are the global land use changes which have grown four times higher in the last six decades more than previously estimated (Winkler et al., 2021). The studies at global scale level are of positive Influence to biodiversity conservation because they provide early warning signs on factors promoting the general forest diversity loss. Despite the effort, the growth of land use practices for example rapid human development and the extension of farming practices into forested zones continue to escalate necessitating the need for similar investigations at the local scale.

The influence of land use practices has shifted and overtaken the traditionally known tree cover and diversity drivers such as speciation, competition, colonization, climate change, anthropogenic practices, altitude, latitudes, soil type, pests and diseases. The exponential human population growth has led to high demand for land to cater for the ever changing settlement patterns and agricultural development. Because the tree cover is on the declining trend, the biodiversity conservationists have raised concerns from the global to local scale. Several mitigation measures such as securing forests, tree planting in public forests, and carbon funding have been proposed for the implementations but still in vain. The most current remedy being championed is the allocation of the 10% of all the arable private farms to tree cover establishment meant to compensate for the tree loss in the encroached natural forests (Lambin & Meyfroidt, 2011; Ritchie & Roser, 2013). It is therefore apparent that the change in the practices may influence the overall forest ecosystem outlook, however, to which extent it influences the species diversity, richness, evenness, and abundance is missing in literature.

The Food and Agriculture Organization (2016), noted that the Dominant tree species diversity, Richness, Evenness, and abundance play a pivotal role in ecosystem services provision and regulation. Apart from food, biomass products, and hydrological cycle regulation, a variety of the tree species dictated a section of the geo-cultural needs of a given locality. Certain societies attach beliefs and taboos to some tree species which may determine the ethnobotanical interactions and conservation of the relevant trees. The geo-cultural factors affect the land use dynamics and is linked to the local tree diversity conservation policies. However, there is lack of evidence on how the tree species diversity, Richness, Evenness, and abundance are influenced by the local geo-cultural land use practices at the locally.

Furthermore, investigators have determined that the species diversity, richness, evenness, and abundance have association with the tree cover loss. Therefore, these aspects are likely interlinked. But notwithstanding, not numerous theoretical studies have specifically focused on addressing the influence of land use practices on the tree species diversity, richness, evenness, and abundance. (Gaisberger et al., 2022) observed that the dominant tree species diversity, Richness, Evenness, and abundance in tropical and subtropical biozones are threatened.

The dominant tree species abundance and evenness are equally hard hit, the satellite images of the world's rainforests and other crucial global water towers depicted a worrying trend of empty lands occasioned by constant forest clearing (Persson, 2020). Persson (2020) re-emphasized that the destructive Land Use Practices are geo-cultural by nature and have prehistorically changed, spread within and across the geographical divide. The study further emphasized that dominant tree species are paramount in controlling the general food chain in a tree community; they determine species multiplication, succession, and competition. At risk of possible depletion due to the unsustainable changes in land use practices are the world's 80,000 and above dominant tree species, of which less than 1% has been researched for potential use and conservation (IUCN, 2021). Despite the warnings on the Influence of land use practices on general biodiversity and forest loss, a negative trend on the general forest diversity decline continues to be witnessed.

In the above context, Gaisberger et al., (2022), (Persson, 2020), and (IUCN, 2021) performed a commendable job because they addressed a critical state of the dominant tree species in the world of forest conservation. There was a unanimous agreement that the dominant tree cover in the tropical moist biozone was fast depleting due the changing land use practices. Forest cover decline has a direct influence on the general biodiversity changes. However, to which extent the changes in Land Use Practices influenced the dominant tree species diversity, Richness, Evenness, and abundance in the tropical and sub-tropical moist biozones remained unaddressed, thus the need for a similar study within the mentioned geographical regions.

FAO (2015) reported that in Africa, more than 70% of the people living in the rural areas depended on the ecosystem services supplied by the natural resources such as forests. Because natural forests are either degraded or depleted, households are beginning to visualize an economic opportunity in growing trees on their own farmlands (Luc & Lionel, 2018). In Nigeria, the alien or exotic dominant tree species indicated economic importance because the trees serve the function of improving the forest density (Adekunle et al., 2018). The adopted exotic dominant tree species have however acclimatized to local landscape conditions and are portraying strong competitive attributes like pests and disease resistance and are likely to colonize the indigenous dominant tree species (Ignazio et al., 2019). The surveys performed in Africa revealed both the environmental and economic importance of the new concept of Farm-forestry. The benefits of On-farm tree growing and their contributions to natural resource conservation was emphasized. The adoption of the alien or exotic tree species for tree cover enhancement was widely recommended. Common to many is the presence of tracts of land featuring a single tree species. Having such farms may be beneficial as far as enhancing tree count is concerned. Even so, replacing a diverse community of tree with a single fast cash tree species can lead to massive tree genetic loss in the long run. Despite the fact, the contribution of the Farm-forestry to tree species diversity, richness, evenness, and abundance is currently unresolved which is a gap in knowledge worth exploring.

Most of the on-farm dominant tree species are mainly the exotics, which portray a relatively fast growth rate compared to the indigenous dominant trees of the local tree community (Onefeli & Adesoye, 2014). The prime news is, the small holder farmers in the region for example Cameroon, recognize the benefits of farm-forestry which has assisted in toning down the negative contribution of modern intensive agriculture on the ecology (Muthuri, 2016). A study in Ghana revealed a strong statistical correlation between the heterogeneous Farm-forestry (mixed dominant indigenous and exotic trees) And the ecological benefits (Acheampong, 2017). To mitigate the tree species diversity Richness, Evenness, and abundance decline, Africa is embarking on tree growing by funding the ecological restoration campaigns (UNEP, 2019). Rwanda is engaging on-farm tree growing in bid to offset the ecological pollution contributed to by human and livestock; Farm-forestry may improve the ecosystem food provision, resilience through constant annexation and replacement of lost dominant tree species diversity, Richness, Evenness, and abundance (Liliane et al., 2019). Despite the mitigation surveys, the forest diversity, Richness, Evenness, and abundance variation at regional scale persists.

Percentage on-farm tree cover is the ultimate indicator of success in farm-forestry adoption. Currently the benchmark stands at 10% of the farmland. The profitability in farm-forestry depends on the selection of the fast-growing tree variety. The perceived slow in growth, mostly native tree varieties are likely to be omitted in farm-forestry (Hegazy, 1992). The tree species are either naturally established or planted. Sometimes the native species are uprooted and replaced by the perceived economically viable tree species. The maturity age of the tree species is an important factor for consideration in farm-forestry; it is an indicator of economic resilience in ecological conservation. Choice and preference have been known to influence the distribution of human ideas and physical items (Pantaleo et al., 2016). Household's preference or non-preferential on certain tree species is likely to affect the decisions of tree species selection for farm-forestry (Daie, 2019). The tree trunk size *(DBH)* affects the economic value and profit margins in tree farming. In addition to timber quality, the tree trunk cross-section size is an important factor for consideration (Chomba et al., 2020). Though little understood in the world of tree research, dendrophobia is associated with Influences in embracing tree growing (Henry, 2021).

The research on farm-forestry by (Hegazy, 1992), (Pantaleo et al., 2016), (Daie, 2019), (Chomba et al., 2020), and (Henry, 2021) are relevant as far as the role of farm-forestry in combating the environmental pollution and global warming is concerned. The positive Influence of the heterogenous Farm-forestry in conserving the indigenous tree species landscape was extensively explored. Conversely, (Pantaleo et al., 2016) recommended the monogenic farm forestry for specialization and quick economic returns. All the measurable attributes of farm-forestry were extensively deliberated upon. For example, tree age and DBH are dependent on tree variety or species. Some tree species attain a larger trunk at an early age while others take long to mature. Therefore, the late maturing trees generally perceived unsuitable for farm-forestry. In spite of the fact, the Influences of both the Farm-forestry qualitative and quantitative characteristics on the tree species diversity, richness, evenness, and abundance were unclarified.

Extending the human settlement into forested zones reduced the forest area size (Kinyanjui, 2009). The national water towers have been encroached by the uncontrolled human settlement, which was associated with forest degrading practices such as charcoal burning (UN, 2012). Human settlement in the forest neighborhoods recorded low dominant tree species abundance in comparison to the adjacent undisturbed forests in Kakamega County (Vuyiya et al., 2014). The settlements had been linked to massive destruction of tree species in Chepalungu region, this was because the residents practiced uncontrolled illegal settlement within the forest premises (Ronoh, 2016). Rural residents prefer proximity to forests for convenient ecosystem goods and services extraction. Ronoh (2016) notes that Between 1990 and 2015, the dominant tree species basal area in Kenya decreased from 4724-4413 (000 Hectares). Consequently, human residence registered an exponential growth from 57-143 000 Hectares. Land cover clearing and encroachment of the ecological and sensitive zones are common human practices accelerated by human settlement development.

The studies by (Kinyanjui, 2009), (UN, 2012), (Vuyiya et al., 2014), and (Ronoh, 2016), are complemented because they clearly discussed the role of human settlement on the natural forest neighborhoods. Vuyiya et al., (2014), for instance noted that the geo-cultural orientation within a settlement pattern dictated housing and the ethno-botanical conservation. In this light, it is apparent that not all tree species are culturally important within a human settlement. Furthermore, the least functional tree species are likely to be eradicated from the local tree community, an act that may influence the distribution of the tree species. However, despite the fact, the influence of the geo-cultural functions on the dominant tree species diversity, richness, evenness, and abundance within a human settlement remained unknown.

The residential area size in the rural landscape determines the magnitude of economic practices that a household may undertake. Education level and the natural resource conservation awareness are qualitatively assumed to be positively correlated. It has been perceived that this type of housing development reveals the geo-cultural and economic wellbeing of an individual household. Permanent houses are associated with relatively better living standards (Ochola, 2018). Likewise, land size owned by the individuals in arable zones is likely proportional to the farming activities. The households with smaller land parcels are forced to look for alternatives or intensify the economic practices. Communal land ownership has been a source of socio-cultural and political conflict. This is because while people scramble for the available natural resources, they lack the good will to replenish (Jebiwott et al., 2019). Culture, sometimes manifests itself as beliefs or taboos and is a vital societal organ which controls the way things happen or how they are supposed to be done. For instance, tree species play particular societal roles like cultural functions, they are conserved as long as culture is preserved (Tanui, 2021). Tanui (2021) added that gender disparity is an emotive topic, female stakeholders are perceived marginalized in various societal platforms including the natural resource management and conservation.

(Ochola, 2018), The national discoveries on human settlement and forest conservation are justified. The mentioned settlement characteristics are known to affect the tree species population and distribution. However, whether the attributes influence the tree species diversity, richness, evenness, and abundance is missing in the knowledge.

Stocking rate is related to forage availability and land size. When the stocking rate outweighs the carrying capacity as the case in Ugenya sub-county, then the unfavorable balance in the feed chain is inevitable (Marigi, 2015). Households have been encouraged to adopt Hybrid livestock because they are more productive compared to native breeds (Kaguyu & Wanjohi, 2015). However, the cost of acquisition and maintenance are out of reach for many households (Ministry of Agriculture Livestock and Fisheries [MoALF], 2016). Conversely, MoALF (2016) advised that native livestock breeds are more resilient, though with lower productivity. Further, the study noted that depending on economic power, households have two choices to make, either extensive livestock farming or the intensive option. The two livestock farming systems show strengths and weaknesses in ecological conservation, while the intensive livestock farming system is associated with pollution and human health concerns, the extensive version is linked to land degradation (Muriuki, 2019). The stocking rate in the sub-county is in excess of 2 $TLUH^{-1}$ above the recommended carrying capacity which is 3 $TLUH^{-1}Year^{-1}$ (County Government of Siaya, 2019). Constant mutilation of tree organs is known to inflict injuries on tree species (Ministry of Environment and Forestry [MEF], 2019). The traditional livestock feeding method is associated with direct livestock-forest destruction while the modern feeding method minimizes direct livestock and forest interactions through mechanization of the feeding program (Egger et al., 2020). The studies at the local level are significant because they revealed that the county was overstocked. Most affected was Ugenya sub-county that led in higher livestock units by spatial distribution. The role of tree forage in supplementing the conventional livestock was exhaustively discussed. However, the information relating to how livestock farming influenced the tree species diversity, richness, evenness, and abundance was scarce.

It has been observed that livestock varieties interact with forage trees in different ways. Some households keep single livestock species as others do mix livestock farming. Faced with feed shortage, livestock have been seen violating the feeding norms, others divert to feed on tree organs or even tree manufactured products (Koech, 2021). The local scale results are important because they revealed the livestock farming problems and solutions at both the county and the sub-county level. Livestock farmers are faced with the problem of limited grazing land and inadequate forage supply, prompting the sampling, and harvesting of palatable parts of the tree species for feed supplement. It is in common knowledge that livestock farming factors Influences the overall vegetation cover. What is unclear in the protocol is whether a relationship exists between the quantitative, qualitative livestock farming factors, and the dominant tree species diversity, richness, abundance, and evenness.

1.2. Statement of the Problem

Despite the longstanding, global and regional extensive mitigation campaigns against the tree species diversity Richness, Evenness, and abundance decline to change of land use practices, locally, Siaya county continues to register a worrying trend in tree cover decline. However, the Influences of the land use practice on the tree species diversity, richness, evenness, and abundance remain unclear. Out of the six counties of the lake basin region, Siaya county is the lowest ranked nationally in the rural categories in terms of tree species forest cover at less than one percent in comparison to the UN set benchmark of 10%. Ugenya sub-county being among the most socio-economically marginalized, has been perceived as the leading in grass thatched houses, wood fuel use and is the highest significant contributor to the county's 90% of rural biomass fuel expenditure and an exponential household growth rate. Between 2009 and 2019 the households of Ugenya sub-county grew from 12,407 to 33,565 household units, representing an increase of 171%. It is the highest ranked within the county in terms of household growth rate. The sub-county is adversely mentioned in gender parity and resource distribution inequity. The data from livestock farming suggests that the sub-county's stocking rate is in excess by 2 $TLUH^{-1}$ above the recommended carrying capacity 3 $TLUH^{-1}Year^{-1}$.

The mitigative farm-forestry has been misconceived to mean the planting exotic, fast growing tree cultivars at the expense of either the indigenous or endemic dominant tree species. The above-mentioned human practices, if left unaddressed, do affect the tree species population and distribution, through spatial displacement, invasion or colonization and the general disturbance of the dominant tree species. The sub-county is located within a subtropical moist biozone; valuable tree species under similar geographical conditions are threatened globally. Moreover, the dominant tree species are insignificantly surveyed. The dominant tree species diversity Richness, Evenness, and abundance loss or decline has got a direct negative impact on the local ecosystem service provision chain. These trees play a pivotal role in livelihood hence the need to restore and conserve them. Therefore, the purpose of the study is to assess the Influences of land use practices on dominant tree species diversity Richness, Evenness, and abundance in Ugenya sub-county, Kenya.

1.3 Objectives

This section displays both the General and the Specific Objectives of the study.

1.3. 1 General Objective

The main aim of the study was to assess Influence of land use practices on dominant tree species diversity, Richness, Evenness, and abundance in Ugenya sub-county, Kenya.

1.3.2 Specific Objectives

i. To evaluate the Influence of in farm-forestry on dominant tree species diversity, Richness, Evenness, and abundance in Ugenya sub-county.

ii. To analyze the Influence of human settlement on the dominant tree species diversity, Richness, Evenness, and abundance in Ugenya sub-county.

iii. To assess the Influence of livestock farming on the dominant tree species diversity, Richness, Evenness, and abundance in Ugenya sub-county.

1.4 Research Hypotheses

The following research hypotheses guided the study:

$H_{0\ 1}$: Farm-forestry has no significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a-value = .05.

$H_{A\ 1}$: Farm-forestry has a significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a-value = .05.

$H_{0\ 2}$: Human settlement has no significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a -value = .05.

$H_{A\ 2}$: Human settlement has a significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a -value = .05.

$H_{0\ 3}$: Livestock farming has no significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a -value = .05.

$H_{A\ 3}$: Livestock farming has a significant statistical Influence on the dominant tree species diversity, Richness, Evenness, and abundance at 95% Confidence interval a -value = .05.

1.5 Justification of the study

Out of the six counties of the lake basin region, Siaya county is the lowest ranked nationally in the rural categories in terms of tree species forest cover at less than one percent in comparison to the UN set benchmark of 10%. Ugenya sub-county being among the most socio-economically marginalized, has been perceived as the leading in grass thatched houses, wood fuel use and is the highest significant contributor to the county's 90% of rural biomass fuel expenditure and an exponential household growth rate. Between 2009 and 2019 the households of Ugenya sub-county grew from 12,407 to 33,565 household units, representing an increase of 171%. It is the highest ranked within the county in terms of household growth rate. The sub-county is adversely mentioned in gender parity and resource distribution inequity. The data from livestock farming suggests that the sub-county's stocking rate is in excess by 2 $TLUH^{-1}$ above the recommended carrying capacity 3 $TLUH^{-1}Year^{-1}$.

The mitigative farm-forestry has been misconceived to mean the planting exotic, fast growing tree cultivars at the expense of either the indigenous or endemic dominant tree species. The above-mentioned human practices, if left unaddressed, do affect the tree species population and distribution, through spatial displacement, invasion or colonization and the general disturbance of the dominant tree species. The sub-county is located within a subtropical moist biozone; valuable tree species under similar geographical conditions are threatened globally. Moreover, the dominant tree species are insignificantly surveyed. The dominant tree species diversity Richness, Evenness, and abundance loss or decline has got a direct negative impact on the local ecosystem service provision chain. These trees play a pivotal role in livelihood hence the need to restore and conserve them. Therefore, the purpose of the study is to assess the Influences of land use practices on dominant tree species diversity Richness, Evenness, and abundance in Ugenya sub-county, Kenya.

1.5.1 Significance of the Study

The households' perceptions in Ugenya sub-county on the Influence of land use practices on dominant tree species diversity, Richness, Evenness, and abundance is likely to assist in the understanding of the contributory roles in their coexistence with the tree species. Bringing households to the Knowledge of species diversity, richness, evenness, and abundance, is likely to help them and other stakeholders appreciate the multifunctional approach towards the valuation of dominant tree species for farm-forestry adoption purposes. The survey is meant to clarify the poor understanding and contradiction in literature about the Influence of farm-forestry on tree species cover abundance between Bijalwan et al. (2020) and the Government's 10% farm-forestry policy. This is necessary in addressing the implication of the national Government's Farm-forestry agenda for the 10% tree cover on the indigenous and the endemic Dominant tree species diversity, Richness, Evenness, and abundance restoration at the local scale. From the qualitative conclusion noted in Hegazy (1992), Juma (2009), and Ofori (2015), the unexplained quantitative Influence of the introduction of new or foreign invasive tree species on the native dominant tree species is to be deliberated upon. In reference to the weaknesses found in Oloo et al. (2013), the indigenous and the endemic Dominant tree species which meet the competitive quality ratings of the exotic tree species are to be proposed for local Farm-forestry adoption. Based on the knowledge gap noted from Mohammed et al. (2021), the survey is geared towards identifying and addressing the training gaps in Farm-forestry. Because of geographical uniqueness in the study area noted in Imo (2009), the research is purposed to offer a critique on the Influences of monoculture farm-forestry on the tree species diversity. By interrogating the missing literature on preferential treatments of the tree's species identified in Pantaleo et al. (2016), the uniqueness and function of the dominant tree species are to be assessed to achieve the species diversity, Richness, Evenness, and abundance restoration and conservation at local scale.

Depending on knowledge inadequacy portrayed in Zhang et al. (2012), the study may demonstrate the value of residential area size on the dominant tree species diversity Richness, Evenness, and abundance. The qualitative justification in Whitescarver and Kalman (2009), on the relationship between the size of land owned, the tree species diversity Richness, Evenness, and abundance may statistically be signified. The scarcity in literature identified in Mackenzie (2003), on the concern about the role of higher education and the deteriorating tree species diversity and richness is aimed at statistical ratification. Provided the inconclusive literature between Živković (2018) and Gnonlonfin (2018) the survey is directed at comparing the tree species diversity and richness across the house type categories. By changing the research methodologies and tools applied in Kinyanjui (2009), Kambo

(2018), and Jebiwott et al. (2019) the current study is dedicated to detecting and addressing possible statistical disparities in tree species diversity, richness, evenness, and abundance. The qualitative finding in Meske et al. (1994) that reported a no possible Influence between gender and the tree species diversity, Richness, Evenness, and abundance, needs further quantitative verification. Lack of conclusive literature on households' cultural orientation, species evenness, and abundance between Vliet et al. (2015) and Yeboah (2020) is to be revisited for authentication.

Grounded on the recommendation in Scimone et al (2007), Kabunga (2014), and Odadi et al. (2017) the survey focuses on assessing the association between both the tree diversity, species richness, evenness, abundance, and stocking rate. This survey aims at an awareness creation, pegged on unclear literature noted in Al-Rowaily et al. (2015), Kikoti and Mligo (2015), Ronoh (2016), and Mugabe et al. (2017) about the rate of forage harvesting and the tree species diversity, Richness, Evenness, and abundance. Because of the methodological, statistical tools, climatic, and geographical discrepancies detected in the following studies; Soder (2007), Lorena (2019), Aquino (2019), Mazzetti (2020), FAO and UNEP (2020), the Influence of livestock breeds on tree species diversity, Richness, Evenness, and abundance is to be addressed for conservation. The unexplored information regarding the Influence of livestock farming system on the species diversity, Richness, Evenness, and abundance as spotted in Raja et al. (2017), FAO (2018), Cheng et al. (2019), and Eijrond (2019) is to be interrogated. By studying the Influence of livestock composition, farming method, and tree forage palatability on the tree species diversity, richness, evenness, and abundance, the survey may inform the households and stakeholders on livestock-tree species compatibility in local ecological conservation framework.

Working together with the local stakeholders, including key informants and professionals in the survey is testimony of an achievement resulting from an all-inclusive effort, in championing the likeliness of ecological restoration, sustainability, resilient livelihood and dominant tree species diversity, Richness, Evenness, and abundance conservation in the sub-county. The future research information on dominant tree species diversity, Richness, Evenness, and abundance in the sub-county is likely to be made in reference to this study. The knowledge gained from the perceptions of the households and other stakeholders of Ugenya sub-county, is applicable to localities with similar sociological conditions and geographical characteristics.

1.6 The Scope of the Study

The purpose of the Study Sample Size 384 proportionally drawn per ward Ugenya Sub-County Data was collected Dec 2021 and Feb 2022 Von Thunen Land Use Theory Individuals who satisfied census Requirement Each population sub-set comprised 100 animals. Because of the smaller farm sizes (Wanjira ,2019), a spatial scale of 20M × 20M quadrats were measured and applied in collecting data on the attributes of farm-forestry such as the tree population, number of species, Age, and DBH.

The survey was performed in Ugenya Sub- County, a sample size of 384 household heads participated in the survey. Systematic simple random sampling was used because the sampling population was assumed to be of an even distribution. Because the study sought to address the Influence of independent variables on dependent variables, the descriptive cross-sectional survey design applied, questionnaires, key informants; focused group discussions, observation and photography was incorporated in the case study. Correlation and descriptive statistics were analyzed using computer software (*R Statistics version 4.1.3*). To calculate both the on-farm tree density and cover, standard tree density of 1600 trees/Hectare (640 trees/Acre) was used as recommended in (Coder, 2017 & Gachie, 2021). The dominant tree species of *DBH* ≥ 5 inches (BH = 4.5 feet from DRC) on both the residential compounds, fences, farm plots, and along the farm boundaries had the *DBH* measured using a D-tape, ordinary tape, and metric ruler. The trees were counted, the local, common, scientific name and ethno-botanical function noted where applicable. Subset population of grazing/browsing livestock was sampled, for participation in tree fodder palatability test. Household size composed of the individuals that are dependent on a household head for the last 12 months. The land size was reported in acres because the sub-county is characterized by smaller land parcels (Wanjira 2019). Gender role analysis, dominant tree species observation sheets were adopted and modified from (Kokwaro, 1994), Oloo et al., 2013 & Oloo, 2013).

1.6.1 Limitation of the Study

Household characteristics were assumed to be homogeneous, therefore systematic random sampling was used. To avoid sampling bias, the starting point for sample selection was randomized, this was maintained until a sample size of 384 household heads attained. Using a formula cited in Daniel (1975), non-response was solved by adding an extra five percent of the total respondents, by including the relevant questions and items in the questionnaire, by sending reminders upon the lapse of agreed response time. Though the seasonality Influence is a possible problem in the research, it was assumed to be statistically insignificant. The dominant tree species diversity, Richness, Evenness, and abundance was unlikely to be affected by the time Influence within a period of less than 30 days. The problem of possible respondent's bias was solved by incorporating other study methodologies such as observation, measurement, and photography. In case of cultural and language barrier or the tree species identification difficulty, the relevant observable data was collected using an effective first language, the dialect acknowledged and later translated. There is lack of previous research on the Influence of land use practices on dominant tree species diversity, Richness, Evenness, and abundance at the local scale level. Therefore, for criterion validity, the results were compared with the previous findings from the studies of other geographical locations. The *DBH* measuring tape (D-tape) is expensive and unavailable at the local market. The D-tape was hired from an expert attached to KEFRI Maseno. In addition, under the expert guidance, 5 ft. measuring metric rulers and ordinary tape measures were improvised. A minimum of three measurements were performed and averaged calculated to reduce measurement bias (Miljiko, 2017). All the interviews and discussions were performed at the convenience of the respondents. To fit in the time budget, twelve enumerators, three per ward were trained and recruited in the survey.

1.7 Theoretical Framework

The research is based on Von Thunen's theory of agricultural land use. The theory is basically concerned by the rural land use patterns. According to the theory, there is an isolated territory which is self-reliant with no external interference. The land is completely flat and has no physical features to interrupt the terrain. The soil quality and climate are uniformly distributed throughout the regime. Farmers transport their own goods to market via ox-cart across land, express to the market. Farmers remain the sole decision makers and their main aim is to maximize profit. The state is depicted as a concentric framework, with the city occupying the central position followed by intensive agriculture, forest resources, extensive field crops, and livestock farming respectively. The model has a weakness because it assumes the existence of the modern transport and food storage system. However, in spite of the weakness, the Von Thunen model is currently relevant because it is modifiable to fit local Land Use Practices of less developed rural societies.

Rural Land use practices are no matters of chance. Rather, it is always the outcome of logical human decisions. Even before Von Thunen, farmers worldwide made rational land use decisions. The theory is used to describe agricultural land and varying spatial patterns in rural areas. The six distinctive societal drivers explain rural Land use practices namely; Demographic, Economic, Technological, Institutional, Sociocultural, and Location factors. Households and their attributes are a key organ in land use management decision making which end up initiating land use change processes. The two possible manifestations of the land use change are either classified as the Intensification or Deintensification options. In the recent past this theory has been applied in assessing factors influencing agricultural land use change in Europe (Vliet et al., 2015). Furthermore, the theory successfully guided the study on Agriculture and its impacts on Land-use pattern changes, Environment, and ecosystem services (Kanianska, 2016)

The theoretical framework benefits this study because the six land use drivers are fully in play at the local scale level. The demographic trend of the sub-county is characterized by an exponential population growth in the last ten years possibly straining the dwindling natural resources. Due to the global economic crunch attributed to climate change, global warming, and the COVID-19; the rural population has been hard hit warranting a likeness of the ecosystem service over dependency. To maximize economic output, the households are tapping the benefits of technological advancement for example the adoption of new or exotic tree species and livestock breeds. Institutionally, land use policies like the 10% Farm-forestry rule are likely to affect the land use decisions and pattern locally. The sociocultural land use drivers such as the ethnobotanical interactions and gender parity have been cited as possible factors affecting the equity in natural resource distribution. Like any other region Ugenya sub-county is confined within a unique geographical location which predetermines the spatial temporal distribution of both the physical and human phenomena.

1.7.1 Conceptual Framework

The global human population is trending in exponential growth; Africa and a great number of developing nations are the highest ranked in such demographic patterns. Quality land which is the primary factor of human development is however constant. Distribution of the explosive human population in a logical spatial-temporal frame is a challenge, because the projected human development should have positive correlation with natural resource sustainability and provision.

From global to local scale, human interaction with the natural ecosystem has witnessed a change in approach resulting from technological advancement due to constant research and scientific discoveries. Advanced agricultural mechanizations, use of chemical supplements such as; fertilizers, herbicides, and pesticides among many have led to intensification of land use practices. The main objective of such practices is to minimize inputs for maximum returns. However, for output maximization, there is a possible corresponding outcome on the ecosystem provision chain.

Trees are cleared with little regard for neither replacement nor compensation to pave way for human settlement. A condition which continues to be replicated through time and space. The human livestock relationship is inseparable due to the symbiotic coexistence, though both do compete at the same trophic level resulting in pressure on edaphic factors. For example, over reliance on a single primary producer may affect the decline in biodiversity or it triggers the loss of the subject dominant tree species.

The Government, stakeholders have realized the Influence of the land use practices on the tree cover decline. Some of the mitigation measures proposed for implementation include tree planting and the 10% farm forestry campaigns to alleviate the dominant tree species cover decline witnessed on a worldwide scale. However, the dominant tree species diversity Richness, Evenness, and abundance’s conservation, restoration and sustainability is yet to be realized at the local scale. Some of the recommended dominant tree species qualified for both botanical and ecological audit to assess their compatibility with local landscape. Pure tree stands are likely to offer significant economic paybacks and an inadequate ecosystem service, compared to a diverse community of the dominant tree species.

Steep changes in altitude, latitudes, weather, and climate are likely to cause a variation in the distribution of both the Land Use Practices and the Dominant tree species. The average annual rainfall is 1,700mm per annum, the environmental temperature is 23.75^{0}C per annum, the average latitudinal position 16' N while the altitudinal average range 1,270m above the sea level (Abura 2017). Because of the possible confounding Influence, the mentioned physical geographical factors are held constant and qualify to be treated as control variables during the entire survey process, as illustrated in Figure 1. It is hypothesized that Average Latitudinal extent, Altitudinal range, weather, and climate of Ugenya sub-county are held constant and therefore, have no significant statistical Influence at 95% confidence level in the research. Based on the Von Thunen theory, that held certain factors constant, this study similarly found it wise to keep the above mentioned intervening variables constant.

Dominant trees are considered valuable geographical phenomena because their ecological functions are non-substitutable; these trees are adapted to a geographical space from prehistoric times. The dominant tree species diversity, Richness, Evenness, and abundance has unique genetic characteristics which require protection from invasion, colonization, depletion, because the ecosystem depends on the existence of these trees.

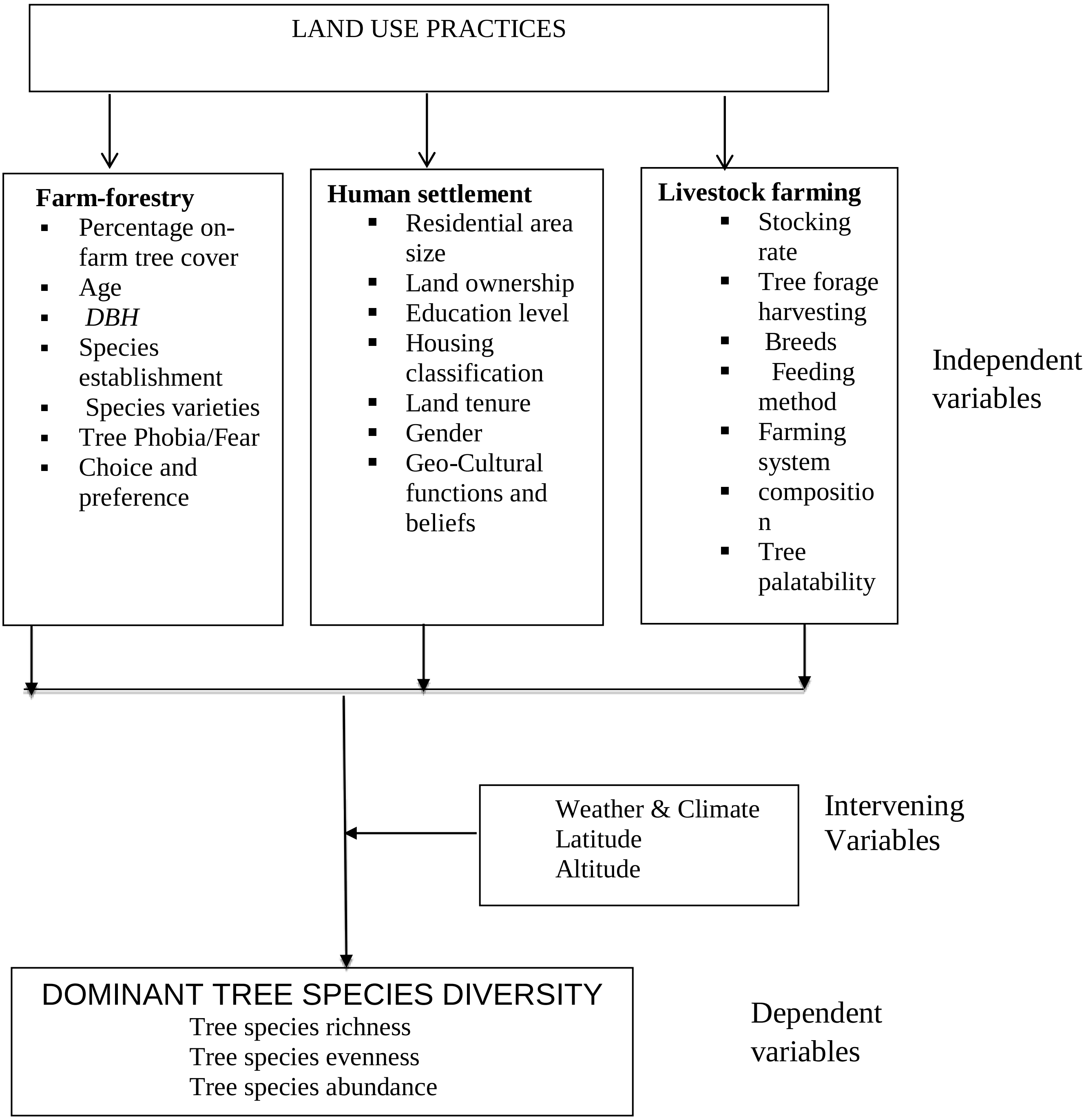

Figure 1: A diagram Showing the Conceptual Framework

Source: The Researcher's Own Conceptualization 2021

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Based on specific objectives, the following subtitles are reviewed; farm-forestry, and dominant tree species, human settlement, and dominant tree species, and; Livestock farming on dominant tree species.

2.2 Farm-forestry and Dominant Trees Species Diversity Richness, Evenness, and abundance

Monoculture is a common practice in farm-forestry translating to a large tract of land under a few or single tree species thus negatively affecting both the species diversity and richness (Chaudhary, 2016). In a like manner, Daie (2019) reported a decline in tree species evenness as an outcome of farm-forestry practices in Ethiopia. In support, Bijalwan et al. (2020) noted low tree species population among the households practicing farm-forestry in India. Such results in Bijalwan et al. (2020) were possible because the survey was based on post harvested farms, peak species abundance have been reported in pre-harvested tree farms while the lowest species abundance occurred in post-harvested farms of Australia (Denovan, 2021). The consequences of planted farm trees on species diversity are commendable, the studies revealed the absolute negative Influence of tree farming on species diversity, richness, evenness, and abundance. Even so, for instance, Bijalwan et al. (2020) contradicted the envisaged benefits of the 10% governments farm-forestry agenda for increasing tree cover.

Imo (2009) revealed Kenya's tree diversity loss to monoculture farm forestry. The low tree species evenness was attributed to a possible removal of a diverse community of tree species to pave way for the fast-growing farm-forestry tree cultivars (Siaya County Annual Development Plan [SCADP], 2019). Ugenya sub-county is at the very initial stages of the

(10%) Farm-forestry Adoption (G.o.K, 2020). Currently, Siaya County is the lowest ranked at less than one percent in terms of forest cover (G.o.K, 2013, MEF,2019 & Koech, 2021). Therefore, it is prudent to undertake a similar study at the local scale to verify if similar trends exist.

A positive relationship between the age of trees and species diversity was conclude in the conserved natural forests (Marine & Catherine, 2012). The long run Influence of forest conservation includes the appreciation in tree age, species diversity, and richness (Onefeli & Adesoye, 2014). The SCADP (2018) reported a decline in tree species evenness as an Influence of age factor in Siaya county. The decline in tree species evenness is occasioned by the possible harvesting of a particular community of mature tree species for socio-cultural and economic utilities, thus creating uneven species distribution in local natural forests (Kagombe, et al., 2020). Consistently, Fritscher (2020) observed a reduction in tree species abundance with an appreciation in forest age. Such observations were possible because the tree maturity is dependent on age of the tree which determines the rate of forest harvesting (Castro et al., 2021). The revelations on the relationship between tree age and species diversity are relevant because they addressed the importance of socio-cultural and economic attributes in natural forest conservation. Even so, the reason behind a worrying negative trend on tree species abundance with increase in tree age was inadequately explained. Furthermore, the surveys were based on conservation of the natural forests. Therefore, whether there are existing reasons other than tree age affecting tree species abundance in the tree farms remain unknown.

Hirons and Percival (2011) realized that higher values of *DBH*, species diversity, and richness occurred among the economically endowed households. Economic endowment is associated with households' reluctance to over utilize tree resources hence positively impacting long-term ecological conservation (Lindenmayer et al., 2012). Kawaletz et al.

(2013) reported a positive correlation between *DBH* and seedlings/sapling species evenness. The higher seedlings/sapling species evenness was attributed to the farm-forestry's clear cutting which is known to favor the natural tree species regeneration along the lower Nzoia flood zones prompting higher species evenness (Ngaina, 2014). Furthermore, Ngaina (2014) paid no attention to the *DBH* calibrations which likely inflated the species evenness by the inclusion of the tree seedlings and saplings in species enumeration. Proper tree species enumeration for conservation purposes should include tree trunks of $DBH \geq 5$ inches (Yang, et al., 2017). However, in Japan Lizuka (2018) observed low tree species count among the households which registered higher *DBH.* The finding in Lizuka (2018) was likely because in farm-forestry the tree species with relatively larger trunks are first harvested leaving the trees with relatively lower *DBH* to continue maturing (Ayaz et al., 2019). The studies on the association between tree trunk size and the species diversity are extensively explored. The positive function of households' economic power in improving the tree trunk size was clarified. But because some of the studies such as the survey by Ngaina (2014) drew conclusions without strict adherence to the recommended *DBH* for tree count prequalification, the accuracy was likely compromised. Therefore, there is a requirement for performing a similar study with conformity to the stipulated *DBH* for tree species enumeration.

Hegazy (1992) revealed an escalation in global natural forests tree species richness and diversity loss to man-made forest farms. The observed uptake in the global tree planting was likely due to the international tree conservation conventions that promote the 10% farm-forestry campaigns in bid to increase the on-farm tree cover (Juma, 2009). In contradiction, Lambin and Meyfroidt (2011) and Meyfroidt (2011) using close global satellite observation found no visible tree species canopy difference in tree farms and natural forests. However, Ofori (2015) reported a higher percentage of planted trees in relation to the naturally growing tree species. The outcome of tree planting and the species diversity are well undertaken. The studies showed the positive contribution of farm tree planting in increasing the tree population (abundance). Despite the fact, the contribution of tree species establishment to the species diversity, richness, and evenness is yet to be understood.

FAO (2015) performed a comparative forest conservation survey on tree species richness and diversity, the survey registered a significantly low dice coefficient of the Sorensen's similarity index in tree varieties in exotic and natural indigenous forests. The natural forests are associated with higher indigenous tree species richness and diversity driven by natural selection (UN, 2016). Meanwhile Musingo (2016) reported a significantly higher value of Simpson's index in tree species evenness in the indigenous than the exotic tree species. At the local scale, Ugenya sub-county wood fuel use is estimated at 30% above the county's biomass fuel expenditure extracted from indigenous forests (CADP, 2017). Conversely, Brancalion (2020) revealed a higher percentage rank abundance for the exotic trees compared to other indigenous tree species. The conclusions on the distribution of tree varieties on the species diversity and richness were comprehensively performed. The benefits of both indigenous and the exotic tree varieties in farm-forestry were emphasized. Even so, the justifications on tree species evenness and abundance were inconclusive because the Simpson's index pays more attention to species evenness and abundance (dominance). A similar survey based on Shannon Wiener's index of biodiversity conservation is therefore necessary.

Through verbal interviews, a conclusion was reached that tree-fear respondents were likely to report love for fewer tree species compared to the non-tree phobia group (Tomalak, 2010). This is because societal motivation and personal attitude play an important role in determining tree species selection in farm-forestry (Kanianska, 2016). Thus, Rotich et al. (2017) argued that personal attitude would negatively affect species evenness. And that tree fear affected category were likely to precautionary handle tree species or plant a few tree species in their wish list that they would manage with confidence (Liu et al., 2018). Further, Lalisa (2019) relying on simulated video indicated a likely variation in tree species abundance due to human attitude. The studies on dendrophobia laid bare the negative Influences passed over to trees due to fear factor. It is however poorly known if tree phobia affects diversity, richness, and abundance.

Pantaleo et al. (2016) through interviewing key informants, who included chainsaw operators, timber yard owners, carpenters involved in furniture, and house construction concluded that the tree species preferred by these particular respondents were becoming rare in physical species diversity assessment in Tanzania. The research outcome by Erle (2021) which by observation and interview of large-scale plantation farmers reported no statistical relation in values of tree species evenness in tree preference and non-preference. Esmail (2021) noted that the increase in the species abundance outcome based on qualitative report was possible because of non-preference by the public on *Prosopis juliflora* (the infamous *Mathenge*) tree, occasioned the tree population growth due to low human disturbance and increased species invasion. Preference and non-preference of tree species is a core principle in farm-forestry. The attitude is as varied as the choices of trees to be adopted. However, the Influence of attitude variations on the tree species diversity, richness, evenness, and abundance is inconclusively understood at the moment.

2.3 Human settlement and Dominant Tree Species Diversity Richness, Evenness, and abundance

Zhang et al. (2012) based on Simpson's index revealed a significant positive statistical association between both the tree diversity, species abundance and residential area size. Similarly, Sottile et al. (2014) reported an increase in values of tree species evenness due to an increase in residential area size. Again, using Simpson's index, Melliger et al. (2018) observed a higher tree species richness in residential areas. The studies on the Influence of residential area size on tree species were successfully carried out. The contrary perception that human residential development negatively impacted tree species was proved otherwise. For instance, both Zhang et al. (2012) and Melliger et al. (2018) reported higher values of species diversity and richness with increase in residential area size because the surveys were pegged on Simpson's index of biodiversity assessment which is known to disregard the presence of rare species in an ecological community. Therefore, for factual verification, using a better tool of biodiversity assessment, a study revisit is necessary.

In conclusion Whitescarver and Kalman (2009) revealed a significant positive statistical relationship between both the tree diversity, species richness and size of land parcels owned by nature conservancies. In agreement, Biancas et al. (2013) made Similar observations in an investigation performed on public lands. In the contrary, Vuyiya et al. (2014) reported a decline in the species abundance with increase in land annexation around Kakamega forest. Dittoh et al. (2015) realized a likeliness of a depreciation in values of tree species evenness because of an increase in land size, sentiments that contradicted Wanjira (2019) in a similar study in Siaya county which observed a higher tree species count in relatively larger farms. The studies performed on the Influence of land size on tree species diversity, richness, evenness, and abundance are beneficial in the formulation of farm forestry adoption parameters. Public forests have been associated with higher values of tree species conservation. However, little is known about the tree species diversity in private lands.

In matters relating education level and the tree species, Mackenzie (2003) through qualitative justification, concluded a possible difference in tree species richness and diversity in basic and higher education categories. Tanui (2015) assessed tree canopy and reported no visible difference in tree species evenness among the households, irrespective of education categories. G.o.K (2019) envisaged a positive association between education level and natural resource management in a report. Surveys about the role of education on natural resource management and conservation are appreciated. The planned inclusion of the natural resource management into the high school curriculum is likely to improve the value with which the tree species are handled. Despite the initiative, nothing is known about the role of education level on the tree species diversity, richness, evenness, and abundance.

Živković (2018) reported observable differences in the tree species richness, diversity in traditional grass-thatched and modern housing. Egger et al. (2020) through observation assessed lower tree species evenness in grass thatched than modern housing. The mentioned study was dubbed "give directly" "follow" up study in Siaya county with specific reference to Ugenya sub-county. IUCN (2021) revealed low tree species abundance in modern housing. The exploration of the association between housing classification and tree species is relevant. House classification is a contentious issue seen as a socio-cultural and economic status indicator. At the local scale, the construction of modern brick houses has been blamed as the highest in degrees of tree species depletion. At the same time the traditional grass-thatched houses are perceived as a symbol of economic underprivileged and cultural backwardness. In the background of such contradicting views, a poor understanding of the relationship between housing classification and the tree species diversity, richness, evenness, and abundance is eminent.

While studying the emotive forest land tenure in Kenya Kinyanjui (2009) spotted a difference in the tree species richness and diversity in both the communal and private tenures studied. Kambo (2018) concluded a variation in tree species evenness in the private and communal land tenure. Furthermore, Jebiwott et al. (2019) discovered an observably low species abundance in private lands. The exploration of the land tenure system and the tree species are of potential to both the land economists and tree species conservation. The communal land tenure system has been linked to forest encroachment and natural resource exploitation. The responsibility to plant, conserve, and manage trees comes with private land ownership. The decision-making organs for both communal and private land ownership differ. Therefore, whether household decisions on private lands affect the tree species diversity, richness, evenness, and abundance differently or similarly in comparison to public land is subject to survey.

Based on snowball sampling, Meske et al. (1994) reported a difference in the tree species richness and diversity in gender-based categories. However, while undertaking similar studies in Siaya county Oloo (2013), Oriedi (2016), G.o.K (2017), and Oranga (2018) failed to address the Influence of gender inequality on tree species diversity, richness, evenness, and abundance. Despite their acknowledgment that female headed households were culturally excluded from a number of forest management functions. Liliane et al. (2019) revealed a possibility of higher tree species abundance in male headed households of Rwanda. Gender parity is among the global issues, therefore an attempt to bring gender equality in tree species conservation is a brilliant idea. Female members of the society are claimed to be marginally represented in the geo=socio-cultural, political, and economic arenas. Oloo (2013) relied on snowball sampling which is known for statistical bias due to common sample dependency factor. However, despite the higher agricultural productivity attributed to female headed households of the rural areas, nothing is statistically understood on the relationship between gender, tree species diversity, richness, evenness, and abundance.

Through verbal interviews, Vliet et al. (2015) concluded no Influence on the relationship between culture and tree species diversity. Taesuk et al. (2019) associated higher tree species richness with cultural conservation. Yeboah (2020) on the other hand found a variation in the tree species evenness and abundance in traditional and modern culture categories. The exploration of culture and tree species is important because it reinforces the need for the inclusion of the indigenous ethnobotany in tree species conservation. Material culture has been related to the conservation of native biodiversity for instance (Trees) which are used to perform rituals and a number of cultural practices. Modernity and the native cultural erosion are associated with societal and ecological changes driven by adoptions of foreign ideas and materials. The cultural divide is known to affect the nature and mode of human practices, such as agriculture, settlement, and other infrastructure development. It is however unclear if cultural difference affects the distribution of the tree species diversity, richness, evenness, and abundance.

2.4 Livestock farming and Dominant Trees Species Diversity Richness, Evenness, and abundance

Scimone et al. (2007) in the study of trees in pure dairy farms by reported no significant statistical association between both the tree species diversity, species richness, and stocking rate. (Kabunga, 2014) noted a decrease in values of tree species evenness owing to an increase in stocking rate. Conversely, Odadi et al. (2017) observed an inverse relationship between tree species abundance and stocking rate. The inclusion of the Influence of stocking rate on tree species conservation is consistent with nature and biodiversity balancing act. There is a necessity in understanding the optimum number of livestock which is beneficial to the farmer and at the same time ecologically sustainable. For example, Scimone et al. (2007) revealed a positive correlation between the values of stocking rate, species diversity, and richness. Even so, the trend on tree species diversity, richness, evenness, and abundance in farms domesticating mixed livestock for other purposes is yet to be conclusively resolved.

Tree forage harvesting by Al-Rowaily et al. (2015) portrayed a significant positive statistical association between both the tree diversity, species richness, and the rate of tree forage harvesting. However, Ronoh (2016) reported no observable Influence between the tree species evenness, abundance, and the rate of tree forage harvesting. The tree forage harvesting is an important component in livestock feeding. The forage tree organs are meant to supplement livestock feeds. The trees are harvested, sometimes transported to feed the animals. Constant infliction of injuries is known to negatively impact on tree health. The information on sustainable rate of tree forage harvesting is unavailable. Therefore, equally the knowledge on Influence of the rate of the tree forage harvesting on tree species diversity, richness, evenness, and abundance is lacking.

Soder (2007) noted that the percentage in tree species richness and diversity in farms that reared the two livestock breeds was likely different. Furthermore, Aquino (2019) reported a significant low value of five percent of Jaccard similarity index for values of tree species evenness in farms rearing exotic and the farms with indigenous livestock breeds. However, FAO and UNEP (2020) revealed a relatively higher abundance in farms that domesticated the exotic livestock. A consideration of livestock breeds is an important part in livestock-tree species interactions. The native livestock are diverse feeders on trees and other vegetation while the exotic breeds are renowned heavy forage consumers. Locally, households keep either the native livestock breeds, pure exotic, or a mixture of the two livestock types. The report by Aquino (2019) was concluded based on Jaccard similarity index which has insufficient ability to prove the significance in the difference. Therefore, for more accurate conclusion a similar study needs to be performed using an independent two sample t-test.

Raja et al. (2017) reported a qualitative difference in tree species richness and diversity in farms that employed the traditional livestock feeding and the modernized livestock farms. Cheng et al. (2019) noted a significantly higher Gini inequality index of .57 for tree species evenness in the modern and the traditional livestock feeding method. Eijrond (2019) showed a lower mean score on species abundance in farms practicing the traditional livestock feeding. Analyzing livestock feeding methods is a helpful survey because the less wasteful and ecologically friendly methodology was identified. For example, Cheng et al. (2019), computed a significant higher Gini coefficient among the categorized farmers which included a discrepancy analysis on livestock keeping. The Gini coefficient is known for the inability to significantly differentiate a variety of inequalities. For further validation, there is a need for a similar comparative study using relevant statistical tools of analysis.

The finding by Bagchi et al. (2012) through Moses's mean rank assessment identified no significant statistical rank difference in the tree species richness and diversity in the intensive and extensive livestock farming systems. Anadon et al. (2014) based on practical assessment reported a possible difference in the tree species representation in the intensive and extensive livestock farming systems. Adimassu et al. (2020) courtesy of enumeration computed a higher percentage of tree species abundance in intensive livestock farming. An exploration on the relationship between livestock farming system and the tree species is logical, because the shrinking land resource calls for a more intensive farming approach. Bagchi et al. (2012) found no significant rank difference in species tree diversity and richness in the two farming systems. As a non-parametric statistical measurement tool, Moses's mean rank assessment is characterized by relatively low statistical power. Therefore, for accuracy, further analysis is necessary using a parametric independent two sample t-test.

In a book published by Foster (1973), it was concluded that the tree species were equally distributed across the livestock farm categories hence no difference existed in the values of the tree species richness and diversity in farms that reared single livestock species and the ones with mixed livestock. Gibson et al. (2016) reported no tangible difference in values of tree species evenness in the intensive farming system where single and mixed livestock were domesticated. Glowacz and Niznikowaski (2017) accounted for a lower percentage in tree species abundance with increase in livestock composition. Livestock composition plays a key role in ecological interactions because they feed on different tree species and other vegetation. Even so, the conclusions were majorly drawn from observations as the case of (Gibson et al., 2016). Observation is one of the methodologies which when used alone lack statistical backing hence associated with inadequate parametric significance nor power of accuracy hence unsuitable for independent sample comparison.

Chesson (1983) observed a difference in forage palatability preference among different ruminant animal species. The recommendation by Usman et al. (2009) proposed the adoption of the Yellow Oleander's (*Thevetia peruviana*) seed cake for livestock feed supplement. A forage tree identification study by Forbes (2010) enumerated 63 vegetation species which included all classes of tree species irrespective of trunk size. Elsewhere, Waternan et al. (2011) drew conclusions on forage palatability and preference based on verbal interviews. The deductions on tree forage palatability and preference are valuable as far as the use of forage trees to feed livestock is concerned. Selecting non-toxic forage trees for livestock feeding is challenging. However, most of the data available is based on informal verbal information. To arrive at a scientific conclusion, there is a need to seek the livestock own oral perception through an expert guided palatability test.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the study area, Research design, and Methodology.

3.2 The Study Area

The Ugenya Sub- County is a rural village located in Western Kenya. It is found in 0^0 02, 0^0 18'N and 34^0 06', 34^0 23'E, See Figure 2. It is one of the Sub-Counties in Siaya County. It has 4 political electoral wards: East Ugenya, North Ugenya, Ukwala and West Ugenya. It borders Butula Sub-County, Ugunja Sub-County, Funyula Sub-County and Alego Usonga Sub- County. It covers an approximate area of 322.3 Km^2.The latitudinal gradient determines the spatial temporal distribution, characteristics, and adaptation. Dominant tree species have been observed to exhibit varied seasonal adaptive characteristics and distribution according to the geographical attributes of an area (SCADP, 2017).

3.2.1 Climatic Conditions of the Study Area

The agro-ecological zone of Ugenya sub-county ranges from ML1 to ML 2. The rainfall distribution is of class B bimodal rainfall between 1200-2200 mm per annum. The thermal zoning falls between 1 and 3 which is 22.5^0 C-> 25.0^0 C. The main precipitation is experienced around March to June while the short rains begin from September to December, (G.o.K, 2019). Dominant tree species are reported to demonstrate dominance depending on climatic zones hence the geographical naming characteristics of vegetation, trees, and forests. However, global climate change or variability is affecting the dominant tree species establishment and adaptation. Frequent disturbance by nature's instigated fire, decline in plant germination and growth due to global warming affects the intolerant dominant tree species.

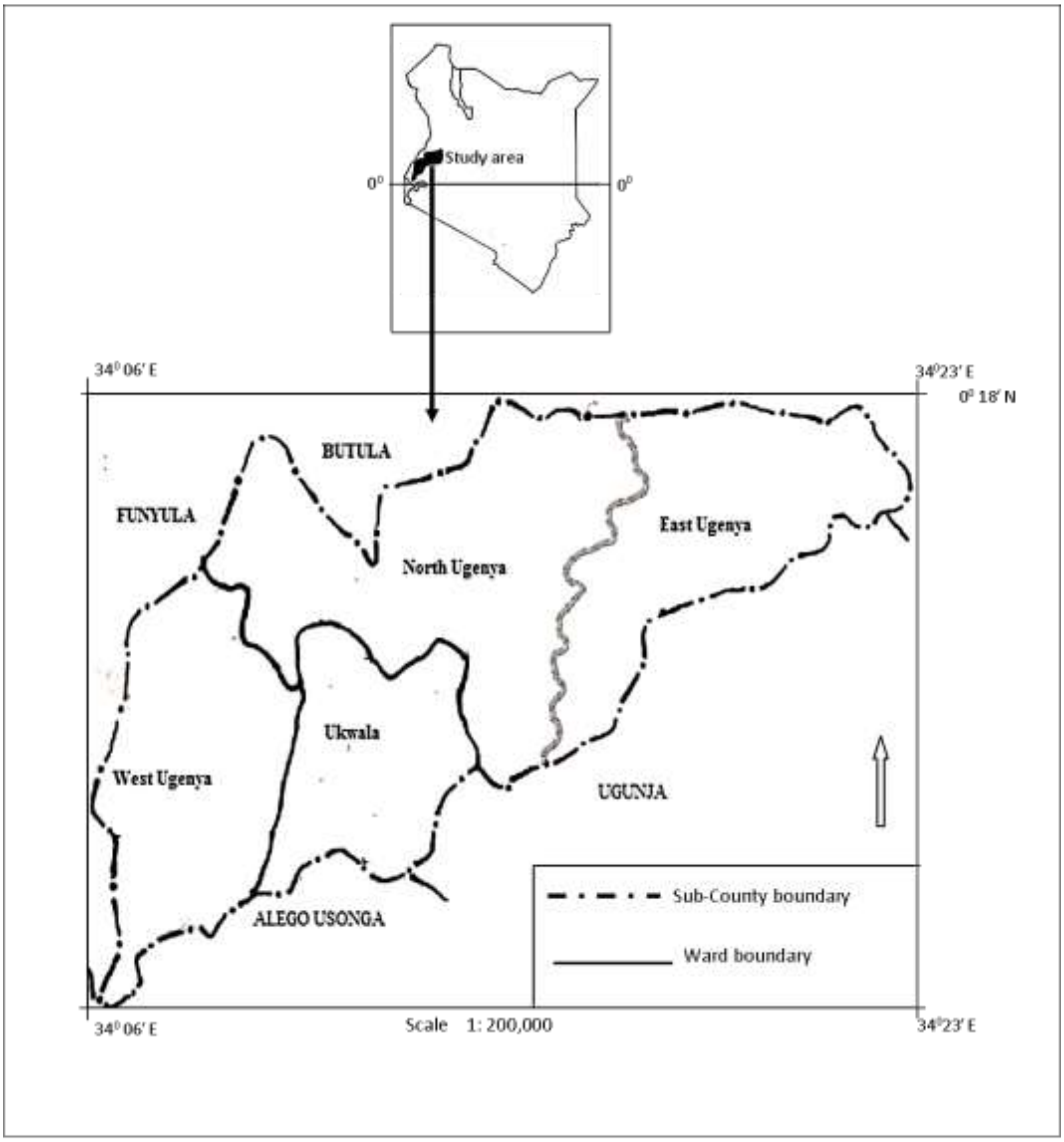

Figure 2: A Map Showing Location and Outline of the Study Area

Source: Adapted and Modified from SCADP (2017)

3.2.2 Physical Characteristics of the Study Area

Ugenya falls under the high-altitude areas of Siaya County. The topography rises from 1140m on the lower Nzoia flood plans to 1440 m above the sea level (Abura, 2017). The report further identified Odiado and Odima as the two hills found in Ugenya sub-county. The land is undulating; there are swamps and streams which drain into the Nzoia River. The local soil consists of red loams, clay, and sandy soils. Vegetation type, characteristics depend on altitude and edaphic factors.

Topographical modification by humans resulting in land degradation which has both direct and indirect impact on dominant tree species resilience. To emphasize, altitudinal gradient is associated by steep variation in the ecosystem and its interaction dictated by the height above the sea level which predetermine vegetative adaptation. For example, the low altitude flood plains of Nzoia River in Ugenya sub-county are prone to flooding (Ngaina, 2014).

Flooded soil is characterized by insufficient oxygen and low PH which affects the growth of some dominant tree species. The additional cost of either reclaiming or rehabilitating water-logged soil may affect the local dominant tree species diversity, Richness, Evenness, and abundance restoration agenda.

3.2.3. Economic Activities of the Study Area

Crop and livestock farming represent nearly 80% of total economic activities and a sizable fraction of employment opportunities in the sub-county. Youths in the sub-county are exploring the gap in transport system contributed to by the numerous distributions of weather roads which favor motorcycle taxi business. For spatial connectivity, the sub county is bisected by the B1 highway, linking Kenya to Uganda, enabling continuous movement of people, goods, and services. SMEs are distributed in the shopping centers. Brick, Charcoal manufacturing, craft, building, and construction are included among the economic practices in the sub-county. The local economic practices are likely to affect dominant tree species diversity, Richness, Evenness, and abundance, for instance the industrial inertia of brick and charcoal-manufacturing is likely to culminate in an unsustainable ecosystem because of the potential depletion of wood fuel and trees. This may degenerate to over exploitation of the dominant tree species hence affecting the tree species diversity, Richness, Evenness, and abundance (SCADP, 2017) (Rodrigue, 2020).

3.2.4 Vegetation

Located in the ITCZ, Ugenya sub-county has been home to several dominant tree species, both indigenous and exotic while some are considered endemic species. The locality is perceived to have a wide range of medicinal plant species, though reported dominance of 27 tree species. The classification of vegetation is Subtropical, moist biozone; geographical adaptation of trees depends on the surrounding biota. Competition among species or genus is intense because the individuals compete for similar edaphic factors. Dominant tree species are stationary in search for resources, competition for space and resources are vital. The above ground includes competition for sunlight, space, symbionts, and pollinators. Below ground, species compete for water, nutrients, space, and symbionts such as nitrogen fixers (Kokwaro, 1994).

The vegetation which exploits, sustains, and maintains itself in a habitat tends to be dominant. Dominant tree species have evolved trunks which allow for the aerial access to sunlight and gaseous exchange and in addition to the root system which assists in the subterranean infiltration. Kambo (2018), noted that apart from climatic setbacks, the disadvantages which trees face are either competition or invasion from a section of the plant species or related to human practices.

3.2.5. Social and Cultural Factors

Poverty, low level of education and HIV prevalence are the main social characteristics of Ugenya Sub-County. A society has socio–cultural norms which its members adhere to. For example, Oloo (2013) confirmed that there is cultural exclusion of female-headed households in Siaya County from a classified tree growing practices apart from weeding and watering. There are myths associated with a sample of plants and dominant tree species. It is a home to a rich ethno-botanical culture. In Africa, the societies attach different cultural values to the dominant tree species hence the preferential treatments accorded a number of dominant tree species. Ethno-botanical knowledge is an important tool in the rural tree diversity, Richness, Evenness, and abundance conservation, the native people are perceived to have an in-depth knowledge and understanding gained from years of constant interaction with the local ecosystem. Apart from the informal pollution-oriented brick-manufacturing industry, the region is known for ethno-botanical culture, beliefs, and gender inequality as reported by (Oloo, 2013, Oriedi, 2016, G.o.K, 2017, & Oranga, 2018). For example, it is a taboo for a female-headed household to engage in a number of farming and classified tree establishment practices in some parts of the sub-county when the male spouse is alive but absent (Wanjira, 2019).

Ugenya sub-county have a possibility of being among the contributors to the dominant tree species low abundance observed at the county level, the sub-county is perceived to be the highest ranked in terms of grass thatched houses Miguel (2021), in addition to wood fuel use at an approximate 30% above the county's average biomass fuel expenditure (SCADP, 2019). The report provided an additional indication for a plan to raise the county's dominant tree species abundance to more than two percent by the end of the year 2022.

3.3 Research Design

Cross section research design was used in the study. Dawadi (2021) recommends the use of a cross-section survey design, data to be collected at an instant from the study locality justified the Influence of land use practices on the dominant tree species diversity, Richness, Evenness, and abundance based on the perception of the respondents. It is a technique of collecting data meant for answering questions about the contemporary trend, it involves a one-time interaction with the respondents. This is a survey design used to assess respondent's (household heads) perceptions, feelings, and preferences in social sciences problem-solving studies. It is an ideal study design when proving or disapproving assumptions.

3.4 Study Population

The study involved four wards adding up to a household total of 33,565 for Ugenya Sub-County. Table 1 shows Households' Sample Distributions.

Table 1: Households' Sample Distributions in Ugenya sub- county

Ward	Households	Sample size proportions
East Ugenya	8858	101
North Ugenya	9624	110
Ukwala	6188	71
West Ugenya	8895	102
Total 4	33,565	384

Source: Adapted and Modified from KNBS (2019)

To attain a minimum sample size of 384 household heads (Table 1), the total number of households from each ward, was divided by the total households for the entire Ugenya Sub-County and multiplied by the total sample size. According to Kenya National Bureau of Statistics (2019), the population of Ugenya sub-county was 134,354 persons distributed in 33,565 households, compared to 12,407 household units in 2009. Based on Fisher et al. (1998), sample size calculation formula, a minimum sample size of 384 household heads is recommended when the study population is more than 10,000 units. The following Fischer's formula was applied

$$n = \frac{z^2 pq}{e^2} \qquad (1)$$

$n = (1.96)^2 \times 0.5(1\text{-}0.5) / 0.05^2 = 384$ household heads

Where:

n = desired sample size.

z = a constant of 1.96 based on confidence level at 95%

p = standard deviation at 50%

ε = the error margin of 5%

$q = p-1$

A total of 384 household heads were interviewed. The household heads that are either male or female were the target. They offered information on land use practices and how they are associated with dominant tree species. To ensure fair distribution in the study, all the four wards in Ugenya Sub- County were represented in the study.

To attain a minimum sample size of 384 household heads, the total number of households from each ward, as presented in Table 1 was divided by the total households for the entire Ugenya Sub- County and multiplied by the total sample size. Sample proportion =

$$\frac{\text{Ward Population}}{Sub\text{−}county\ Population\ (33{,}565)} \times 384 \qquad 2$$

3.4.1 Systematic Sampling

A *KMO* sampling adequacy test was performed to test sampling Reliability and Validity. Table 2 displays the KMO and Bartlett's test result.

Table 2: The Result of KMO and Bartlett's Test

Test	Result
KMO	.81
Chi-square	1003.8
Df	3
Sig	≤ .001

An adequate sample should be a true representation of the population (universe) attributes. It should be of random and proportional selection. A *KMO* coefficient value of .810 (Table 2) was revealed. Therefore, with reference to Miljiko (2017), a KMO coefficient of ≥ .80 indicates a strong sample adequacy suited for factor analysis.

To arrive at an adequate sample size of 384 household heads, the household totals from each ward was divided by the total of the entire survey area and multiplied by the desired sample as depicted. See Table1 column 4. Systematic random sampling was applied to select the household heads. Household heads' names were derived from the lists provided by the Ward administrators.

$$Sampling\ interval = \frac{\text{Entire Population } (N)}{Desired\ Sample\ Size\ (n)} \qquad 3$$

For an illustration, to calculate the sampling interval for the North Ugenya Ward, a total of 9624 households was divided by the proportional sample size of 110, thus the sampling interval was 87 for the North Ugenya Ward. The starting point was randomized from which every 87^{th} household head's name in a list of 9624 was sampled, it was repeated till an adequate sample size of 110 household heads was attained. This was replicated for the rest of the Wards.

Starting from a random point minimized sampling bias and enhanced sampling adequacy. The sampling method was appropriate because the sampling population is assumed to be normally distributed. Livestock was sampled according to species for tree acceptance palatability testing. Forbes (2020) recommended a sample of 30 animals is recommended if palatability test is performed under the guidance of an expert, although for the informal test, 100 animals are capable of meeting a similar objective.

An adequate sample should be a true representation of the population (universe) attributes. It should be of random and proportional selection. A *KMO* sampling adequacy test was performed and a *KMO* coefficient value of .810 revealed the adequacy as shown in Table 2. Therefore, with reference to Miljiko (2017), a KMO coefficient of ≥ .80 indicates a strong data adequacy suited for factor analysis.

3.4.2. Purposive Sampling

The sampling method was used to select key informants that included; A farm-forestry expert from KEFRI (Maseno) provided guidance on tree *DBH* measurement criteria and tool improvising. A seedlings supplier, four chainsaw operators, four brick manufacturers, four charcoal manufacturers, four timber yard enterprises, an herbalist, three institutional catering departments, a seedlings vendor, a physical planner, two livestock veterinary officers and one forest department officer. The sampling aided the researcher in interviewing a section of experts in specific fields (Dawadi, 2021). The forestry department provided an insight on farm-forestry and its importance to the Sub- County, Physical Planner explained facts related to human population distribution, veterinary and livestock extension officer provided insight on livestock rearing and inventory, livestock extension officer provided supervisory guidelines on how to perform tree palatability test. Forest Department Field Personnel assisted with botanical identification, naming, and classification of the dominant tree species. The Ukwala land registry assisted in the interpretations of the local land ownership names and meanings, while brick, charcoal manufacturers and timber yard enterprises provided information on timber quantity, demand, quality, and preference.

3.5 Data Collection Methods

Both the primary and secondary data collection methods were applied.

3.5.1 Primary Data Collection Methods

Questionnaires, interviews, focused group discussions, observation and photography were used to collect primary data on: socio-demographic characteristics of the respondents. Both human settlement and farm forestry were measured in residential per unit area (acre) and tree basal area (acre) respectively while the stocking rate (*TLU*) represented livestock farming. Using a *D*-tape, ordinary tape measures and 5 feet long measuring metric ruler, the dominant tree species of $DBH \geq 5$ inches were measured, counted, function noted, and recorded on the observation sheet, the tree measurement was applied in line with (Lizuka, 2018). The survey recommended a $DBH \geq 5$ inches' pre-qualification for a tree count, the perception is: if a tree attains such size and height it ceases to be a sapling. The trees then have the ability to withstand both climatic and ecological disturbances hence may have successful chances of growth to maturity. Palatability tests were performed on selected dominant tree species where applicable; the test was assigned binary attributes for reliability testing. A suggestion by Mederos (2004) recommended grazers/browsers livestock's oral perception during short-term feeding tests which is a key step in formal documentation of pasture and fodder trees. Secondary data was sourced from: relevant geographical textbooks, journals, print media and audio visual. Key informants included; ward administrators, chainsaw operators, veterinary, livestock extension officers, county physical planners, a forest department officer, and the sub-county land registry office.

3.5.2 Questionnaires

An additional estimate of five percent or 20 respondents were proportionally included to cater for non-response. Table 3 shows an Additional questionnaire due to possible non-Response by proportion per Ward.

Table 3: Additional questionnaires due to possible non-Response by Proportion per Ward

Ward	Households	sample	Adjusted sample	Actual response	Response %
East Ugenya	8858	101	106	102	96.22
North Ugenya	9624	110	116	112	96.55
Ukwala	6188	71	75	73	97.33
West Ugenya	8895	102	107	103	96.26
Total 4	33,565	384	404	390	96.53

Source: Adapted and Modified from KNBS (2019)

The questionnaires were pretested between 9th to 14th December and then administered between December 18th 2021 and February 20th of 2022. Each of the 12 trained enumerators distributed and collected back the questionnaires within the timeframe. To minimize non-response bias, ethical data collection techniques were incorporated. The instrument was summarized for a higher response rate. For the respondents who opted to retain the questionnaires, a reminder was sent upon the elapse of the agreed-on time. Non-response rate was determined using formulae as cited in a book by (Daniel, 1975). The survey registered an overall acceptable questionnaire return rate of roughly 97%, representing 390 respondents which was well above the desired sample size of 384, as shown in Table 3.

$$Sample\ size\ adjustment = \frac{\text{desired sample size}}{\text{expected response rate(95\%)}} \times 100 \qquad 5$$

$$\text{Response rate} = \frac{\text{Actual response}}{Adjusted\ sample\ size} x\ 100 \qquad 6$$

3.5.3 Verbal Interviews

Key informants were verbally interviewed on diverse dates. The interview schedule included questions which required expertise. Their inclusion provided the study with the technical knowledge in specific subject fields (Muellmann et al., 2021).

3.5.4 Focused Group Discussions

One focused group discussion per sub-set selected by simple random sampling was involved. At least eight to twelve persons per focused group as recommended by Carson (2001) & Snover (2020) participated in the discussion. The agenda was communicated in advance to the assistant chiefs and the group leaders of the respective local organization. At least one chief’s baraza per sub location, four motorcycle umbrella organizations, Outdoor Catering Units and Gender groupings (*Chamas*) was involved. Questions posted on the interview schedule were discussed and notes taken for data reinforcement.

The methodology was important in the study because it allowed for the clarification of preconceived perceptions and inference. It offered the investigator a chance to hear the respondents' own voices and words. It was applicable in uncovering the ideas or issues which were in the initial considered insignificant in the research and decision formulation. The flexibility to indulge deeper into the subject matter that arose in the discussion made the investigator understand both the accomplished and the unaccomplished study needs (Carson, 2001).

3.5.5 Observation

The methodology was found ideal because the observer is able to ascertain the accuracy from the realia. This is a common methodology for both the social and physical sciences hence the universality of practice and application. Observation is always possible without the respondent's knowledge (Aquino, 2019). Data collection involving absolute linguistic barriers such as palatability tests rely on the observation. The feeding process was assigned the binary attributes of between 0 and 1 for fodder non-acceptance and acceptance respectively (Esmail, 2021).

3.5.6 Photography

The photographs were used to illustrate or depict the relationship between land use practices and dominant tree species. Photos are useful in the survey because they capture a moment in time therefore documenting the imagery observations (Esmail, 2021)

3.5.7 Measurement and Enumeration

The tree species were identified grouped according to the local and scientific name. the frequencies were worked out and their relative abundance calculated as presented in appendix 8. *DBH* measurement was used to prequalify the dominant tree species for enumeration. Land parcels were quantified in acres. Farm-forestry cover was calculated using the following formula;

$$\text{Farm} - \text{forestry cover} = \frac{\text{Tree count/acre}}{\text{Recommended trees/ basal area}} \text{x}100\%$$

7

3.5.8 Secondary Data Collection

Secondary data was extracted from; publications, print, and audiovisual media.

3.6 Data Processing, Analysis and Result Presentation

Data was processed, analyzed, and results presented in a manner prescribed.

3.6.1 The Procedure for Processing Data

The extracted data was verified, organized, transformed, and integrated in an appropriate output format for subsequent application. Data was entered in a computer for further processing. Microsoft Excel Software Office was used to code, edit, and categorize quantitative data.

The independent and the dependent variables in the objectives one to three were run by the application of the R Statistics version 4.1.3. The software was applied in calculating the measures of the central tendencies such the mean, median and the mode. The measures of dispersion included the standard deviation and the variance. The software was further applied in the generation of the statistical graphics like Tables and charts. It was again used to test for; sampling adequacy, Linearity, Collinearity (Independence), and Normality (Netscher & Eder, 2018)

3.6.2 Linearity Test

The dependent and independent variables were run in the multiple regression model to assess the justification of the formula. The Root Mean Square Error (*RMSE*) was calculated to verify the model accuracy. The RMSE was .26 that lied between 0.2 and 0.5 with .78) of an adjusted R^2 more than .75 which are described as very good values for showing precision (Mackinnon, 2002) and (Wei, 2021). Using the formula:

$$y = \beta_0 + \beta_1 X_1 + \ldots \beta_n X_n + \varepsilon \qquad 8$$

3.6.3 Collinearity Result

Collinearity is an indication that two or more independent variables are almost in perfect linear conditions. Table 4 illustrates the Collinearity Test Results.

Table 4: Collinearity Test Results

	95% CI Lower Bound for B	95% CI Upper Bound for B	Tolerance (CS)	*VIF* (CS)
Constant	1.46	2.21		
Tree cover %	0.315	0.697	0.845	1.183
Tree age	1.426	2.054	0.819	1.438
Mean *DBH*	0.437	0.724	0.872	1.176
Residential size	0.02	0.09	0.811	1.569
Land size	1.265	1.733	0.905	1.066
Stocking rate	0.263	0.378	0.846	1.182
Rate of tree forage harvesting	2.155	2.449	0.916	1.041

Variance Inflation Factors gauge the inflation in the variances of parameter estimates as a result of collinearities that exist among the regressors.

$$VIF = \frac{1}{1 - R2} = \frac{1}{Tolerance} \qquad 9$$

The *VIF* values were all < 5, (See Table 4) a sign the Influence of collinearity was statistically insignificant (Bhandari, 2020).

3.6.4 Test of Normality

To test data compatibility with the linear model, Test of Bivariate Normality was performed. Table 5 displays the Bivariate tests of Normality.

Table 5: Test of Normality

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
	Statistic	*df*	*Sig.*	Statistic	*df*	*Sig.*
Tree cover%	.211	384	.173	.965	384	.865
Tree age	.194	384	.062	.929	384	.613
Mean *DBH*	.148	384	.269	.947	384	.861
Residential size	.237	384	.112	.895	384	.058
Land size	.165	384	.088	.948	384	.174
Stocking rate	.229	384	.156	.914	384	.236
Rate of tree forage harvesting	.181	384	.073	.921	384	.140

The Kolmogorov-Smirnov and the Shapiro-Wilk Test were both run. Despite being exact and accurate in measuring continuity in comparative sample distribution, the Kolmogorov-Smirnov Test is most appropriate for sample sizes ≤ 30. However, the Shapiro-Wilk Test of normality is more relevant because it can measure sample sizes from < 50 to ≥ 2000 without compromising the accuracy. Because the significance values of the Shapiro-Wilk test were *p* > .05, (Refer to Table 5) the null hypothesis of a no significant deviation from the normal distribution was accepted in line with (Farnsworth, 2019).

3.6.5 Quantitative Data Analysis Procedure

The bivariate pairwise Pearson's correlation coefficient analysis was applied. In bivariate analysis, it is easy to align several result coefficients in a single matrix Table. The study aimed at ordinarily reporting comparing and reporting means. The emergence of categorical variables informed the incorporation of the independent two sample t-test. This was necessary in improving the statistical power for qualitative reporting. Similarly, the survey initially proposed the use of *SPSS* for data analysis. Even so, after cost benefit consideration, *R statistics version 4.1.3* was found suitable. Changing the statistical packages has no significant Influence on the results (Farnsworth, 2019). The outcomes of both quantitative, qualitative data were analyzed and used to report the results for the study. The data was first edited by going through the questionnaires to identify gaps, errors and omissions in the information obtained from the respondents. The raw data was coded then computed, for analysis. The Shannon Wiener Diversity Index was used to measure the diversity, Richness, Evenness, and abundance of dominant tree species. The index is relevant because it pays more attention to rare species hence the recommended biodiversity conservation index for conservation.

$H = [(P_i) \times I_n (P_i)]$ 10. where;

P_i = Proportion of total sample represented by species

S = number of species, = species richness

$H\ Max = I_n (S)$ = Maximum diversity possible

$$E = evenness = \frac{H}{Hmax}$$

The *R Statistics version 4.1.3*. Was used to perform Pearson's correlation analysis to determine the relationship between land use practices and dominant tree species diversity, Richness, Evenness, and abundance. The Pearson's correlation formula is

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2]\,[n\sum y^2 - (\sum y)^2]}} \qquad 11$$

X and y are the independent and the dependent variables respectively.

Hypotheses

Null hypothesis: $p = 0$ (if the universe correlation coefficient is 0, correlation unlikely exists).

Alternative hypothesis: $p \neq 0$ (if the universe correlation coefficient is different from 0, correlation may exist).

The model was found appropriate because the data justified the basic assumptions.

3.6.6 Statistical Significance of the Intervening Variable

The intervening variable equations were used*:*

$$y = \beta 0(1) + \tau X + \varepsilon (1) \dots (1),$$

$$y = \beta 0(2) + \tau X + \beta I + \varepsilon (1) \dots (2) \qquad 12$$

$$\mathrm{I} = \beta 0(3) + \mathrm{a} X + \varepsilon (3) \dots (3).$$

In the equations, X is the predictor variable, Y is the response variable, and I the intervening variable. $\beta_{0(1)}$), $\beta_{0(2)}$), and $\beta_{0(3)}$) represent the population regression intercepts (Mackinnon, 2002). The τ signifies the correlation between the predictor and the response variables for the Influences adjustment in the intervening variable in the second equation, a is the relationship between the regressor and the intervening variable in the third equation. β is a representation of the Influence of the intervening on the response variables adjustment for the Influence of the predictor variable in the second equation. The $\varepsilon_{(1)}$, $\varepsilon_{(2)}$, $\varepsilon_{(3)}$ are residuals in the three equations respectively. Because the intervening variables were constants, they were automatically rejected from the Pearson's correlation coefficients analysis. This was in line with Von Thunen's theory statements that the 'land is flat throughout the territory; soil quality and climate are invariant'.

3.6.7 Qualitative Data Analysis

The Independent Two-sample t test was used to verify the mean difference of two independent categorical samples. The test was appropriate because data were assumed meet the following conditions: Dependent variable which is continuous, grouped independent variable, Cases with values on both the dependent and independently grouped variables, Independence of observation, Randomness of data, distribution normality of the dependent variable for each group, Constant variances with No outliers. This was meant to assess the statistical evidence that the related population means significantly differ (Mackinnon, 2002).

At 95% Confidence interval and significance level $\alpha = 0.05$, the null hypothesis (H_0) and the alternative hypothesis (H_1) were stated as follows:

Null hypothesis: $\mu 1 = \mu 2$ (the two-universe means are likely equal)

Alternative: $\mu_1 \neq \mu_2$ (the two-universe means are likely unequal)

Rejecting the null based hypothesis is a confirmation that the *p*-value is less than the set α-value (alpha) and it is concluded that the population mean of category 1 and category 2 significantly differ.

Levene's Test for Equality of variances was applied to determine the assumption of homogeneity of variance. At 95% Confidence interval and significance level $\alpha = 0.05$, the Levene's test hypotheses were:

$H_{0:}\ \sigma_1^2 - \sigma_2^2 = 0$ (the universe variances of category 1 and category 2 are likely equal)

$H_{1:}\ \sigma_1^2 - \sigma_2^2 \neq 0$ (the universe variances of category 1 and category 2 are likely unequal)

Rejecting the null hypothesis of Levene's Test is an indication that the variances of the two categorical populations are unequal, which means that the homogeneity of equal variances assumption is likely violated.

The following formulae are instrumental in determining the homogeneity of variances assumptions:

Equal Variances Assumed; $(\sigma_1^2 = \sigma_2^2)$ $t = \frac{(X1 - X2)}{Sp\sqrt{\frac{1}{n1} + \frac{1}{n2}}}$ 13

With $sp = \sqrt{\frac{(n1 - 1)s1^{2} + (n2 - 1)s2^{2}}{n1 + n2 - 2}}$ (14)

X_1 = Mean of Sample 1

X_2 = Mean of Sample 2

n_1 = number of observations of sample 1

n_2 = number of observations of sample 2

s_1 = Standard deviation of sample 1

s_2 = Standard deviation of sample 2

s_{pa} = pooled Standard deviation

No assumption for equal variances

$$t = \frac{(X1 - X2)}{\sqrt{\frac{s1^{\ 2}}{n1} + \frac{s2^{\ 2}}{n2}}} \quad 13$$

X_1 = Mean of Sample 1

X_2 = Mean of Sample 2

n_1 = number of observations of sample 1

n_2 = number of observations of sample 2

s_1 = Standard deviation of sample 1

s_2 = Standard deviation of sample 2

After calculating the t-value it is compared to the critical t-value from the t-distribution Anova Table with the degrees of freedom. $df = \frac{\left(\frac{S12}{n1} - \frac{S22}{n2}\right)2}{\frac{1}{n1-1}(\frac{S12}{n1})2 + \frac{1}{n2-1}(\frac{S22}{n2})2}$ 15

3.6.8 Tree Forage Palatability and Preference Tests

Feed acceptance as depicted in Figure 8 was assigned a binary value of one (yes), while for the non-acceptance the value was zero (no). The feed preference index was based on (Manly, 1974) and (Chesson, 1983) Manly-Chesson's formula. $\beta = \frac{log\left(\frac{R}{r}\right)}{log\left(\frac{B}{b}\right) + log\left(\frac{R}{r}\right)}$ 16

where R and B are the number of livestock combinations present at the start of the palatability tests. The r and b_{an} are the number of forage tree species consumed, β is the estimated preference (Manly's alpha/Chesson's index). The inverse index was $\frac{1}{n} = 0.11$ denoting a random preference. Values of $\frac{1}{n} < 0.11$ meant forage avoidance while an inverse index of $\frac{1}{n} > 0.11$ was treated as an absolute preference on forage trees.

3.6.9 The Results Presentation

The results of the Influence of land use practices on the dominant tree species diversity, Richness, Evenness, and abundance were described, presented in form of; discussions, Table, graphs, charts, and histograms were used to illustrate the strength of the Influence of independent variables on the dependent variable. Photographs (plates) were used to illustrate the Influence of land use practices on the dominant tree species diversity, Richness, Evenness, and abundance as recommended by (Dawadi, 2021).

3.7 Reliability and Validity

For data credibility and integrity, the data collection tools were tested for both the Validity and Reliability.

3.7.1 Reliability

A sample size of 39 household heads equivalent to around 10% of the total sample was Piloted, it was executed to assist in refining the data collection instruments; this was done to ensure the outcomes obtained from the field have a true representation of the actual situation on the ground. The piloted respondents were omitted in the final survey; such exclusions contributed to the elimination of sampling bias. The piloted instrument was tested using the Spearman-Brown formula for prediction. The formula takes the split half reliability (*r half*) and generates the full-length estimation (*r full*) This reliability coefficient is appropriate for the questionnaire because it measures the observable variables and psychometric tests as cited by (Mazzetti, 2020). A strong reliability coefficient of *r* = .858 was attained, after addressing linguistic divergence in tree identification, the instrument was therefore adopted without further amendment. $rfull = \frac{2(rhalf)}{1+rhalf}$ 17

3.7.2 Validity

Content validity was ensured by including all the relevant questions and variable attributes in the questionnaire and interview schedule. This type of validity is performed to improve the accuracy of a tool of measurement in research. The face and content validity of the instrument are approved by receiving the subjective judgments by the discipline experts in the field, they critique its appearance, relevance, or effectiveness (Gibson et al., 2016). The advice of the supervisors each from the School of Arts and Social Sciences, Maseno University and School of Agriculture and Food Security was sought. The two supervisors assessed the ease of use, clarity, readability, and the concepts to be measured by the instrument in relation to the objectives of the study. To evaluate the criterion validity, the finding was compared with those of the previous studies in the relevant field.

3.8 Research Ethics

The consent form was hand delivered to the subject participants; they were required to read and understand it before consenting. In case the respondent portrays a language barrier, they had the consent form read and or translated to them. This was performed to ensure that the potential respondents understand what they are being requested to perform. The overall purpose of the survey was to assess change of land use practices Influence and the dominant tree species diversity, Richness, Evenness, and abundance. Data collection involved interviews with dominant tree species enumeration, observation, livestock palatability testing and photography. Respondent's participation was voluntary; the participants were free to opt out without any condition. The identity of the participants was treated with confidentiality. Instead of the name request, the questionnaires were coded to guarantee anonymity in the study. There was no direct benefit attached to the participation, apart from the fact that survey may contribute toward conservation of the dominant trees. The information obtained from the respondents was only used for academic purposes. No tree species nor livestock was subjected to harm whatsoever. In case the foreseen risk outweighs the intended benefits, the MUERC office was to offer an alternative guidance. The extracted data was coded, entered, and retained in a computer with a password for confidential access. Data was processed in Excel and analyzed using the *R Statistics version 4.1.3*. The conclusion of the study was to be communicated through the local administrators.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1: Introduction

The chapter provides Results, Discussions on household characteristics, land use practices, and the Dominant tree species diversity, Richness, Evenness, and abundance in Ugenya sub-county as presented in Tables, figures, Plates, and themes per both the general and specific objectives respectively.

4.2: Socio-economic and Demographic Attributes of the Households in Ugenya Sub-County

The socio-economic and demographic information was collected and presented in tables.

4.2.1 Household Size

The information on Household Size was sourced from a total of 384 household heads. Table 6 illustrates the Household Size of the respondents that participated in the study.

Table 6: Household Size

Number of occupants	Frequency	Percent (%)
1 – 2	32	8.33
3 – 4	120	31.25
5 – 6	202	52.61
≥7	30	7.81
Total	384	100

The modal household size class was around 53% and had between 5 - 6 occupants as listed in Table 6. Household size and human population growth are related to tree species diversity, Richness, Evenness, and abundance decline. A negative statistical correlation between the household size and the tree species diversity, Richness, Evenness, and abundance was reported in Kakamega county by Vuyiya et al. (2015). This is because households in the rural areas unsustainably rely on the tree species for various ecosystem services (Ochola 2018).

4.2.2 Housing Type

The information on House Type was obtained from a total of 384 household heads. Table 7 shows the House Type of the respondents that participated in the study.

Table 7: House Type

House type	Frequency	Percent (%)
Traditional/grass thatched	22	2.15
Semi-permanent	913	88.55
Permanent	87	8.43
makeshift	9	0.87
Total	1,031	100

Most respondents, nearly 89% lived in semi-permanent dwellings as shown in Table 7. While less than one percent was dwelling in makeshifts. This was a total contrast in comparison to (Egger et al., 2020). The survey by Egger et al. (2020) was performed before the locally famous "give direct", when house type composed 40% grass thatched houses. The report further associated the massive vegetative diversity, Richness, Evenness, and abundance loss to grass thatched houses, even so, only grass species was quantified. According to an account by a key informant, an external monetary aid is applauded for the zero tolerance to grass thatched human dwellings in the sub-county.

4.2.3 Distribution of Gender in Ugenya Sub-County

The information on Gender Distribution was gathered from a total of 384 household heads. Table 8 displays the Gender Distribution of the respondents that participated in the study.

Table 8: Gender Distribution

Gender	Frequency	%
Male	162	43%
Female	222	57%
Intersex	0	0%
Total	384	100%

The conclusion revealed more female headed households than males in relation an insignificant statistical representation of the intersex as displayed in Table 8. This is consistent with KNBS (2019), Oloo (2013), and Wanjira (2019) which reported a heterogenous gender distribution of 53% female-headed households, 47% for the males and an insignificant low figure of less than one percent for others (intersex included), in the entire county. However, the discrepancies in the percentages are attributed to the differences in sample sizes. Gender roles are known to affect natural resource distribution and management (Oloo, 2013).

4.2.4 Households' Age

The information on Household's Age was collected from a total of 384 household heads. Table 9 shows the Ages of the respondents that participated in the study.

Table 9: Households' Age

Age (years)	Frequency	Proportion %
≤30	18	4.69
31-39	35	9.12
40-49	140	36.46
≥50	191	49.7
Total	384	100%

The most prevalent households' age class in Ugenya sub-county comprised nearly half 49% of the elderly as shown in Table 9. The younger households (≤ 31 years) are likely receptive to the adoption of new technologies and farming methods by (Yeboah, 2020). The elderly respondents are however perceived as cultural, conservative, and are reluctant to embrace contemporary changes Meske et al. (1994).

4.2.5 Respondents' Education Level in Ugenya Sub-County

The information on Education Level was found from a total of 384 household heads. Table 10 lists the Education Level of the respondents that participated in the study.

Table 10: Education Level

Education	Frequency	%
Pre-primary	31	8
Primary	215	56
Secondary	77	20
Tertiary	61	16
Total	384	100

The survey indicated that the majority of the household heads had acquired primary education. (See Table 10). The findings identified with the conclusions of SCADP (2017) that recorded about 52%, for the same level in the sub-county. Education is an important factor in natural resource conservation, that is the reason why the national government is aiming to infiltrate the tree agenda in the secondary school syllabus (G.o.K, 2019). However, brainwashing is associated with the emulation of the western (exotic) culture at the expense of the indigenous ideologies and material culture (Saka et al, 2012).

4.2.6 Source of Income in Ugenya Sub- County

The information on Sources of Income was collected from a total of 384 household heads. Table 11 illustrates the income distribution of the respondents that participated in the study.

Table 11: Source of Income

Income	Frequency	%
Farming	315	82
Employment	30	7.8
Remittances/others	39	10.2
Total	384	100

Farming was the most significant source of income in the sub-county (See Table 11). The result is consistent with (Mutavi, 2016) that reported farming practices of around 47% as the most prevalent economic occupation in the rural setups of Kibwezi Sub- County, Makueni county. According to the FGD by the Got Nanga motorcycle taxi umbrella on the 22nd December 2021, this was attributed to the global economic crunch triggered by the *COVID-19* pandemic. The job loss witnessed in most urban centers accelerated urban-rural migration hence subjecting the majority of the respondents to reconsider farming options. New farming adoptions are linked to the general tree clearing (Recha et al,2013).

4.3 Farm-Forestry and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

The qualitative information on Farm Forestry collected from the primary data sources. Table 12 shows Farm-forestry data summary.

Table 12: Farm-Forestry Data Summary

Cover %	Age	*DBH*	Establishment	Varieties	Tree phobia	Choice
N = 384 M = 4.92 SD = 0.48	N = 384 M = 9.22 SD = 4.42	N = 384 M = 6.83 SD = 1.99	Planted = 52% Natural = 48%	Exotic = 40.74% Native = 59.26%	Phobia = 47.24% Non-phobia = 52.76%	Preferred = 50% Not preferred =50%

At an average DBH of (M = 6.83, SD = 1.99), the mean tree age stood at (M = 9.22, SD = 4.42). Absolutely all the households surveyed established the tree species on their farms as shown in Table 12 and appendices H, I, and J. The on-farm tree cover stood at nearly two percent, which was significantly higher compared to the county's 2016th ranking of less than one percent. However, the value posted was far much lower (approximately 5%) than the recommended 10% farm-forestry. According to FGD, the weekly Chief's Barazas, NGOs, were instrumental in championing the uptake of tree planting and growing in Ugenya sub-county.

Despite the mitigation effort, "exotic tree seeds and seedlings were more readily available compared to the planting materials derived from native tree species", sentiments shared by the sub-county Forest Department office on 23rd January 2022.

A total of 2510 dominant tree species were enumerated, the average age was (*M* = 9.22, *SD* = 4.42), as depicted in Table 12, 2nd column. The FGD attributed the decline in older trees to overutilization of timber and other wood products in brick-making and charcoal manufacturing.

An interview with a key informant showed that:

> The influx of Urban-rural migrants in 2007 and 2021 due to post election violence and COVID 19 respectively, occasioned the high demand for timber (Male 59 years old key informant in carpentry business on the 22nd January 2022).

The *DBH* was (*M* = 6.83, *SD* = 1.99), see Table 12, 3rd column. A comparison of post-harvested tree stumps with the current tree trunks indicated a possible depreciation in tree trunk size in the sub-county as illustrated in figure 5. Similar sentiments were shared by an FGD that noted an increase in demand for mature trees. An interaction with James Ochieng, a 42 years old key informant in timber business on 18th December 2021 concluded that, "Trees with relatively larger trunks were highly sought after by local chainsaw owners".

At least 52% of the enumerated tree species were established through planting as depicted in Table 12, 4th column. The FGD in Jera sub location, North Ugenya ward observed that, new home owners who acquired fallow land parcels were involved in tree planting in bid to replace the tree cover cleared prior to land purchase agreement. Mr. Koech, 36 years old key informant attached to physical planning department, (real name withheld), alluded that, "Most modern home owners to be, start by planting the aesthetic and peripheral trees before the actual home construction".

In the survey, 11 exotic tree species were sampled, representing about 41% of the dominant tree species richness as depicted in appendix L and Table 12, 5th column. Forest mosaics and fragments of indigenous tree species were visible. Majority of the exotic tree varieties were established through planting. The respondents who portrayed a liking for the indigenous trees mentioned resilience, quality timber, cultural functions, among a number of home-grown ecosystem services. "Exotic tree species seedlings are resilient and invasive", the words of Mr. Ngira (name withheld) a key informant running a tree nursery business, from an interview held on 22nd February 2022. The exotic tree varieties were preferred because of their fast growth rate, aesthetic outlook, and ready planting materials availability.

Of the surveyed respondents, 120 household heads agreed to having experienced tree species related fear, see Table 12, 6th column. On top of the mentioning, included insects and reptiles associated with some tree species. physiological characteristics such as thorniness were contributing to dendrophobia. In one of the FGDs, female members unanimously agreed to absolute fear for caterpillar infested tree species. "Sometimes I develop a feeling that a tall tree next to my house may fall on a windy day and destroy the property or even kill me in the house," reads one of the comments from a questionnaire coded EU 36.

The respondents identified 10 dominant tree species in preference list as portrayed in appendices O, P, and Table 12, 7th column, of which 50% were preferred while the other half were adversely mentioned. The reasons provided by the FGD were corroborated by Joshua Ojwang, 84 years old, "good tree species are those that fulfill the socio-cultural and economic obligations. The unwanted tree species are perceived as capable of evil potential, culturally prohibited, and or have poor water and soil conservation, among other possible disadvantages".

4.3.1 Percentage On-Farm Tree Cover and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The results on the relationship between the Percentage Tree Cover, Average Tree Age, Average DBH, the tree species diversity, richness, evenness, and abundance were displayed as shown in table 13.

Table 13: Percentage tree cover, Age, DBH in relation to the tree species Diversity, Richness, Evenness, and Abundance

Dependent Variables/ (20m×20m) plots	R	R Square	Adjusted R Square	P-Value	Std. Error of the Estimate
Shannon Wiener diversity index	.852[a]	.769	.768	.035	.218
Dominant Tree Species Richness	.782[a]	.643	.642	.049	.809
Dominant Tree Species Evenness	.743[a]	.615	.614	.027	.024
Dominant Tree Species Abundance	.912[a]	.842	.841	.001	.809

a. Predictors: (Constant), Average DBH/(20mX20) plots, Average Tree Age/ /(20mX20) plots, Percentage Tree Cover//(20mX20) plots

By approximation, the results of linear coefficient of determination (R^2) revealed that 76.8%, of the variation in tree species diversity, 64.2% of the species richness, 61.4% of the species evenness, and 84.1% of the variation in species abundance could possibly be explained by the combined changes in values of Percentage Tree Cover, Average Tree Age, and the Average DBH in a spatial scale of 20mX20 plots (Table 13).

To assess if a significant statistical correlation occurred between the Percentage On-Farm Tree Cover, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 13 displays the bivariate Pairwise Pearson's correlation coefficients analysis.

Table 14: Pairwise Pearson's correlation coefficients analysis: Percentage On-Farm Tree Cover, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Species Richness	Species Abundance	Species Evenness	Diversity (H)	On-farm tree cover (%)
Species Richness	Correlation	1	-028	.023	.027	-.72
	Sig. (2-tailed)		.058	.66	.084	.001
	N	384	384	384	384	384
Species Abundance	Correlation	-.028	1	-.047	-.038	.703
	Sig. (2-tailed)	.058		.067	.074	.036
	N	384	384	384	384	384
Species Evenness	Correlation	.023	-.047	1	.055	-.76
	Sig. (2-tailed)	.066	.067		.02	.027
	N	384	384	384	384	384
Diversity (H)	Correlation	.027	-.038	.055	1	-.691
	Sig. (2-tailed)	.084	.074	.062		.039
	N	384	384	384	384	384
On-farm tree cover (%)	Correlation	-.72	.703	-.762	-.691	1
	Sig. (2-tailed)	.001	.036	.027	.039	
	N	384	384	384	384	384

The null hypothesis statement of no significant statistical Influence between farm-forestry and dominant tree species diversity was rejected at 95% confidence interval *p*-value = .05. Persistent adoption or long run practice of the Farm-forestry (percentage on-farm tree cover) on the Dominant tree species Diversity, Richness, and Evenness was likely negatively associated. Despite the fact, Farm-forestry may possibly contribute positively in increasing the overall tree count (Abundance) in Ugenya sub-county. Pearson correlation coefficients were computed to assess the existence of a linear relationship between the percentage on-farm tree cover and the Shannon Wiener's diversity index, species Richness, Evenness, and Abundance (Table 13). There was a significant negative linear correlation between the percentage on-farm tree cover and the Shannon Wiener's diversity index $r(382) = -.69$, $p = .039$. In simple terms, the implementation of the (10%) farm-forestry was likely linked to a decline in diversity of the dominant trees. The species richness *r (*382*)* = - .72*, p* < .001, implied that the values of individual tree species reduced possibly because of increased uptake of farm-forestry. Equally, species evenness was *r (*382*)* = - .76*, p* = .017*,* suggesting a likeliness that the tree species representativeness declined as farm-forestry adoption intensified. Conversely, a statistically significant positive linear association was observed between the percentage on-farm tree cover and the species Abundance *r (*382*)* = .70*, p* = .036, in other words, a significant adoption of farm-forestry was a likely prerequisite if the households of Ugenya sub-county were to increase the general tree count. Plate 1 displays small-scale Farm-Forestry. Notice the monoculture dominated by the *Eucalyptus SSP*.

Plate 1: Ground General View Photo; Small Scale Farm-Forestry in Ukwala Ward

The reports on species diversity are consistent with the finding in western Kenya by Imo (2009) which revealed Kenya's tree diversity loss to monoculture farm forestry. Monoculture is a common practice in farm-forestry subjecting a large tract of land under a few or single tree species thus negatively affecting both the species diversity and richness (Chaudhary, 2016). The observations of species evenness are replicated in the greener belt of Ethiopia by Daie (2019) that reported a decline in tree species evenness as a result of monoculture farm-forestry practices in Ethiopia. The low tree species evenness is attributed to a possible removal of a diverse community of tree species to pave way for the fast-growing farm-forestry tree cultivars (shown in Plate 1) as reported in the County Government of Siaya's Development plan (CADP, 2019). However, the tree species abundance differed from the verdicts of a similar study in India by Bijalwan et al. (2020) that observed low tree species among the households which practiced farm-forestry. Such outcomes by Bijalwan et al. (2020) were possible because the survey was based on post harvested farms, peak species abundance have been reported in pre-harvested tree farms while the lowest species abundance occurred in post-harvested farms of Australia as reported by (Denovan, 2021). Notice the pure tree stand of Eucalyptus SPP in the left-middle ground. Farm-forestry monoculture is associated with low dominant tree species' diversity in Ugenya Sub- County.

One male participant involved in tree nursery business expressed the following:

> Most people that plant trees in their farms only buy the exotic species. This is because these trees grow fast hence guarantee quick returns in comparison to the indigenous species. Exotic tree seeds and seedlings are more readily available compared to the planting materials derived from native tree species (Male, 57 years old).

4.3.2 Age and the Dominant Tree Species, Diversity, Richness, Evenness, and abundance

To assess if a significant statistical linear relationship occurred between the Age, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 14 presents the bivariate Pairwise Pearson's correlation coefficients analysis.

Table 15: Pairwise Pearson's Correlation Coefficients Analysis: Age, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Species Richness	Species Abundance	Species Evenness	Diversity (H)	Age of the tree species
Species Richness	Correlation	1	-.039	.016	.023	.482
	Sig. (2-tailed)		.078	.059	.077	.000
	N	384	384	384	384	384
Species Abundance	Correlation	-.039	1	-.039	-.038	-.840
	Sig. (2-tailed)	.078		.057	.073	.005
	N	384	384	384	384	384
Species Evenness	Correlation	.016	-.039	1	.043	-.661
	Sig. (2-tailed)	.059	.057		.059	.000
	N	384	384	384	384	384
Diversity (H)	Correlation	.023	-.038	.043	1	.524
	Sig. (2-tailed)	.077	.073	.059		.000
	N	384	384	384	384	384
Age of the tree species	Correlation	.482	-.840	-.661	.524	1
	Sig. (2-tailed)	.000	.005	.000	.000	
	N	384	384	384	384	384

Ugenya sub-county was likely to attain a higher tree species diversity index, and Richness if the tree species were sustained to a relatively higher age (Years). The tree count (Abundance) and species representativeness (Evenness) were inversely proportional to age factor. Most of the enumerated tree species that registered both higher tree count and evenness were relatively younger while older trees were likely fewer by tree count and unevenly distributed. Pearson correlation analyses were performed to determine the linear association between the Age of the tree species and the Shannon Wiener's diversity index, species Richness, Evenness, and Abundance. The null hypothesis was rejected at 95% confidence interval, *p*-value = .05. There was a positive linear correlation between the Age of the tree species and the Shannon Wiener's diversity index r (382) = .52, $p < .001$. This is interpreted as; households with relatively older trees were likely to report a significantly higher species diversity and Richness r (382) = .48, $p < .001$ in Ugenya sub-county. Conversely, both the species Abundance $r(382) = -.84$, $p = .005$, and Evenness $r(382) = -.66$, $p < .001$, showed an inverse relationship with the increased tree age. As age increased, the tree species population and representativeness possibly decreased (Refer to Table 14).

The species diversity indices are consistent with the global finding by Marine and Catherine (2012) which revealed a significant positive statistical relationship between the age of trees and species diversity in the conserved natural forests. The long run Influences of forest conservation are the increased tree age, higher species diversity, and richness as observed in Ibadan Nigeria (Onefeli & Adesoye, 2014). The results of species evenness are identical to a report in Siaya county by SCADP (2018) that reported a decline in tree species evenness due to age factor in Siaya county. Similar to elsewhere in Kenya, the low tree species evenness is attributed to a possible harvesting of a particular community of tree species for socio-cultural and economic utilities, thus creating uneven species distribution (Kagombe, et al., 2020). In addition, the tree species abundance corroborated the study by Fritscher (2020) that observed low tree species abundance with an appreciation in forest age. Such observations by Fritscher (2020) were possible because in the Brazilian Amazon the tree maturity is dependent on age of the tree which determines the rate of forest harvesting (Castro et al., 2021). Tree species with relatively larger trunks are highly sought for by the chain-saw owners in Ugenya Sub-County.

An interview with a key informant revealed the following:

> Abandoned farms have more aged and diverse community of trees. This is due to natural selection and low ecological disturbance as the main reason (male officer from forestry department on, 23rd January 2022).

4.3.3 Average *DBH* and Dominant Tree Species Diversity, Richness, Evenness, and abundance

To assess if a significant statistical linear relationship occurred between the Average *DBH*, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 15 lists the bivariate Pairwise Pearson's correlation coefficients analysis.

Table 16: Pairwise Pearson's Correlation Coefficients Analysis: DBH, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Species Richness	Species Abundance	Species Evenness	Diversity (H)	*DBH*
Species Richness	Correlation	1	-.038	.019	.026	.831
	Sig. (2-tailed)		.078	.057	.069	.006
	N	384	384	384	384	384
Species Abundance	Correlation	-.038	1	-.041	-.038	-.746
	Sig. (2-tailed)	.078		.089	.065	.024
	N	384	384	384	384	384
Species Evenness	Correlation	.019	-.041	1	.065	-.681
	Sig. (2-tailed)	.057	.089		.082	.043
	N	384	384	384	384	384
Diversity (H)	Correlation	.026	-.038	.065	1	.818
	Sig. (2-tailed)	.069	.065	.082		.007
	N	384	384	384	384	384
DBH	Correlation	.831	-.746	-.681	.818	1
	Sig. (2-tailed)	.006	.024	.043	.007	
	N	384	384	384	384	384

The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. To sample the Dominant tree species with larger trunks, a more diverse and richer community of trees was a likely requirement. Beyond the average *DBH* $\geq$ 5.0 inches, the species Evenness and Abundance showed a likeness in decline with an increase in tree trunk size. The statistical significance between *DBH* and the Shannon Wiener's diversity index, species Richness, Evenness, and Abundance were tested. The overall Pearson correlation coefficients were found linear and statistically significant (Table 15). There was a positive correlation between the household's mean *DBH*, the Shannon Wiener's diversity index $r(382) = .82$, $p = .007$, and Richness $r(382) = .83$, $p = .006$, an indication that the households maintaining a significant majority of tree species were likely to record larger tree trunks in the sub-county. However, the species Abundance $r(382) = -.75$, $p = .021$, was negatively correlated. By-the-same-token, the tree evenness $r(382) = -.68$, $p = .043$ showed a negative linear relationship with the increase in tree *DBH*, the tree population was possibly depreciating with respect to an appreciation in *DBH*, such was likely the case between the species evenness and *DBH*. Plate 2 shows the relationship between DBH and the tree harvesting. Notice the *DRC* (stamp size) left behind.

Plate 2: *DBH* Measurements: A Ground Close-up Photo Showing a Fig Tree (*Ficus capensis*) Stump of DRC > 50 inches cut a few days prior to enumeration in West Ugenya ward.

The species diversity figures are in compatibility with the finding in Birmingham by (Hirons & Percival , 2011) which reported a significantly higher *DBH*, species diversity, and richness among the economically endowed households. Economic endowment is associated with households' reluctance to over utilize tree resources hence positively impacting ecological conservation (Lindenmayer et al., 2012). The species evenness contradicted (Kawaletz, et al., 2013) that reported a positive correlation between *DBH* and tree species evenness. The higher tree species evenness was attributed to the farm-forestry's clear cutting which is known to favor the natural tree species regeneration along the lower Nzoia flood zones prompting higher species evenness (Ngaina, 2014). Furthermore, Ngaina (2014) paid no attention to the *DBH* calibrations which likely inflated the species evenness by the inclusion of the tree seedlings and saplings in species enumeration as revealed in a study in China (Yang et al., 2017). However, the tree species abundance conformed to the inferences of a study in Japan by Lizuka (2018) that observed low tree species count among the households which registered higher *DBH.* Findings by Lizuka (2018) were likely because in farm-forestry the tree species with relatively larger trunks are first harvested leaving the young trees with relatively lower *DBH* to continue maturing (Ayaz et al., 2019).

Similar sentiments were shared FGD:

> Trees with larger trunks are highly sought for, brick making, schools, and catering units are the main consumer large timber logs. Therefore, tree species with relatively larger trunks are highly sought for by the chain-saw owners (FGD attached to Kagonya Catering Unit on 18th December 2021).

4.3.4 The Dominant Tree Species Establishment

The Independent two-sample t-test was performed to verify if a significant contrast in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in planted and naturally grown trees prevailed. Table 16 shows the Independent two-sample t-test.

Table 17: Group statistics and t-test Results; the Tree Species Establishment, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Establishment	N	Mean	SD	T test
Diversity(H)	Planted	1305	1.83	0.082	t (2508) =
	Natural	1205	2.26	0.27	2.28, *p* = .024
Richness	Planted	1305	6.42	1.14	t (2508) =
	Natural	1205	14.72	3.86	2.73, *p* = .017
Evenness	Planted	1305	.95	0.04	t (2508) =
	Natural	1205	.86	0.02	1.81, *p* = .015
Abundance	Planted	1305	34.67	3.86	t (2508) = 2.83
	Natural	1205	30.29	4.24	*p* < .001

The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. The 1305 planted tree species scored (*M* = 1.83, *SD* = 0.08) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 1205 tree species (*M* = 2.26, *SD* = 0.27) with a statistical significance of t (2508) = 2.28, *p* = .024 for the naturally grown trees. Furthermore, the mean score of the tree species richness was significantly lower in trees established through planting, (*M* = 6.42, *SD* = 1.14) compared to the naturally growing tree species, (*M* = 14.72, *SD* = 3.86*)* with a significance of, t (2508) = 2.73, *p* = .017. With regards to a t-test significance of, t (2508) = 1.81, *p* = .015, the same scenario was replicated in species evenness where, a significant low mean score, (*M* = .86, *SD* = 0.02) in tree species evenness was observed in planted tree group compared to (*M* = .95, *SD* = 0.04) for the nature's growth dictated trees. A significant mean score dissimilarity occurred in planted and naturally grown tree species t (2508) = 2.83 *p* < .001, even so, planted tree species (*M* = 34.67, *SD* = 3.86) posted a higher mean score in dominant tree species abundance than the trees under natural growth (*M* = 30.29, *SD* = 4.24) as displayed in Table 16.

The study outcome on species diversity and richness are consistent with the finding in Nubariah Egypt by Hegazy (1992) which reported an escalation in global natural forests diversity loss to man-made forest farms. On lower species diversity and richness observed in planted tree category, the revelations were likely due to the national governments 10% farm-forestry campaigns which promote the on-farm tree cover without emphasis on the importance of restoring the tree species diversity as a Kakamega county survey portrayed (Juma, 2009). Species evenness are incompatible with the exploration of satellite images by Lambin and Meyfroidt (2011) that reported no visible tree canopy change in tree farms and natural forests. In eastern Australia, above forest images are known to lack specific tree identity, caused by possible machine error and the atmospheric screening which might have caused the variation (Kirkpatrick et al. 2012). The species abundance is in line with the finding by Ofori (2015) that reported a higher percentage of planted trees in relation to the naturally growing tree species. Natural forests that by a bigger proportion comprise the perceived slow in growth indigenous tree species are cleared to provide space for the fast-growing money-making exotic trees Raja et al., 2017).

4.3.5 The Dominant Tree Species Varieties

Independent two-sample t-test was computed to analyze if a significant discrepancy in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in exotic and the indigenous tree species occurred. Table 17 demonstrates the Independent two-sample t-test outcome.

Table 18: Group Statistics and t-test Results; Tree Species Varieties, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Varieties	N	Mean	SD	T test
Diversity(H)	Exotic	11	1.76	0.09	t (25) = 2.61, *p*
	Indigenous	16	2.34	0.23	= .021
Richness	Exotic	11	6.40	1.12	t (25) = 1.71, *p*
	Indigenous	16	13.45	3.85	= 0.019.
Evenness	Exotic	11	.79	0.06	, t (25) = 1.02,
	Indigenous	16	.82	0.03	*p* = .057,
Abundance	Exotic	11	35.65	6.68	t (25) = 2.84, p
	Indigenous	16	31.26	8.23	= .001

The null hypothesis was rejected at 95% confidence interval, *p-value* = .05 for species diversity, richness, and abundance. The 11 exotic dominant tree species scored (*M* = 1.76, *SD* = 0.09) which demonstrated lower mean of Shannon Wiener's diversity index, compared to the 16 indigenous tree species (*M* = 2.34, *SD* = 0.23) with a statistical significance of t (25) = 2.61, *p* = .021. Likewise, the mean score of the tree species richness was significantly lower in the exotic tree species, (*M* = 6.40, *SD* = 1.12) in relation to the indigenous, (*M* = 13.45, *SD* = 3.85) with a statistical significance to match, t (25) = 1.71, *p* = 0.019. With a t-test, t (25) = 1.02, *p* = .057, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*. The trend in species evenness differed where, an insignificant mean score unlikeness was recorded, despite the exotic species (*M* = .79, *SD* = 0.06) registering a lower mean score in comparison to (*M* = .82, *SD* = 0.03) for the indigenous trees. Again, a significant statistical mean score discrepancy in exotic and indigenous tree species t (25) = 2.84, p = .001 was realized however, the exotic tree species (*M* = 35.65, *SD* = 6.68) revealed a higher mean score in dominant tree species abundance than the indigenous tree species (*M* = 31.26, *SD* = 8.23) as illustrated in Table 17.

The survey revelations on species diversity and richness are consistent with the finding of a comparative forest conservation surveys by FAO (2015) which registered a significantly low dice coefficient of the Sorensen's similarity index in tree species composition in planted and natural forests. The conclusion by FAO (2015) were likely because in farm-forestry, a few exotic tree species are selected based on fast growth rate traits and profitability hence low species richness and diversity. Again, the natural forests are associated with higher indigenous tree species richness and diversity driven by natural selection (UN, 2016). The species evenness differed from the study by Musingo (2016) in the coastal region of Kenya that reported a significantly higher values of Simpson's index in tree species evenness in the indigenous than the exotic tree species. The anomalousness was occasioned by the diversity tools of analysis used, while the current study relied on Shannon Wiener's diversity index, the previous comparative results in sub-Saharan Africa were derived based on the Simpson index of biodiversity assessment (Chomba et al., 2020). Chomba et al. (2020) argued that Simpson index, unlike Shannon Wiener, pays more attention to species abundance and evenness (dominance). The species abundance identified with the findings by Brancalion (2020) that revealed a higher percentage rank abundance for the exotic *Eucalyptus SPP* compared to other indigenous trees such as the *Markhamia lutea*. The forestry extension services, NGOs, and other external agents have found it easy to advance subsidized and readily available exotic tree seedlings to tree farmers in tropical and sub-Saharan Africa (Borges et al., 2021).

4.3.6 Phobia/Fear and Dominant Tree Species

The two-sample t-test was carried out to justify if a significant dissimilarity in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance among 254 respondents in tree phobia and non-phobia groups was likely to prevail. Table 18 expresses the Independent two-sample t-test results.

Table 19: Group Statistics and t-test Results: Phobia/Fear, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Tree Phobia	N	Mean	SD	T test
Diversity(H)	Phobia	234	2.44	0.26	t (252) = 2.80,
	Non-phobia	120	2.02	0.12	*p* = .015
Richness	Phobia	234	16.50	2.00	t (252) = 2.71,
	Non-phobia	120	15.00	1.29	*p* = .018
Evenness	Phobia	234	.96	0.02	t (252) = 1.81,
	Non-phobia	120	.90	0.02	*p* = .005
Abundance	Phobia	134	31.25	5.63	t (252) = 0.23
	Non-phobia	120	30.20	3.30	*p* = .061

The null hypothesis was rejected at 95% confidence interval, *p-value = .05* for species diversity, richness, and abundance. The 134 respondents that admitted no Influence (*M* =

2.44, *SD* = 0.26) demonstrated a higher mean score of Shannon Wiener's diversity index, compared to the 120 tree-fear affected group (*M* = 2.02, *SD* = 0.12) with a statistical significance of t (252) = 2.80, *p* = .015, while 130 respondents remained non-committal. Equally, the mean score of the tree species richness was significantly lower among the tree fearful households, (*M* = 15.00, *SD* = 1.29) in relation to the non-phobia category, (*M* = 16.50, *SD* = 2.00) and a corresponding t-test significance, t (252) = 2.71, *p* = .018. With reference to a t-test significance of, t (252) = 1.81, *p* = .005, a similar sequence reoccurred in species evenness where, a significant low mean score, (*M* = .90, *SD* = 0.02) was observed in tree phobia category (*M* = .95, *SD* = 0.02). Conversely, the null hypothesis was accepted at (95%) confidence interval, *p-value = .05* because there was no significant statistical mean score distinction for tree phobia and non-tree phobia t (252) = 0.23 *p* = .061, despite non-phobia group scoring (*M* = 31.25, *SD* = 5.63) which was a higher mean of dominant tree species abundance than the phobia group (*M* = 30.20, *SD* = 3.30) as listed in Table 18.

On species diversity and richness, the finding backed by Fountain (n.d) and Tomalak et al. (2010) whom through verbal interview reached a conclusion that tree-fear respondent was likely to report love for fewer tree species compared to the non-tree phobia group. This is because societal motivation and personal attitude play an important role in determining tree species selection in farm-forestry (Kanianska, 2016). The species evenness identified with the study outcome by Rotich et al. (2017) which argued that personal attitude would negatively affect species evenness. Tree fear affected category are likely to precautionary handle tree species or plant a few tree species in their wish list that they may manage with confidence (Liu et al., 2018). The outcome differed from a simulated experimental survey in Montpellier by Lalisa (2019) that indicated a likely variation in tree species abundance due to human attitude. The findings likely differed because a simulated video of tree species in perceived natural habitat were shown to the respondents where their panic levels through a polygraph was assessed (Lindberg, 2020). The major weakness of simulation is; it lacks absolute reality. People are likely to react in a different way when faced with real world situations (Grant, 2021).

4.3.7 Dominant Tree Species Choice and Preference

The Independent two-sample t-test was run to identify if a significant variation in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in unpreferred and preferred tree species categories was in existence. Table 19 illustrates the Independent two-sample t-test results.

Table 20: Group Statistics and t-test Results: Choice/Preference, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Preference	N	Mean	SD	T test
Diversity(H)	Unpreferred	5	2.35	0.21	t (8) = 1.62, *p*
	Preferred	5	1.98	0.16	= .024
Richness	Unpreferred	5	6.64	1.24	t (8) = 1.73, *p*
	Preferred	5	5.25	0.96	= .017
Evenness	Unpreferred	5	.85	0.03	t (8) = 1.51, *p*
	Preferred	5	.91	0.04	= .044
Abundance	Unpreferred	5	33.25	2.88	t (8) = 2.83 *p*
	Preferred	5	21.40	2.63	= .002

The null hypothesis was again rejected at 95% confidence interval, *p-value = .05*. Out of the 27 tree species surveyed, only 10 species were distinctively mentioned in preferential list. The 5 unpreferred dominant tree species registered (*M* = 2.35, *SD* = 0.21) which demonstrated higher mean score of Shannon Wiener's diversity index, compared to the 5 preferred tree species (*M* = 1.98, *SD* = 0.16) with a statistical significance of t (8) = 1.62, *p* = .024. The mean score of the tree species richness was significantly lower in preferred tree species, (*M* = 5.25, *SD* = 0.96) in relation to the unpreferred tree category, (*M* = 6.64, *SD* = 1.24) and a corresponding t-test significance, t (8) = 1.73, *p* = .017. In harmony with a t-test significance of, t (8) = 1.51, *p* = .044, a similar trend was repeated with species evenness where, a significant low mean score, (*M* = .85, *SD* = 0.03) in tree species evenness was observed in preferred tree species group in comparison to (*M* = .91, *SD* = 0.04) for the unpreferred tree species. There was significant statistical discordance in mean score t (8) = 2.83 p = .002, because the unpreferred tree species (*M* = 33.25, *SD* = 2.88) recorded a higher mean score in abundance than the preferred dominant tree species (*M* = 21.40, *SD* = 2.63) as displayed in Table 19.

The species diversity and richness are consistent with the finding in landscapes of West Usambaras, Tanzania by Pantaleo et al. (2016) that by interviewing key informants, whom included chainsaw operators, timber yard owners, carpenters involved in furniture, and house construction concluded that the tree species preferred by these particular respondents were becoming rear in physical species diversity assessment. The discoveries by Pantaleo et al. (2016) were likely attributed to informed customers preference for wood work made from quality timber obtained from rare tree species. The species evenness differed from Erle (2021) that by observation and interview reported no statistical relation in values of tree species evenness in tree preference and non-preference. The discrepancy was likely due to the fact that Erle (2021) performed the survey among the households owning large tree plantations with predetermined homogeneous tree species (Esmail, 2021). Further, the species abundance validated the qualitative report by Esmail (2021) which noted that possible non-preference by the public on *Prosopis juliflora* (the infamous *Mathenge*) tree, occasioned the tree population growth due to low human disturbance and increased species invasion.

An interview with a key informant clarified that:

> Umbrella was an exotic dominant tree species in the sub-county in the late 90s. The tree is however associated with unprecedented mortality among the households when grown within the homestead. The species is being uprooted or cut down due to fear of death(s) in the family", own words of Mrs. Helida Were Oduor on the 20th December 2021. The planting of the Jack tree is another bad omen in a home, the

tree is linked misfortune and poverty (Female 83years old, a key informant on cultural issues on the 20th December 2021).

4.4 Human Settlement and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The qualitative information on Human Settlement was collected from the primary data sources. Table 20 explains Data Summary on Human Settlement.

Table 21: Human Settlement Data Summary

Residential Areas Size	Land Ownership	Education Level	House Classification	Land Tenure System	Gender	Culture/beliefs
N = 384 M = 0.43 SD = 0.19	N = 384 M = 1.74 SD = 0.53	N = 384 Basic = 246 Higher = 138	Modern = 98% Traditional = 2%	Private =113 Collective = 271	Female = 222 Male = 162	YES = 75 NO = 290 Undecided = 19

Pegged on 384 households, residential characteristics were assessed and area estimated. The average residential area size in acres was (M = 0.43, SD = 0.19). The FGD maintained that cultural shift and education was responsible for the reducing homestead size. Most of the educated were adopting urbanite home styles. However, Dennis (real name withheld), 40 years old a physical planner, key informant attached to county departmental office, attributes the smaller home sizes to a growing land scarcity.

The minority 24% with valid land ownership owned an average of (M = 1.4, SD = 0.9) acres. See Table 20, 2nd column. The FGD reiterated that the tree species were negatively affected due to delayed land successions, common interest, and conflict in resource sharing under the collective land tenure system. “The exponential household growth rate between 2009 to 2019 was adding more spatial pressure on the declining land resource due to land subdivision and fragmentation fueled by the prevalence in land sales”. John, 44 years old, key informant from west Ugenya ward administration office.

Majority, nearly 64% had acquired at least basic education as shown in Table 20, 3rd column. The FGD revealed that economic underprivilege was the main reason hindering higher education acquisition. “The acquisition of higher education is low owing to higher school dropout rates catalyzed by the prevailing socio-demographic and economic hardship”. An interview with Caren, 33 years old (real name withheld) a high school teacher and a key informant in Geography, on 16th February 2022,

Nearly 98% of households lived in either semi-permanent or permanent houses. According to FGD in Ukwala ward, the traditional or grass-thatched houses were almost faced out as illustrated in Table 20, 4th column. Apart from the declining grass fields for roof thatching, the foreign cash flow initiative dubbed “give direct” was appreciated for the change in house types.

About 70% of the households lived under collective land tenure as displayed in Table 20, 5th column. An FGD in East Ugenya ward emphasized that, inadequate awareness of property succession legislation, and lack of land adjudication fees, were the main reasons provided for the low land ownership validation. The acquisition of land titles was likely driven by the fear of potential emotive land conflicts. “Most of us only make land succession follow up when conflict looms or when there is a potential economic gain”, an interview with a key informant, Mr. Okiya, 71 years old former local administrator in North Ugenya.

More than a half 58% of the interviewed household heads comprised females. See Table 20, 6th column. FGDs reported that female spouses were the custodians and caretakers of the rural homes while males pursued employment opportunities in urban centers. Female headed households were culturally restricted from interacting with some dominant tree species because of the reasons provided in appendix K.

From a total of 384 household heads questioned, 76% dissociated with traditional cultural practices, 20% were culturally conservative while four percent were undecided as shown in Table 20, 7th column. A number of dominant tree species performed certain cultural functions as illustrated in appendix S. Majority of respondents, who disagreed with the traditional cultural practices, argued that the culture was based on unnecessarily prohibitive and retrogressive ideologies, which undermined socio-cultural and economic development. Conversely, according to FGDs, most of the proponents of cultural conservation held the view that culture was the only societal ancestral heritage which needed to be conserved at all cost.

4.4.1 Residential Area Size and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The results on the relationship between the residential area size, land ownership, the tree species diversity, richness, evenness, and abundance were displayed as shown in table 22.

Table 22: Residential area size, Land ownership in relation to the tree species Diversity, Richness, Evenness, and Abundance

Dependent Variables/ (20m×20m) plots	R	R Square	Adjusted R Square	P-Value	Std. Error of the Estimate
Shannon Wiener diversity index	.722[a]	.633	.632	.026	.116
Dominant Tree Species Richness	.688[a]	.594	.593	.034	.873
Dominant Tree Species Evenness	.746[a]	.658	.657	.019	.038
Dominant Tree Species Abundance	.675[a]	.549	.548	.046	2.071

a. . Predictors: (Constant), Residential Area Size (M^2), Land Ownership (M^2)

The results of linear coefficient of determination (R^2) indicated that 63.2%, of the variation in tree species diversity, 59.3% of the species richness, 65.7% of the species evenness, and 54.8% of the species abundance could possibly be explained by the joint variation in values of the Residential Area Size and the Land Ownership (in a spatial scale of 20mX20 plots (Table 22).

To assess if a significant statistical linear relationship occurred between Residential Area Size, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 21 shows the bivariate Pairwise Pearson's correlation coefficients analysis.

Table 23: Pairwise Pearson's Correlation Coefficients Analysis: Residential, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Residential area	Species Richness	Species Abundance	Species Evenness	Diversity (H)
Residential area	Correlation	1	.165	.504	.721	.870
	Sig. (2-tailed)		.086	.000	.028	.002
	N	384	384	384	384	384
Species Richness	Correlation	.165	1	.028	.025	.029
	Sig. (2-tailed)	.086		.078	.055	.091
	N	384	384	384	384	384
Species Abundance	Correlation	.504	-.028	1	-.032	-.038
	Sig. (2-tailed)	.000	.078		.085	.051
	N	384	384	384	384	384
Species Evenness	Correlation	.721	.025	-.032	1	.024
	Sig. (2-tailed)	.028	.055	.085		.053
	N	384	384	384	384	384
Diversity (H)	Correlation	.870	.029	-.038	.024	1
	Sig. (2-tailed)	.002	.091	.051	.053	
	N	384	384	384	384	384

Quantitatively, Larger homes by size were likely associated with positive values of the Dominant tree species diversity index, Evenness, and Abundance. Even so, the residential area size was proved statistically insignificant in explaining the Dominant tree species Richness in Ugenya sub-county. Residential area size registered a significant linear relationship with the Shannon Wiener's diversity index, species abundance, and Evenness. The computed variables were found significantly fit for the bivariate Pearson correlation model. A positive unit change in residential area size was likely associated with an increase in values of Shannon Wiener's diversity index *r (382)* = .87, *p* = .002, the larger the homesteads by area size was likely associated with higher tree species diversity, so was the trend with tree species Abundance *r (382)* = .50, *p* < .001, and Evenness *r (382)* = .72, *p* = .028. Even so, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*, the residential area size was found statistically insignificant in predicting the Dominant tree species Richness *r (382)* = .17, *p* = .086, in other words the tree species richness was linearly unaffected by the residential area size in the sub-county (Refer to Table 21).

The species diversity and abundance outcomes are in line with the finding in eastern Qinghai-Tibetan plateau China by Zhang et al. (2012) which revealed a significant positive statistical association between both the tree diversity, species abundance and residential area size. In Siaya county, larger residential area sizes are likely linked to a higher household population which may exhibit varied choices and preferences on the tree species hence the possible appreciation in tree species diversification (Oloo et al., 2013). The species evenness reports are in agreement with Sottile et al (2014) that reported an increase in values of tree species evenness because of a possible increase in residential area size. The high tree species evenness observed is attributed to habitat space size which generally affect the speciation, the rate of tree species regeneration, growth rate, and competition in an ecological community (Deisser & Njuguna, 2016). However, the tree species richness differed from the conclusions of a similar study by Melliger et al. (2018) that observed a higher tree species richness in residential areas. The findings reported by Melliger et al. (2018) were possible because the conclusion was drawn pegged on Simpson's index for species diversity. The species richness and diversity mean one and the same thing according to Simpson's index of biodiversity measurements thus possibly leading to the declaration of higher species richness in human residential as noted eastern Ghana by (Seidu et al., 2018).

A key informant maintained that:

> Cultural shift and education is responsible for the reducing homestead size. Most of the educated are adopting urbanite home styles. However, other members of the group attribute the smaller home sizes to a growing land scarcity (male geography high school teacher on 16th February 2022).

4.4.2 Land Ownership and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

To assess if a significant statistical linear relationship occurred between Land Ownership, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 22 demonstrates the bivariate Pairwise Pearson's correlation coefficients analysis.

Table 24: Pairwise Pearson's correlation coefficients analysis: Land Ownership, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Land ownership	Species Richness	Species Evenness	Species Abundance	Diversity (H)
Land		1	.172	-.676	.440	.240
ownership	Correlation		.059	.014	.005	.054
	Sig. (2-tailed)	384	384	384	384	384
Species	N	.172	1	.020	.022	.032
Richness	Correlation	.059		.071	.078	.082
	Sig. (2-tailed)	384	384	384	384	384
Species	N	-.676	.020	1	-.051	.056
Evenness	Correlation	.014	.071		.073	.068
	Sig. (2-tailed)	384	384	384	384	384
Species	N	.440	-.022	-.051	1	-.038
Abundance	Correlation	.005	.078	.073		.070
	Sig. (2-tailed)	384	384	384	384	384
Diversity	N	.240	.032	.056	.038	1
(H)	Correlation	.054	.082	.068	.070	
	Sig. (2-tailed)	384	384	384	384	384
	N					

A statistical analysis proved that the Dominant tree species diversity and Richness were likely unaffected by the size of land owned. The tree species Evenness and Abundance were, however, likely to depend on the increase in land size owned by the households in Ugenya sub-county. The null hypothesis was accepted at 95% confidence interval, *p-value = .05,* because, the Pearson correlation coefficients analysis predicted a statistical insignificance between Land ownership, the Shannon Wiener's diversity index $r(382) = .24$, $p = .054$, and species Richness $r(382) = .172$, $p = .059$. Conversely, the null hypothesis was rejected at 95% confidence interval, *p-value = .05,* a statistically significant negative linear dependency was realized between the households' land ownership and Evenness $r(382) = -.68$, $p = .014$, while the species Abundance registered a positive Pearson's correlation coefficient of $r(382) = .44$, $p = .005$ with land ownership size in the sub-county (See Table 22).

On species diversity and richness, the revelations are inconsistent with the finding by Whitescarver and Kalman (2009) which revealed a significant positive statistical relationship between both the tree diversity, species richness and the size of land parcels. Relatively larger lands in Tehuacan valley of Mexico are likely associated with a low intensity biodiversity disturbance which possibly promote the tree species richness and diversity (Biancas et al., 2013). Again, unlike the current study that surveyed private lands, Biancas et al. (2013) performed the study in public lands set aside for nature conservation, private lands are known for constant species disturbances due to human activities compared to the undisturbed public land utilities of Kakamega county (Vuyiya et al., 2014). The results of species evenness are compatible with an exploration in Ghana's upper East region by Dittoh et al. (2015) that reported a likelihood of a depreciation in values of tree species evenness as result of an increase in land size. The decreasing tree species evenness observed is attributed to biased utilization of a section of tree species (Doss et al., 2018). For example, the harvesting of the tree species such as *Eucalyptus SPP* in a monoculture regime is directly proportional to land size and negatively affects the tree species evenness (Chhem, 2019). In addition, the tree species abundance conformed to a study in Siaya county by Wanjira (2019) that observed a higher tree species count in relatively larger farms. The report by Wanjira (2019) was possible because the dominant trees, like any biological phenomena, require an ample geographical space in order to multiply (Rodriguez, 2020).

4.4.3 Education Level and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

For a statistical verification, a t-test was applied in comparing if a significant inequality in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in households with higher level of education and those with basic education was prevalent. Table 23 confirms the Independent two-sample t-test results.

Table 25: Group statistics and t-test Results: Education Level, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Education	N	Mean	SD	T test
Diversity(H)	Basic	246	2.43	0.26	t (382) = 1.74,
	Higher	138	2.02	0.12	*p* =.036
Richness	Basic	246	15.00	2.00	, t (382) =
	Higher	138	16.50	1.29	1.62, *p* = .028
Evenness	Basic	246	.97	0.016	, t (382) =
	Higher	138	.90	0.018	1.52, *p* = .055
Abundance	Basic	246	30.20	5.63	t (382) = 2.85,
	Higher	138	34.25	3.30	*p* = .003

The 138 households (Table 23) with higher education level registered (*M* = 2.02, *SD* = 0.12) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 246 households characterized by basic level of education (*M* = 2.43, *SD* = 0.26) with a statistical significance of t (382) = 1.74, *p* =.036. The mean score of the tree species richness was significantly lower among the respondents with higher education, (*M* = 15.00, *SD* = 2.00) in relation to households with basic level of education, (*M* = 16.50, *SD* = 1.29) and a corresponding t-test significance, t (382) = 1.62, *p* = .028. Evidenced by a t-test significance of, t (382) = 2.85, *p* = .003, the same statistical direction was replicated in species abundance where, a significant high mean score, (*M* = 34.25, *SD* = 3.30) in tree species abundance was observed among the respondents with higher education levels in comparison to (*M* = 30.00, *SD* = 5.63) for the basic level of education. Therefore, the null hypothesis was rejected at 95% confidence interval, *p-value = .05*. Conversely, the null hypothesis was accepted at 95% confidence interval, *p-value = .05* because there was no significant statistical Influence for education level, t (382) = 1.52, *p* = .055 despite the respondents with basic education level (*M* = .97, *SD* = 0.016) attaining a higher mean score in dominant tree species evenness than the ones with higher levels of education (*M* = .90, *SD* = 0.018). Plate 4 illustrates an example of the culturally modernized of the educated. Notice the even distribution of the exotic tree varieties.

Plate 3: Ground Close-up Photo: Depicting A typical Home of the Educated and Culturally Modernized Household in North Ugenya Ward

There was a tally in species diversity, richness, and the finding in Murang'a county by Mackenzie (2003) which, through qualitative justification, concluded a possible disproportion in tree species richness and diversity in basic and higher education categories. The low mean score in species diversity and richness in higher education category was likely due to more emphasis put on a few exotic tree species by the high school geography syllabus with no mention of the importance of planting indigenous tree species (Ikeke, 2013). The species evenness contrasted the research by Tanui (2015) in Nandi County that by assessing tree canopy reported a visible imbalance in tree species evenness among the households respective of education level. The inequality in tree species evenness reported was likely because unlike the current study the previous survey was based on a short-term observation period of 4 months (Zhang[a], 2017). The limitation of observation as a methodology, is that it requires a longer time frame to realize the statistical power of prediction. Furthermore, it is inapplicable in assessing the non-linear latent variables that are crucial in tree species adoption (Ochola, 2018). The species abundance revealed consistency with G.o.K (2019) that found no tangible statistical relationship between education level and tree species abundance. The imparity was likely occasioned by the fact that G.o.K (2019) survey data was sourced from the national tree farms inventory records. The periodic forest inventory records are known for data obsoleteness because real time forest changes are inevitable (Pak, 2021). Notice the distribution of the indigenous tree species in the foreground. Conservation of culture and traditions has been associated with higher indigenous dominant tree species' richness and diversity. (Photo by the researcher) Notice the distribution of the exotic tree species in the middle center ground. Education and cultural modernity have been associated with the introduction of the exotic dominant tree species. Photo by the researcher (2021)

4.4.4 Housing Classification and Dominant Tree Species Diversity, Richness, Evenness, and abundance

To compare if a significant nonequivalence in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in homes with the traditional house type and the modernized housings was in occurrence. Table 24 displays the Independent two-sample t-test results.

Table 26: Group Statistics and t-test Results: House Type, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	House type	N	Mean	SD	T test
Diversity(H)	Modern	1009	1.69	0.76	t (1029) =
	Traditional	22	1.78	0.91	1.41, p= .056
Richness	Modern	1009	11.23	4.03	t (1029) =
	Traditional	22	13.60	6.91	0.63, *p* = .057
Evenness	Modern	1009	.76	0.08	t (1029) =
	Traditional	22	.89	0.06	2.84, *p* .022
Abundance	Modern	1009	35.25	9.54	t (1029) =
	Traditional	22	30.24	11.94	1.72, *p* = .037

There was no significant statistical Influence for house type t (1029) = 1.41, p = .056, despite traditional houses (*M* = 1.78, *SD* = 0.91) attaining a higher mean score in Shannon Wiener's diversity index than the modern houses (*M* = 1.69, *SD* = 0.76). Therefore, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*. Similarly, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*, provided the 1009 modern houses registered (*M* = 11.23, *SD* = 4.03) which demonstrated lower score of the dominant tree species richness, compared to the 22 houses characterized by traditions (*M* = 13.60, *SD* = 6.91) despite the statistical insignificance of t (1029) = 0.63, *p* = .057. However, the mean score of the tree species evenness was significantly lower in modern house type, (*M* = .76, *SD* = 0.08) in relation to the traditional houses, (*M* = .89, *SD* = 0.06) and a corresponding t-test significance, t (1029) = 2.84, *p* .022. Supported by a t-test significance of, t (1029) = 1.72, *p* = .037, a contrary trend was noticed in species abundance where, a significant high mean score, (*M* = 35.25, *SD* = 9.54) in tree species abundance was observed in modern housing classification in comparison to (*M* = 30.24, *SD* = 11.94) for the traditional houses (See Table 24).

The conclusions on species diversity and richness are inconsistent with Živković (2018) that reported statistically significant divergence in the tree species richness, diversity in traditional grass-thatched and modern housing. The deductions by Živković (2018) were likely linked to the fact that in the traditional housing category, it has been perceived that more trees are utilized compared to modern house construction in reference to sentiments shared in a conference proceeding in Sekete, Benin (Gnonlonfin, 2018). In constructing traditional houses more saplings, twigs, and lower vegetation such as grass are used leading to a misplaced impression that trees are over utilized. The species evenness is similar to research in Ugenya sub-county by Egger et al. (2020) that by observation assessed lower tree species evenness in grass thatched than modern housing. The lower mean score in tree species evenness observed was because socio-cultural and economic underprivileged which subject likely characterizes traditional housing the households to conserve a diversity of the tree species so as to supplement the needs by tapping the ecosystem services (Hussein, 2020). The species abundance reflected the conclusions by IUCN (2021) that indicated a higher tree population in modern housing. Good housing is an indicator of better standards of living, households with economic power are likely less dependent on tree species (Gachuri et al., 2022).

4.4.5 Land Tenure System and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The Independent two-sample t-test was necessary in determining if a significant nonconformity in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in private and collective land tenure occurred. Table 25 displays the Independent two-sample t-test results.

Table 27: Group Statistics and t-test Results: Land Tenure, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Tenure systems	N	Mean	SD	T test
Diversity(H)	Private	113	1.48	0.81	t (362) = 2.81,
	Collective	251	1.88	0.86	*p* < .001
Richness	Private	113	4.52	3.61	t (362) = 2.90,
	Collective	251	9.68	1.00	*p* = .004
Evenness	Private	113	.95	0.01	t (362) = 1.66,
	Collective	251	.93	< 0.01	*p* = .015
Abundance	Private	113	34.38	6.51	t (362) = 1.72,
	Collective	251	19.34	6.43	*p* = .017

The null hypothesis was rejected at 95% confidence interval, *p-value* = *.05*. The 113 households under private land tenure registered (*M* = 1.48, *SD* = 0.81) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 251 households characterized by communal land ownership (*M* = 1.88, *SD* = 0.86) with a statistical significance of t (362) = 2.81, *p* < .001. Even so, 20 households accounted for leasehold and other forms of land tenure. In the same way, the mean score of the tree species richness was significantly lower in privately owned land parcels, (*M* = 4.52, *SD* = 3.61) in relation to land under communal ownership, (*M* = 9.68, *SD* = 1.00) and a corresponding t-test significance, t (362) = 2.90, *p* = .004. Represented by a t-test significance of, t (362) = 1.66, *p* = .015, a different trend was noticed in species evenness where, a significant higher mean score, (*M* = .95, *SD* < 0.01) in tree species evenness was observed in private land parcels in comparison to (*M* = .93, *SD* = 0.01) for the communal land tenure. A significant statistical Influence was replicated for the land tenure system and the tree species abundance t (362) = 1.72, *p* = .017. Equally, households in privately owned land parcels (*M* = 34.38, *SD* = 6.51) attained a higher mean score in dominant tree species abundance than the communal land tenure-based households (*M* = 19.34, *SD* = 6.43) as illustrated in Table 25.

The species diversity and richness are in line with the finding by Kinyanjui (2009) which reported a disparity in values of the tree species richness and diversity in the two-land tenure studied. The findings by Kinyanjui (2009) were likely attributed to the socio-cultural and economic characteristics in communal land tenure system, which is associated with a large human population exhibiting varied tree species choices and preferences that possibly led to a higher tree species diversity and richness in the rural Ghana (Acheampong, 2017). The species evenness reports are replicate of the survey outcome in the subarctic alpine tree lines by Kambo (2018) that reported a variation in values of tree species evenness in the private and communal land tenure. The lower mean score in tree species evenness observed was because under communal land ownership, the lack of spatial organization negatively affects the tree species representation (Wagner, 2019). The species abundance conformed to the survey outcomes in Baringo county by Jebiwott et al. (2019) that revealed a significantly higher mean score in private land ownership. It has been observed that private land ownership comes with self-responsibility to grow and to conserve trees (Arvola, 2020).

4.4.6 Gender and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

To verify the discrepancy in distribution of dominant tree species diversity a cross gender category, a t-test for independent samples was useful in detecting if a significant inequality in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in female and the male headed households. Table 26 illustrates the Independent two-sample t-test results.

Table 28: Group Statistics and t-test Results: Gender, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Gender	N	Mean	SD	T test
Abundance	Male	162	30.75	2.63	t (382) = 2.55,
	Female	222	21.20	2.88	*p* = .02
Evenness	Male	162	.91	0.03	t (382) = 1.61,
	Female	222	.85	0.03	*p* = .03
Richness	Male	162	5.26	1.14	t (382) =
	Female	222	6.60	0.96	0.494, *p* = .07
Diversity(*H*)	Male	162	2.40	0.26	t (382) = 0.64
	Female	222	2.42	0.12	*p* = .051

The null hypothesis was accepted at 95% confidence interval, *p-value = .05*. There was no significant mean score contrast in the Shannon Wiener's diversity index in female and the male categories, t (382) = 0.639 *p* = .051, despite males (*M* = 2.40, *SD* = 0.26) attaining a lower mean score of the Shannon Wiener's diversity than the females (*M* = 2.43, *SD* = 0.12). However, no data was reported for the intersex gender category. In a similar manner, the females scored a higher mean in the tree species richness (*M* = 6.60, *SD* = 1.40), even so, the score was insignificantly different from the mean tree species richness posted by the males, (*M* = 5.26, *SD* = 0.96) and a corresponding t-test insignificance, t (382) = 0.494, *p* = .065. The null hypothesis was rejected at 95% confidence interval, *p-value = .05*, the 222 female headed households registered (*M* = .85, *SD* = 0.03) which demonstrated lower mean score in tree species evenness, compared to the 162 households characterized by the male respondents (*M* = .91, *SD* = 0.03) with a statistical significance of t (382) = 1.61, *p* = .033. Identified by a t-test significance of, t (382) = 2.55, *p* = .017, a similar order was again depicted in species abundance where, a significant low mean score, (*M* = 21.20, *SD* = 2.88) in tree species abundance was observed in female headed households in comparison to (*M* = 30.75, *SD* = 2.63) for the males (See Table 26).

On species diversity and richness, the deductions are inconsistent with the study outcome by Meske et al. (1994) which reported a possible dissimilarity in the tree species richness and diversity in gender-based categories. The conclusions in Oban the Hill sector of Nigeria by Meske et al. (1994) was likely because the option to adopt and maintain tree species is dictated by attitude which is a latent variable which affects everyone irrespective of gender (Saka et al., 2012). The species evenness differed with the findings by Oloo (2013) that reported an insignificant mean score imparity in values of tree species evenness in female and male headed households. The likely reason for the insignificant mean score was because Oloo (2013) used snowball sampling technique in recruiting the tree farmers along the gender divide. Snowball is a biased technique whose samples share a common dependent characteristic which compromise statistical independence (Deisser & Njuguna, 2016). The species abundance supported Liliane et al. (2019) that revealed a significantly higher mean score in male headed households. The possible contributing factor was because of gender parity occasioned by the culture/beliefs which barred females from a number of the tree growing practices in Ugenya sub-county (Wanjira, 2019).

4.4.7 Culture and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

To justify if a significant disproportion in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in households with cultural non-adherence and the culturally conservatives possibly did exist, a two-sample t-test was conducted. Table 27 displays the Independent two-sample t-test results.

Table 29 Group Statistics and t-test Results: Culture/Beliefs, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Culture	N	Mean	SD	T test
Diversity(H)	NO group	290	1.49	0.82	t (363) =2.62,
	YES, group	75	1.77	0.87	*p* = .011
Richness	NO group	290	8.67	4.95	t (363) =1.95,
	YES, group	75	11.00	4.34	*p* = .019
Evenness	NO group	290	.85	0.09	t (363)
	YES, group	75	.87	0.06	=0.877, *p* =
Abundance	NO group	290	32.82	9.04	.095
	YES group	75	32.12	13.69	t(363)=0.941,
					p = .052

The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. The 290 households (Table 27) associated with cultural non-adherence registered (*M* = 1.49, *SD* = 0.82) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 75 households that were considered culturally conservative (*M* = 1.77, *SD* = 0.87) with a statistical significance of t (363) = 2.62, *p* = .011, while 19 household heads remained non-committal. The mean score of the tree species richness was significantly lower in culturally unaffected households, (*M* = 8.67, *SD* = 4.95) in relation to the culturally conservative, (*M* = 11, *SD* = 4.34) and a corresponding t-test significance, t (363) = 1.95, *p* = .019. There was no significant mean score anomaly in the tree species evenness in non-cultural and the culturally conservative categories, t (363) = 0.877, *p* = .095, therefore, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*, despite the culturally conservative households (*M* = .87, *SD* = 0.06) attaining a higher mean score of the species evenness than the non-cultural group (*M* = .85, *SD* = 0.09). The culturally conservative scored a lower mean in the tree species abundance (*M* = 32.12, *SD* = 13.69), even so, the score was insignificantly different from the mean tree species abundance posted by the non-cultural households, (*M* = 32.82, *SD* = 9.04) and a corresponding t-test insignificance, t (363) = 0.941, *p* = .052. Plate 3 displays a typical home of the old and culturally conservative household. Take notice of the evenly distributed Indigenous tree species.

Plate 4: Ground Close-up Photo; A typical Home Associated with Old Age, Basic Education, Traditions, and Culturally Conservative Household in West Ugenya Ward

The Shannon Wiener's diversity index differs from the findings by Vliet et al. (2015) in Europe that reported no significant Influence of culture on species diversity. This is because the said study relied on Simpson's index, unlike Shannon Wiener, the Simpson index is known for insensitivity to rare species (Marcon & Zhang, 2017). The outcome of the tree species richness was a corroboration by Taesuk et al. (2019) that associated higher tree species richness with cultural conservation. This was possibly attributed to the fact that functions of indigenous culture and traditions depended on a diverse community of trees (The World Bank, 2019). Both the species evenness and abundance portrayed an inconsistency with Yeboah (2020) in Africa which revealed a contrast in the tree species evenness and abundance in traditional and non-cultural categories. This was likely because in Nigeria, establishing indigenous trees is synonymous with African culture while the exotic trees are perceived as a symbol of cultural modernity as categorized in Borneo, Malaysia (Vernick, 2020). The recent forest conservation studies in Africa have revealed a lower species evenness and higher tree population for the dominant exotic tree compared to higher species evenness and lower population for the indigenous tree species (Mauro & Aquino, 2020).

FGD revealed that:

> Planting and harvesting require matrimonial ritual. In absence of a male spouse, the mentioned farming practices are at a standstill. In modern culture, planting of some tree species is seen as a backward act. For example, households that grow "Ojuok" [*Euphorbia tirucalli*] hedges are considered uncivilized. "Ja Ojuok" ["uncivilized person"]. The negative attitude is linked to tree species diversity loss (FGD, attached to Bar Alando chief's Baraza on the 19th December 2021).

4.5 Livestock Farming and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The qualitative information on Livestock Farming was collected from the Primary Data Sources. Table 28 shows data summary on Livestock Farming.

Table 30: Livestock Farming Data Summary

Stocking Rate	Tree Forage Harvesting Rate	Livestock Breeds	Livestock Feeding Method	Livestock Farming System	Livestock Composition	Palatable Forage Trees
YES = 373 NO = 11 M = 6 SD = 2.8	YES = 373 NO = 11 M = 102 SD = 3.68	Native = 88% Exotic = 8.9%	Traditional = 81% Modern = 16%	Extensive = 76% Intensive = 21%	Single = 13% Mixed = 84%	9

At least 373 of the surveyed households domesticated livestock. An average number (M = 6, SD = 2.8) of animals were kept per household. Cattle, goat, and sheep was the most recurrent livestock combination in the sub-county as displayed in Table 28, 1st column, and appendix M. "Poor Land budgeting is the main factor affecting the livestock population distribution in our sub-county", an interview with a key informant, Mr. Collins Omondi, 32 years old a veterinary officer based in Sega town, North Ugenya ward on the 14th December, 2021.

Ordinarily atypical household keeping livestock was likely to harvest forage tree organs (M = 102, SD = 3.68) times per annum as shown in Table 28, 2nd column. A total of 13 dominant tree species were identified by the respondents as palatably suited for livestock feed supplements. FGDs noted that as the open grazing/foraging space decreased, tree forage harvesting bridged the gap in livestock feed supply.

The most common livestock breeds were indigenous. See Table 28, 3rd column. Nearly 88% of the households domesticated native livestock breeds. The exotic (non-indigenous/cross-breeds) accounted for about nine percent of the livestock distribution in the studied households of Ugenya sub-county. "The indigenous livestock are cheap, readily available, moderate feed consumers, have better pest and disease resistance, though with relatively lower production qualities compared to the exotic breeds in our sub-county", an interview with a key informant, Mr. Collins Omondi, 32 years old a veterinary officer based in Sega town, North Ugenya ward on the 14th December, 2021.

During the study, about 81% of the studied households relied on traditional livestock feeding methods. Approximately 16% of the households assessed had adopted modern livestock feeding methodologies, as portrayed in Table 28, 4th column. The reason cited by the majority of the respondents ranged from modern input inaccessibility to land capital constraints.

A total of 292 or 76% of the interviewed households practiced an extensive livestock farming system as shown in Table 28, 5th column. However, 21% adopted the intensive livestock farming option. Inability to acquire modern farming machinery, structures, higher costs of buying, and maintaining high breed livestock, were the modal questionnaire responses provided for the low uptake of the intensive livestock farming practices.

Single livestock species farms were found in 49 of the studied households, which represented 13% of the livestock composition. Conversely, most homes 84% domesticated mixed livestock. Spreading the risk through farming diversification and customary obligations were the most prevalent reasons provided for mixed livestock farming adoption as depicted in Table 28, 6th column. "Because of inadequate grazing space and the prevalence in stock theft, I find it easy to domesticate a single, exotic, and an economically lucrative animal" an interview with Mr. John O., 48 years old, a key informant and an acting area chief of East Ugenya location on the 5th February, 2022.

A total of 13 possibly palatable dominant tree species were identified by the respondents. However, after ethical consideration and expert advice, 69% or nine dominant tree species were included in the test as shown in appendix M, Table 28, 7th column.

4.5.1 Stocking Rate and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

The results on the relationship between the stocking rate, forage harvesting, the tree species diversity, richness, evenness, and abundance were displayed as shown in table 31.

Table 31: Stocking Rate/(20mX20) plots, Tree Forage Harvested/(20mX20) in relation to the tree species Diversity, Richness, Evenness, and Abundance

Dependent Variables/ (20m×20m) plots	R	R Square	Adjusted R Square	P-Value	Std. Error of the Estimate
Shannon Wiener diversity index	.771[a]	.664	.663	.044	.049
Dominant Tree Species Richness	.702[a]	.616	.615	.021	1.41
Dominant Tree Species Evenness	.689[a]	.599	.598	.039	.015
Dominant Tree Species Abundance	.880[a]	.753	.752	.014	1.932

a. Predictors: (Constant), Stocking Rate/(20mX20) plots, Tree Forage Harvested/(20mX20)

The linear coefficient of determination (R^2) showed that 66.3%, of the variation in tree species diversity, 61.5% of the species richness, 59.8% of the species evenness, and 75.2% of the species abundance could possibly be explained by the joint changes in values of stocking rate and the amount of the forage harvested in a spatial scale of 20mX20 plots (Table 31).

To assess if a significant statistical correlation occurred between Stocking Rate, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance. Table 29 displays the Pairwise Pearson's correlation coefficients analysis.

Table 32: Pairwise Pearson's Correlation Coefficients Analysis: Stocking Rate, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Stocking rate	Diversity (H)	Species Richness	Species Abundance	Species Evenness
Stocking		1	.547	.727	-.819	-.417
rate	Correlation		.000	.006	.007	.001
	Sig. (2-					
	tailed)	384	384	384	384	384
Diversity	N	.547	1	.033	-.038	.045
(H)	Correlation	.000		.075	.078	.067
	Sig. (2-					
	tailed)	384	384	384	384	384
Species	N	.721	.033	1	-.036	.037
Richness	Correlation	.006	.075		.078	.085
	Sig. (2-					
	tailed)	384	384	384	384	384
Species	N	.819	.038	-.036	1	-.044
Abundance	Correlation	.007	.078	.078		.081
	Sig. (2-					
	tailed)	384	384	384	384	384
Species	N	-.417	.045	.037	-.044	1
Evenness	Correlation	.001	.067	.085	.081	
	Sig. (2-					
	tailed)	384	384	384	384	384
	N					

The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. The domestication of a large number of livestock per acre of land was likely associated with higher Dominant tree species diversity. Significant positive statistical Influences were revealed between the Stocking rate (TLUHa-[1]), Shannon Wiener's diversity index $r(382) = .55$, $p < .001$, and the species Richness $r(382) = .73$, $p = .006$. As households adopted more livestock per unit acre of land, the values of the corresponding species diversity and Richness possibly appreciated. The correlation coefficients analysis between the Stocking rate (TLUHa-^{1}), species Evenness r (382) = - .42, p = .001, and Abundance r (382) = - .82, p = .007 revealed a likeliness of negative statistical trend in Ugenya sub-county (See Table 29).

The species diversity and richness are likewise depicted in the finding by Scimone et al. (2007) which showed a significant positive statistical association between both the tree diversity, species richness, and stocking rate. In northern Pakistan, Animal species play a pivotal role ranging from the soil nutrient circulation to the tree genetic dispersal which may positively affect both the tree species diversity and richness (Rahim, 2011). The species evenness is in agreement with Kabunga (2014) that reported a likely decrease in values of tree species evenness due an increase in stocking rate. The declining tree species evenness observed is likely because of the destructive foraging behavior on specific tree species portrayed by the livestock (FAO, 2017). The tree species abundance reflected the outcome of a study in African pastoral rangelands by Odadi et al. (2017) that observed an inverse relationship between tree species abundance and stocking rate. The report by Odadi et al. (2017) were possible because livestock farming does equally compete with tree species for space, therefore, as the number of livestock increases, the tree species population would possibly be negatively affected (Qin, 2020).

An interview with a key informant emphasized that:

> Because of inadequate grazing space and the prevalence in stock theft, I find it easy to domesticate a single, exotic, and an economically lucrative animal (Male 48 years old, veterinary key informant on the 5th February, 2022).

4.5.2 Tree Forage Harvesting Rate and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

Pairwise Pearson's Correlation Coefficients Analysis was used to assess if a significant statistical linear relationship existed between the Tree Forage Harvesting Rate and the Dominant Tree Species. Table 30 demonstrates the Pairwise Pearson's correlation coefficients analysis.

Table 33: Pairwise Pearson's Correlation Coefficients Analysis: Tree Forage Harvesting Rate, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

		Diversity (H)	Species Richness	Species Abundance	Species Evenness	Harvesting rate (per annum)
Diversity (H)	Correlation	1	.042	-.038	.026	.535
	Sig. (2-tailed)		.062	.055	.068	.000
	N	384	384	384	384	384
Species Richness	Correlation	.042	1	-.048	.046	.631
	Sig. (2-tailed)	.062		.078	.063	.000
	N	384	384	384	384	384
Species Abundance	Correlation	-.038	-.048	1	-.026	.208
	Sig. (2-tailed)	.055	.078		.072	.064
	N	384	384	384	384	384
Species Evenness	Correlation	.026	.046	-.026	1	-.192
	Sig. (2-tailed)	.068	.063	.072		.060
	N	384	384	384	384	384
Harvesting rate (per annum)	Correlation	.535	.631	-.208	-.192	1
	Sig. (2-tailed)	.000	.000	.064	.060	
	N	384	384	384	384	384

The sustained harvesting of the palatable Dominant tree species organs for livestock feed supplements was likely linked to higher tree species diversity and Richness while the tree species representativeness (Evenness) and Abundance were possibly unaffected by the practice. The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. The Pearson correlation coefficient analysis revealed a significant positive linear relationship between the Rate of forage harvesting, Shannon Wiener's diversity index $r(382) = .54$, $p <$

.001, and the species Richness $r(382) = .63$, $p < .001$. However, despite the negative correlation coefficients, the null hypothesis was accepted at 95% confidence interval, *p-value = .05*, the rate of tree forage harvesting failed a statistical significance test in predicting the Dominant tree species Evenness $r(382) = -.19$, $p = .06$, and Abundance $r(382) = -.21$, $p = .064$ in Ugenya sub-county (Refer to Table 30).

The species diversity and richness are consistently depicted in the qualitative finding by Al-Rowaily et al. (2015) in western Saudi Arabia which portrayed a significant positive statistical association between both the tree diversity, species richness, and the rate of tree forage harvesting. In the slopes of Mount Kilimanjaro, Tanzania, households with livestock were likely conserving palatable forage trees which may have positive Influence on both the tree species diversity and richness (Kikoti & Mligo, 2015). The species evenness and abundance were replicable in the findings by (Ronoh, 2016) in Bomet county that reported an insignificant statistical correlation between both the values of tree species evenness, abundance, and the rate of tree forage harvesting. In North Botswana, the unaffected tree species evenness and abundance observed was because instead of feeding the animals directly on trees, palatable organs were first harvested, and value added where applicable (Mugabe, et al., 2017). The tree forage organs if carefully harvested with minimal harm inflicts no negative health Influence on the tree species GoWA (2017), Furthermore, the species evenness and abundance remain unaffected provided that only tree organs are targeted while the whole tree is left intact (Donald, 2021).

A verbal interview with a Key Informant indicated that:

> Nowadays animals feeding on tree organs more often than before. Most livestock farmers have seemingly realized this and are frequently seen harvesting the tree leaves and other organs to feed the animals (Male 42 years old Livestock extension officer on the 7th February, 2022).

4.5.3 Livestock Breeds and the Dominant Tree Species **Diversity, Richness, Evenness, and abundance**

Conducting an independent sample t-test was meant to compare if a significant statistical change in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in farms that reared exotic (non-indigenous/cross-breeds) and indigenous livestock breeds possibly did prevail. Table 31 expresses the Independent two-sample t-test results.

Table 34: Group Statistics and t-test Results: Livestock Breeds, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Breeds	**N**	**Mean**	**SD**	**T test**
Diversity(H)	Exotic	34	1.48	0.81	t (371) = 1.64,
	Indigenous	339	1.98	0.86	*p* = .036
Richness	Exotic	34	8.61	2.20	t (371) = 1.26,
	Indigenous	339	10.00	3.10	*p* = .025
Evenness	Exotic	34	.72	0.05	t (371) =
	Indigenous	339	.88	0.03	0.934, *p*
Abundance	Exotic	34	31.40	7.05	= .031
	Indigenous	339	30.00	13.89	t (371) = 0.422, *p* = .058

The null hypothesis was rejected at 95% confidence interval, *p-value* = *.05*. The 34 households domesticating non-indigenous livestock breeds recorded (*M* = 1.48, *SD* = 0.81) which demonstrated lower mean score of Shannon Wiener's diversity index, compared to the 339 households that kept the indigenous livestock (*M* = 1.98, *SD* = 0.86) with a statistical significance of t (371) = 1.64, *p* = .036. In a like manner the mean score of the tree species richness was significantly lower in non-indigenous breeds category, (*M* = 8.61, *SD* = 2.20) compared to indigenous livestock, (*M* = 10.00, *SD* = 3.10) with a statistical significance of, t (371) = 1.26, *p* = .025. As indicated by a t-test significance of, t (371) = 0.934, *p* = .031, an identical trend was realized in species evenness where, a significant low mean score, (*M* =

.72, *SD* = 0.05) in tree species evenness was observed in non-indigenous livestock breeds in comparison to (*M* = .88, *SD* = 0.03) for the indigenous livestock. Conversely, the null hypothesis was accepted at 95% confidence interval, *p*-value = .05, because there was no significant statistical mean score nonconformity in non-indigenous and indigenous livestock breeds t (371) = 0.422, *p* = .058, despite non-indigenous livestock (*M* = 31.40, *SD* = 7.05) reporting a higher mean score in dominant tree species abundance than the indigenous breeds (*M* = 30.00, *SD* = 11.40) as displayed in Table 31.

The study revelation on species diversity and richness are similar to the finding by Soder (2007) in temperate regions which realized a distinction in values of tree species richness and diversity in farms that reared the two livestock breeds. The low mean score in species richness and diversity observed by Soder (2007) in farms domesticating exotic livestock breeds was likely attributed to the fact that the exotic breeds are heavy feed consumers compared to indigenous livestock. Therefore, it is possible that the would-be tree establishment niches are cleared as observed in Brazil for forage growth (Lorena, 2019). The species evenness is consistent with Aquino (2019) that reported a significant low percentage of Jaccard similarity index for values of tree species evenness in farms rearing exotic and the farms with indigenous livestock breeds. The higher mean score in species evenness observed possibly occurred because the indigenous livestock species are characterized by extensive livestock farming where livestock- tree species interaction is optimal as noted in Brazil (Mazzetti, 2020). As a biological dispersal agent, free moving animals are known to distribute a variety of plant genetic materials (FAO & UNEP, 2020). However, species abundance differed from the conclusion by FAO and UNEP (2020) that revealed a relatively higher abundance in farms that domesticated the exotic livestock. The adoption of exotic livestock breeds is likely linked to economic power and relatively better knowledge, and adherence to the agricultural extension services which encourage households to establish more tree species (Mohammed et al., 2021).

4.5.4 Livestock Feeding Method and Dominant Tree Species Diversity, Richness, Evenness, and abundance

An Independent two-sample t-test was performed to assess if a significant imbalance in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in traditional and modern feeding methods was likely to occur. Table 32 illustrates the Independent two-sample t-test results.

Table 35: Group Statistics and t-test Results: Livestock Feeding Method, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Feeding method	N	Mean	SD	T test
Diversity(H)	Modern	62	1.55	0.51	t (371) = 2.53,
	Traditional	311	1.97	0.66	*p* = .035
Richness	Modern	62	6.34	2.27	t (371) = 2.46,
	Traditional	311	12.54	4.22	*p* = .032
Evenness	Modern	62	0.75	0.07	t (371) = 1.56,
	Traditional	311	.92	0.20	*p* = .023
Abundance	Modern	62	33.75	6.07	t (371) = 2.97
	Traditional	311	28.60	10.89	*p* = < .001

The null hypothesis was rejected at 95% confidence interval, *p-value* = *.05*. The 62 households that practiced modern livestock feeding (*M* = 1.55, *SD* = 0.51) demonstrated lower score of Shannon Wiener's diversity index, compared to the 311 farms characterized by the traditional livestock feeding (*M* = 1.97, *SD* = 0.66) with a significance of t (371) = 2.53, *p* = .035, while 11 households were excluded from livestock farming. The mean score variation in the tree species richness was significantly lower in farms known for modern livestock feeding, (*M* = 6.34, *SD* = 2.27) in comparison to the traditional feeding method, (*M* = 12.54, *SD* = 4.22) backed by a t-test significance, t (371) = 2.46, *p* = .032. A t-test significance of, t (371) = 1.56, p = .023, revealed a recurring trend in livestock feeding categories where again a significant low mean score in species evenness was observed in modern feeding, (M = .75, SD = 0.07) in comparison to (M = .92, SD = 0.20) for the farms that used the traditional technology in feeding livestock. Finally, there was a significant statistical mean score contrast t (371) = 2.97 p = < .001, even so, the modern feeding method (M = 33.75, SD = 6.07) outweighed the traditional livestock feeding method in species abundance mean score (M = 28.60, SD = 10.89) in Ugenya sub-county (See Table 32).

The species diversity and richness depicted the finding by Raja et al. (2017) which reported a visible discrepancy in tree species richness and diversity in farms that employed the traditional livestock feeding and the modernized livestock farms. The observations by Raja et al. (2017) were likely attributed to the fact that the contemporary modern livestock farming is driven by the ready profit maximization which owing to the strained natural resources may deter households from diversification into other long term economic ventures such as the tree species establishment (FAO, 2018). Similarly, the species evenness identified with Cheng et al. (2019) in Wanglang China that reported a significantly higher Gini inequality index for tree species evenness in the modern and the traditional livestock feeding method. In the modern livestock feeding system, a few agriculturally functional trees such as the palatable forage tree species may be adopted. Selective tree growing has been associated with low species evenness (Eijrond, 2019). The species abundance also corroborated the inference by Eijrond (2019) that showed a lower mean score in farms practicing the traditional livestock feeding.in Nigeria, Free roaming livestock under the traditional system are associated with land degradation ranging from soil erosion, pollution, and high bulk density due to compaction which negatively affects tree species population (Ukhurebor & Adetunji, 2020).

4.5.5 Livestock Farming System and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

The Independent two-sample t-test was found applicable in comparing if a significant divergence in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in intensive and extensive livestock farming system occurred. Table 33 demonstrates the Independent two-sample t-test results.

Table 36: Group Statistics and t-test Results: Livestock Farming Systems, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Livestock system	N	Mean	SD	T test
Diversity(H)	Intensive	81	1.74	0.61	t (371) = 2.87,
	Extensive	292	2.76	0.73	*p* = .007
Richness	Intensive	81	10.21	4.44	t (371) = 2.96,
	Extensive	292	12.51	4.27	*p* < .001
Evenness	Intensive	81	.77	0.09	t (371) = 1.75,
	Extensive	292	.84	0.20	*p* = .028
Abundance	Intensive	81	30.61	9.16	t (371) = 2.06
	Extensive	292	29.10	12.81	*p* = .032

The 81 farms under the Intensive Livestock Farming System registered (*M* = 1.74, *SD* = 0.61) which demonstrated lower mean score of Shannon Wiener's diversity index, compared to the 292 farms practicing the extensive livestock keeping (*M* = 2.76, *SD* = 0.73) with a statistical significance of t (371) = 2.87, *p* = .007, however, 11 respondents practiced no livestock farming. Furthermore, the mean score of the tree species richness was found significant, t (371) = 2.96, *p* < .001, though lower score in intensive livestock farms was revealed, (*M* = 10.21, *SD* = 4.44) as compared to the extensive system, (*M* = 12.51, *SD* = 4.27). A t-test significance of, t (371) = 1.75, *p* = .028, was again identified in species evenness where, a significant low mean score, (*M* = .77, *SD* = 0.09) in tree species evenness was observed in the intensive livestock farming system in association to the extensive livestock farming (*M* = .84, *SD* = 0.10). The trend was maintained where a significant statistical mean score unlikeness in the two livestock farming systems was noted t (371) = 2.06 *p* = .032, however, the intensive livestock farming system registered a higher mean score in species abundance (*M* = 30.61, *SD* = 9.16) in relation to the extensive livestock farming (*M* = 29.10, *SD* = 12.81). Leading to a rejection of the null hypothesis was rejected at 95% confidence interval, *p-value = .05* as illustrated in Table 33.

The species diversity and richness are inconsistent with the finding by Bagchi et al. (2012) in Trans-Himalayas, which through Moses's mean rank assessment identified no statistical inequality in mean ranking in the tree species richness and diversity in the two livestock farming systems. The discrepancy in the conclusion by Bagchi et al. (2012) likely contributed to the nature of the statistical tool used. As a non-parametric statistical measurement tool, Moses's mean rank assessment is characterized by relatively low statistical power of accuracy compared to parametric independent two sample t-tests (Alkemade et al., 2012). The species evenness conformed to Anadon et al. (2014) in both the North and South America that by practical assessment reported a possible imparity in the tree species representation in the intensive and extensive livestock farming systems. The relatively low rank in tree species evenness observed in the intensive system was because of small-scale land holding associated with the livestock farming intensification (Brown, 2019). The species abundance was consistent with Adimassu et al. (2020) in central highlands of Ethiopia which by enumeration computed a higher percentage of tree species abundance in intensive livestock farming. In North Eastern China, the livestock lockdown practiced in the intensive farming system favors tree species population growth due to minimized destructive livestock-tree species interaction (Roberts et al., 2021).

4.5.6 Livestock Composition and the Dominant Tree Species Diversity, Richness, Evenness, and abundance

The two-sample t-test was conducted to compare if a significant distinction in mean score of Shannon Wiener's diversity index, species Richness, Evenness, and Abundance in farms that domesticated a single livestock species and the ones that kept mixed livestock species existed. Table 34 shows the Independent two-sample t-test results.

Table 37: Group Statistics and t-test Results: Livestock Composition, Dominant Tree Species' Diversity, Richness, Evenness, and Abundance

	Livestock Composition	**N**	**Mean**	**SD**	**T test**
Diversity(H)	Single	49	1.54	0.81	t (371) = 2.75,
	Mixed	324	1.85	0.86	*p* = .018,
Richness	Single	49	7.42	4.93	t (371) = 2.69,
	Mixed	324	11.34	4.36	*p* = .016
Evenness	Single	49	.81	0.09	t (371) = 1.06,
	Mixed	324	.93	0.07	*p* = .014
Abundance	Single	49	32.29	9.02	t (371) = 0.429
	Mixed	324	31.12	9.89	*p* = .051

The null hypothesis was rejected at 95% confidence interval, *p-value = .05*. The 49 farms with single livestock species registered (*M* = 1.54, *SD* = 0.81) which demonstrated lower mean score of Shannon Wiener's diversity index, compared to the 324 farms characterized by mixed livestock species (*M* = 1.85, *SD* = 0.86) with a statistical significance of t (371) = 2.75, *p* = .018. In a similar manner, the mean score of the tree species richness was significantly lower in farms that domesticated single livestock species, (*M* = 7.42, *SD* = 4.93) in relation to mixed livestock species farms, (*M* = 11.34, *SD* = 4.36) and a corresponding t-test significance, t (371) = 2.69, *p* = .016. When the t-test significance was t (371) = 1.06, *p* = .014, the same format was corroborated in species evenness where, a significant low mean score, (*M* = .81, *SD* = 0.09) in tree species evenness was observed in single livestock species-based farms in comparison to (*M* = .93, *SD* = 0.07) for the farms that reared mixed livestock species. Conversely, the null hypothesis was accepted at 95% confidence interval, *p-value* = *.05*, there was no significant statistical mean score variation in single and mixed livestock species t (371) = 0.429 p = .051, despite farms with a single livestock species (M = 32.29, SD = 9.02) revealing a higher mean score in dominant tree species abundance than the farms with mixed livestock species (M = 31.12, SD = 9.89) as shown in Table 34.

The results on species diversity and richness are inconsistent with the content of a book published about Lake Manyara national park in Tanzania by Foster (1973) which through observation, concluded that the tree species were equally distributed across the livestock farm categories hence no dissimilarity occurred in the values of the tree species richness and diversity in farms that reared single livestock species and the ones with mixed livestock. The report by Foster (1973) likely contributed to the fact that the survey was based on observation. Observation is one of the methodologies of which when used alone lack statistical backing hence associated with inadequate parametric significance nor power of accuracy hence unsuitable for independent sample comparison as revealed in a similar study in southern Zimbabwe (Gandiwa et al., 2013). The species evenness differed with the findings by Gibson et al. (2016) that reported an insignificant disproportion in values of tree species evenness in the intensive farming system where single and mixed livestock were domesticated. The unaffected tree species evenness observed was because under intensive farming; irrespective of livestock composition, specialization, mechanization, and animal confinement are implemented to minimize livestock-tree interactions thus the insignificant contrast (Hempson et al., 2017). The species abundance is different from those of Glowacz and Nizhny Kowaski (2017) that accounted for a lower percentage in tree species abundance with increase in livestock composition. The anomaly was likely occasioned by the fact that Glowacz and Nizhny Kowaski (2017) only surveyed the palatable forage tree species. An increase in livestock composition has been associated with a high rate of tree species disturbance which negatively affects tree species count (Tian et al., 2019).

4.5.7 Tree Fodder Palatability, Preference and Dominant Tree Species Diversity, Richness, Evenness, and abundance

The tree fodder palatability tests were performed to determine the Influence of the forage preference on the dominant tree species. Table 35 displays the Tree Forage Palatability and Preference Test Results.

Table 38: The tree forage palatability and preference test results

Trees	Cattles β_1	Goats $\beta 2$	Sheep $\beta 3$	$\frac{1}{n} = 0.11$	Manly-Chesson's Mean index β	*SD*
Persia americana	1.00	1.00	0.07	0.11	0.79	0.02
Grewia trichocarpa	0.46	1.00	0.08	0.11	0.62	0.13
Psidium guajava	0.88	1.00	0.05	0.11	0.60	0.01
Casuarina equisetifolia	0.93	0.83	0.09	0.11	0.57	0.16
Maesopsis eminii	0.52	0.71	0.06	0.11	0.54	0.15
Grevillea robusta	0.07	0.65	0.64	0.11	0.44	0.24
Markhamia lutea	0.05	0.47	0.04	0.11	0.36	0.29
Bischofia javanica	0.11	0.12	0.10	0.11	0.11	0.02
Thevetia Peruviana	0.03	0.10	0.09	0.11	0.08	0.00

Feed acceptance and preferences as listed in Table 35 was assigned a binary value of one (YES), while for the non-acceptance the value was zero (NO). A sample of 100 animals per sub-population participated in the test. By the livestock's oral response, eight out of the nine dominant tree species were therefore reported palatable. Households noted that during dry weather, grass was fast disappearing leaving animals to depend on forage trees. The most preferred tree species was *Persia americana* with a Manly-Chesson's preference index of (*M*

= 0.79, *SD* = 0.02). This was translated to mean that at any provided time, other factors like constant forage availability uncontrolled, livestock were most likely to forage on *Persia americana*. The livestock's preferential forage behaviors on *Bischofia javanica* were statistically random ($M = 0.11, SD = 0.02$); Unreliable foraging preference. At an index of (*M* = 0.08, *SD* = 0.00), *Thevetia peruviana* failed the palatability tests because it registered zero feed acceptance for all the tested livestock. This was translated as, at any provided time, other factors like an absolute unavailability of alternative forage choices the livestock were unlikely to feed on *Thevetia peruviana* in Ugenya sub-county.

Goats were likely the most aggressive foragers because they registered a relatively high preferential index on seven out of the nine tree species tested with a random foraging preference ($\beta < 0.11$) on one tree species *(Bischofia javanica*). However, like all the livestock species tested, goats showed an insignificant appetite for *Thevetia peruviana* ($\beta < 0.01$). Cattles were moderate feeders on dominant tree species compared to goats with an exceptional appetite for *Persia americana* ($\beta = 1.00$) and *Casuarina equisetifolia* ($\beta = 0.93$). Sheep was likely the best livestock for adoption in the dominant tree species diversity conservation because it portrayed insignificant or no appetite for all the dominant tree species tested except *Grevillea robusta* ($\beta = 0.64$). Plate 5 depicts tree forage acceptance by the livestock.

Plate 5: Palatability Test: A Ground Close-up Photo showing a cattle feeding on the leaves of *Persia americana* (Avocado), one of the Dominant Tree Species in Ugenya sub-county.

The forage preference is consistent with Chesson (1983) which observed a varying tree forage palatability preference among different livestock species. The outcome of palatability tests on *Thevetia peruviana* disapproved the recommendation by Usman et al. (2009) in Nigeria which proposed the adoption of the Yellow Oleander's seed cake for livestock feed supplement. On the quantity of forage trees, the findings indicated a lower value of nine trees compared to the 63 possible palatable forage tree species accounted for by (Forbes, 2010). The observed imparity was likely because Forbes (2010) included all classes of tree species in the survey unlike the current study that focused on dominant tree species with strict adherence to the *DBH* calibration. The observation on forage tree acceptance by the livestock was different from the observation made by Waterman et al. (2011) whose conclusions were drawn from verbal interviews. The palatability and forage preference are best concluded by seeking the livestock's oral responses during short feeding intervals (Franzel et al., 2014). The fact that smallholder livestock farmers were likely to sample palatable tree species for forage supplements was consistent with the Northern Kenya outcome findings by (Kaguyu & Wanjohi, 2015).

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

The chapter Presents Summary, Conclusions, and Recommendations

5.2 Summary of the Findings

The first specific aim of the survey was; to evaluate Influences of Farm-forestry on dominant tree species diversity. By approximation, the results of linear coefficient of determination (R^2) revealed that 76.8%, of the variation in tree species diversity, 64.2% of the species richness, 61.4% of the species evenness, and 84.1 of the variation in species abundance could possibly be explained by the combined changes in values of Percentage Tree Cover, Average Tree Age, and the Average DBH in a spatial scale of 20mX20 plots. On-farm tree cover was found negatively correlated to the tree species diversity, *r (*382*)* = - .69*, p* = .039. conversely, Age of the tree species and the Shannon Wiener's diversity index revealed a positive linear correlated r *(*382*)* = .52*, p* < .001. In addition, the mean *DBH*, the Shannon Wiener's diversity index was positively correlated *r (*382*)* = .82*, p* = .007. The 1305 planted tree species scored (*M* = 1.83, *SD* = 0.08) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 1205 native tree species (*M* = 2.26, *SD* = 0.27) with a statistical significance of t (2508) = 2.28, *p* = .024. Similarly, the 11 exotic dominant tree species scored (*M* = 1.76, *SD* = 0.09) which demonstrated lower mean score of the diversity index, compared to the 16 indigenous tree species (*M* = 2.34, *SD* = 0.23) with t (25) = 2.61, *p* = .021. Likewise, the mean score of the tree species richness was significantly lower in the exotic tree species, (*M* = 6.40, *SD* = 1.12) in relation to the indigenous, the 134 respondents that admitted no tree phobia Influence (*M* = 2.44, *SD* = 0.26) confirmed a higher mean score of the tree species diversity, compared to the 120 tree-fear affected group (*M* = 2.02, *SD* = 0.12) with a significance of t (252) = 2.80, *p* = .015. The 5 unpreferred dominant tree species registered (*M* = 2.35, *SD* = 0.21) which demonstrated higher mean score of Shannon Wiener's diversity index, compared to the 5 preferred tree species (*M* = 1.98, *SD* = 0.16) of t (8) = 1.62, *p* = .024.

The second Specific objective of the study focused on assessing the Influence of Human settlement on dominant tree species diversity. The results of linear coefficient of determination (R^2) indicated that 63.2%, of the variation in tree species diversity, 59.3% of the species richness, 65.7% of the species evenness, and 54.8% of the species abundance could possibly be explained by the joint variation in values of the Residential Area Size and the Land Ownership (in a spatial scale of 20mX20 plots. A positive unit change in residential area size was likely associated with an increase the species diversity *r (382)* = .87, *p* = .002. There was a statistical insignificance between Land ownership, the Shannon Wiener's diversity index *r (*382*)* = .24, *p* =. 054. The 138 households with higher education level registered (*M* = 2.02, *SD* = 0.12) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 246 households characterized by basic level of education (*M* = 2.43, *SD* = 0.26), t (382) = 1.74, *p* =.036. Contrariwise, there was no significant statistical Influence for house type t (1029) = 1.41, p = .056, despite the occupants of traditional houses (*M* = 1.78, *SD* = 0.91) attaining a higher mean score in Shannon Wiener's diversity index than the modern houses (*M* = 1.69, *SD* = 0.76). Correspondingly, there was no significant mean score contrast in the Shannon Wiener's diversity index in female and the male categories, t (382) = 0.639 *p* = .051, in spite of males (*M* = 2.40, *SD* = 0.26) attaining a lower mean score of the Shannon Wiener's diversity than the females (*M* = 2.43, *SD* = 0.12). cultural non-adherence group registered (*M* = 1.49, *SD* = 0.82) which demonstrated lower score of Shannon Wiener's diversity index, compared to the 75 households that were considered culturally conservative (*M* = 1.77, *SD* = 0.87), t (363) = 2.62, *p* = .011.

The third specific objective of the aimed at analyzing the Influence of Livestock Farming on dominant tree species diversity. The linear coefficient of determination (R^2) showed that 66.3%, of the variation in tree species diversity, 61.5% of the species richness, 59.8% of the species evenness, and 75.2% of the species abundance could possibly be explained by the joint changes in values of stocking rate and the amount of the forage harvested in a spatial scale of 20mX20 plots. Constructive statistical Influences were revealed between the Stocking rate (TLUHa-^{1}) and the diversity index *r (*382*)* = .55, *p* < .001. Equally, a positive linear relationship between the Rate of Forage Harvesting and Shannon Wiener's diversity index *r (*382*)* = .54, *p* < .001 existed. The 34 households domesticating non-indigenous livestock breeds recorded (*M* = 1.48, *SD* = 0.81) which established lower mean score of Shannon Wiener's diversity index, compared to the 339 households that kept the indigenous livestock (*M* = 1.98, *SD* = 0.86), t (371) = 1.64, *p* = .036. The 62 households that practiced modern livestock feeding (*M* = 1.55, *SD* = 0.51) revealed a lower score of Shannon Wiener's diversity index, associated to the 311 farms characterized by the traditional livestock feeding (*M* = 1.97, *SD* = 0.66), t (371) = 2.53, *p* = .035, The 81 farms under the intensive system registered (*M* = 1.74, *SD* = 0.61) which demonstrated lower score of the diversity index, in comparison to the 292 farms practicing the extensive livestock keeping (*M* = 2.76, *SD* = 0.73) with a significance of t (371) = 2.87, *p* = .007, The 49 farms with single livestock species registered (*M* = 1.54, *SD* = 0.81) which demonstrated lower mean score of the tree species diversity , compared to the 324 farms characterized by mixed livestock species (*M* = 1.85, *SD* = 0.86), t (371) = 2.75, *p* = .018. The most palatably preferred tree species by the tested livestock was *Persia americana* with a Manly-Chesson's preference index of (*M* = 0.79, *SD*

= 0.02). This was translated to mean that at any provided time, other factors like constant forage availability uncontrolled, livestock were most likely to forage on *Persia americana.*

5.3 Conclusions

In Objective one, the study concludes that, despite the planted tree species scoring a higher mean in species abundance, the 10% Farm-forestry set benchmark was yet to be accomplished in Ugenya sub-county. The average percentage farm-forestry cover (tree basal area) stood at about five percent in comparison to the Government's policy recommendation. Increased adoption of the practice was associated with a decline in the tree species diversity. Farm-forestry was characterized by the growing of a selected recommended exotic tree species. The exotic tree seedlings are cheap and readily available. Commercialization of the tree species is related to the development of pure stand tree species farms. The diversity of the indigenous and endemic dominant tree species is replaced by the few fast-growing commercial tree cultivars, thus negatively affecting the tree species' richness and diversity. The declining species evenness was because of the selective harvesting and removal of a diverse community of perceived slow in growth trees to provide space for a few exotic tree species. The population of the trees with relatively larger trunks was decreasing, because such mature trees are cleared for various functions. The respondents experiencing tree related fear were likely to eliminate tree species which they felt uncomfortable with. The preferred tree species were on the general decline because of the high economic demand.

In objective two the study reached a conclusion that, the species diversity, and richness were higher in human residential because of the varied choices and preferences portrayed by the households. Gender parity in tree species conservation was to blame for the low tree species abundance noticed among the female headed households. Cultural modernity and acquisition of higher education were associated with the decline in the tree species diversity, richness, and evenness. Modernity and higher education are linked to the adoption of exotic materials and foreign ideologies. Basic education was associated with the low tree species abundance because such a category of stakeholders either lacked or portrayed inadequate ecological conservation awareness. Culture/beliefs contributed both positively and negatively in tree species conservation. 'Evil' tree species were likely to be eliminated, while the sacred or culturally functional trees were preserved.

The third objective in conclusion revealed that higher stocking rates led to an improvement on the tree species diversity and richness because of the tree genetic dispersal role which animals play. However, the decline in the tree species' evenness and abundance was due to the destructive foraging behavior on trees by the livestock. Tree forage harvesting stimulated the conservation of various palatable trees by the corresponding households. This was because the trees were seen as an alternative livestock feed source during resilient livelihood. Rearing the exotic livestock breeds, employing the modern intensive livestock keeping system, and feeding methodologies were best tree species conservation practices. The intensification of animal husbandry meant minimal disturbance to tree species. Under the extensive livestock farming, keeping mixed animal species posed more destruction on tree species because of the uncontrolled livestock-tree species interactions. Livestock were predominantly browsers; under favorable herbage height they fed on palatable tree species irrespective of constant availability of conventional forage. The livestock's love for *Persia americana* and *Grewia trichocarpa* was because of the perception that their tree organs were succulent with characteristic sweet taste.

5.4 Recommendations

The national Farm-forestry for the 10% tree cover should be modified to address the inclusion of indigenous and the endemic Dominant tree species diversity restoration at the local scale. The residents should be encouraged to seek both the technical and botanical advice from the county Forestry Department before the introduction of new or foreign invasive Dominant tree species in the local farms or residential setups. The indigenous and the endemic Dominant tree species which meet the competitive ratings of the exotic tree species should be prioritized in local Farm-forestry.

Human settlement should be planned with a fair accommodation of both the indigenous and the exotic dominant tree species in line with the recommended tree basal area. Residential structures should be built with the incorporation of green technology to save on and reduce the use of the Dominant tree species. The Dominant tree species with recurrent stump regeneration and fast growth like *Markhamia lutea* and *Senna SPP* should be integrated in the rural residential development to provide sustainable biomass fuel. Culture and traditions which indicated positive contribution in the conservation of the Dominant tree species should be upheld and encouraged. The gender discriminatory taboos and beliefs which affect the Dominant tree species diversity be addressed and where possible amended.

The cost benefit analysis is conducted to establish the economic viability of Livestock farming and the Dominant tree species combination. The farmers prioritize the palatable Dominant tree species conservation to supplement the livestock rations and the sustainability of tree species diversity. The traditional livestock feeding methods such as tethering and open grazing are to be redefined by introducing the ecological sustainability techniques in modern livestock feeding methods, to minimize the livestock related direct disturbances on the Dominant tree species.

Areas for Further Research

1. During the research on Human settlement and the Dominant tree species diversity, the socio-cultural and economic attributes of the households seem to have a causal relationship with the tree species diversity. Therefore, there is a need for further exploration in the mentioned areas.
2. The FGD involving an outside catering unit and a gender group (chama) of Kagonya sub-location on the 4th December 2021 respectively, revealed some trees other than the known dominant species. The mentioned trees were culturally unsuitable for wood fuel use among other functions. Further survey between the cultural practices and the higher plant species diversity is therefore necessary in Ugenya sub-county.
3. Farm-forestry adoption and distribution occurred along the transportation infrastructure such as feeder roads. Further study is necessary to verify the relationship between the infrastructure development and Farm-forestry in Ugenya sub-county.
4. Left to choose on their own, livestock seemed to show consistency in preference on certain forage tree species such as *Grewia trichocarpa*. Further study on factors affecting tree forage palatability and preference is therefore necessary.

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APPENDICES

APPENDIX 1: DOMINANT TREE SPECIES ENUMERATION LIST

	Frequency	Percent	Cumulative Percent
Eucalyptus SPP	329	13.100	13.100
Markhamia lutea	290	11.600	24.700
Grevillea robusta	251	10.000	34.700
Persia americana	194	7.700	42.400
Senna siamea	175	7.050	49.450
Maesopsis eminii	137	5.500	54.950
Pinus patula	135	5.400	60.350
Albizia coriaria	119	4.700	65.050
Artocarpus heterophyllus	116	4.600	69.650
Euphorbia tirucalli	78	3.100	72.750
Psidium guajava	76	3.000	75.750
Bischofia javanica	62	2.500	77.950
Grewia trichocarpa	61	2.400	80.350
Mangifera SPP	60	2.390	82.740
Zygzium cuminii	59	2.350	85.090
Casuarina equisetifolia	46	1.800	86.890
Ficus capensis	45	1.790	88.680
Jacaranda mimosifolia	44	1.750	90.430
Senna spectabilis	43	1.710	92.140
Spathodea campanulata	42	1.670	94.810
Thevetia peruviana	41	1.630	95.404
Albizia zygia	23	.916	96.356
Cupressus lusitanica	22	.876	97.232
Diospyros abyssinica	21	.836	98.068
Kigelia africana	20	.796	98.864
Combretum collinum	11	.438	99.602
Milicia excelsa	10	.398	100.000
Total	2520	100.0	

APPENDIX 2: OBSERVATION SHEET FOR EXOTIC TREES

The exotic dominant tree species in Ugenya sub-county

Scientific name	Common name	Local dialect	Percent	Rank
Eucalyptus SPP	Eucalyptus/Blue gum	*Bao (Luo)*	13.10	1
Grevillea robusta	Grevillea	*Miti kawa (Luo)*	10.00	2
Persia americana	Avocado	*Abakado (Luo)*	7.70	3
Maesopsis eminii	Umbrella tree	*Msizi*	5.50	4
Pinus patula	Pine	*O/Ubani (Luo)*	5.40	5
Artocarpus heterophyllus	Jack tree	*Apene (Luo)*	4.60	6
Bischofia javanica	Bishop tree	*Yadh Bishop (Luo)*	2.50	7
Casuarina equisetifolia	Whispering pine	*Nyamin ubani (Luo) Omuyeye (Luhyia)*	1.80	8
Jacaranda mimosifolia	Jacaranda	*Jakaranda (common dialect)*	1.75	9
Thevetia peruviana	Yellow oleander	*Chamama (Luo)*	1.63	10
Cupressus lusitanica	Cyprus	*Bap Rais (Luo)*	.876	11

APPENDIX 3: OBSERVATION SHEET FOR INDIGENOUS TREES

Indigenous dominant tree species in Ugenya sub-county

Scientific name	Common name	Local dialect	Percent	Rank
Markhamia	Benth	*Siala/Lusiola*	11.00	1
lutea		*(Luo/Luhyia*		
Senna siamea	Cassod	*Okonyo*	7.05	2
Albizia coriaria	Silk tree	*Ober*	4.70	3
Euphorbia				
tirucalli	Euphorbia	*Ojuok*	3.10	4
Psidium guajava	Guava tree	*Mapera*	3.00	5
Grewia				
trichocarpa			2.40	6
Mangifera SPP	Grewia	*Powo*	2.39	7
Zygzium cuminii	Mango tree	*Mawembe*	2.35	8
Ficus capensis	Java plum	*Jamna*	1.79	9
Senna	Fig tree	*Ng'ow*	1.71	10
spectabilis	White back			
Spathodea	Senna	*Kibrit*	1.67	11
campanulate	Nandi flame	*Nya wend*	0.92	12
Albizia zygya		*agwata*		
Diospiros	Albizia	*Oturbam*	0.84	13
abyssinica	Giant diospyros	*Ochol/Lusui*	0.80	14
Kigelia africana	Sausage tree	*Yago*		
Combretum		*Odugo/Adugo*		
collinum	Bushwillow	*Olua (Luo)/Elua*	0.44	15
Milicia excelsa		*(Teso)*		
	African teak		0.40	16

APPENDIX 4: DOMINANT TREE SPECIES AND GENDER

Dominant Tree Species	gender roles	taboos/beliefs
Markhamia lutea	Female members are prohibited by culture from panting, cutting, or climbing the tree when the spouse is alive	The act is an evil spell and may cause death of the male spouse
Euphorbia tirucalli *Milicia excelsa* *Ficus capensis* *Albizia coriaria*	Female members are prohibited from negotiating the sale of these trees. For example, *Milicia excelsa* require male dominated ritual before cutting.	Young females engaging in such practices are unlikely to get married because it is an abomination.
All the fruit bearing dominant tree species	Mature female members are prohibited from climbing these trees with an intention of either collecting fruits or firewood	The affected tree species may yield no fruit any more

APPENDIX 5: STATISTICAL SUMMARY

	Mean Shannon Wiener (*H*)	*Mean* Species Richness	*Mean* Species Evenness	Percentage Indigenous Species Abundance	Percentage Exotic Species Abundance	*Mean* *DBH*	*Mean* Age	Percentage on-farm tree cover
	1.58	6.00	.71	40.74	59.26	6.83	9.22	4.92
SD	0.24	2.41	0.04			1.99	4.42	0.48

APPENDIX 6: RESULTS OF THE PALATABILITY TEST

Livestock species	Tree species	Variety	Organ(s) fed on
Cattle (*Bos Indicus/Bos Taurus)*	*Casuarina* Equisetifolia	Exotic	Needle like leaves
Cattles and goats	*Grewia* trichocarpa	Indigenous	Leaves
Goats (*Capra SPP*)	*Maesopsis* eminii	Exotic	Leaves/soft twigs
	Bischofia javanica	Exotic	Soft leaves
	Markhamia lutea	Indigenous	Soft bark
	Thevetia peruviana	Exotic	No current data
Cattles / goats/sheep	*Psidium* guajava	Indigenous	Ripe fruits
Sheep (*Ovis SPP*)	*Grevillea* robusta	Exotic	Leaves
Cattles/ goat/sheep	*Persia americana*	Exotic	Unripe/ripe fruits/leaves

APPENDIX 7: TABLE THE MEAN STATISTICS

	N. Ugenya	E. Ugenya	W. Ugenya	Ukwala
Shannon Wiener	1.70	1.64	2.02	1.61
SD	0.83	0.87	0.81	0.89
Species Richness	9	8	10	8
SD	1.16	1.23	0.93	1.42
Species evenness	.87	.85	.96	.84
SD	.03	.04	.07	.06
Species abundance	831	771	514	394
Age	11.44	13.83	9.16	9.04
SD	2.49	2.08	1.95	2.14
DBH	6.65	7.36	6.82	6.19
SD	1.63	1.85	2.21	1.47
Percentage tree cover	3.92	4.17	3.85	3.81

APPENDIX 8: PREFERRED TREE SPECIES AND THE REASONS PROVIDED FOR PREFERENCE

	Frequency	Percent	Cumulative Percent
Eucalyptus SPP	37.0	37.0	37.0
Grevillea	85	22.2	59.3
Robusta	71	18.5	77.8
Maesopsis			
eminii	57	14.8	14.8
Casuarina	29	7.4	100
equisetifolia	384	100	
Persia			
americana			
Total			

	Frequency	Percent	Cumulative Percent
Quality timber	119	31.0	31.0
Fast growth	106	27.6	58.6
Intercropping qualities	79	20.7	79.3
Market demand and economy of scale	53	13.8	93.1
Soil and water conservation qualities	27	6.9	100.0
Total	384	100.0	

APPENDIX 9: REASONS PROVIDED FOR THE LOW PREFERENCE

	Frequency	Percent	Cumulative Percent
Kigelia africana	120	31.3	31.3
Combretum collinum	84	21.9	53.1
Euphorbia tirucalli	72	18.8	71.9
Cupressus lusitanica	60	15.6	87.5
Mangifera SPP	48	12.5	100.0
Total	384	100.0	

	Frequency	Percent	Cumulative Percent
Low percentage germination and growth rate	119	31.4	31.4
Poor tree intercropping qualities	90	22.9	54.3
Low timber and wood quality	66	17.1	71.4
Seedling's unavailability and cost	45	11.4	82.9
Susceptibility to pests (more so caterpillars) and diseases	32	8.6	91.4
Large canopies which are perceived to endanger the household and property	22	5.7	97.1
Low quality and productivity in general	10	2.9	100.0
Total	384	100.0	

APPENDIX 10: SHANNON WIENER DIVERSITY ANALYSIS FORMAT

Frequency	$H = [(P_i) \times I_n (P_i)]$	P_i	*Species*	$H\ Max = I_n (S)$	$E = \frac{H}{Hmax}$

$H = [(P_i) \times I_n (P_i)]$ where;
P_i = Proportion of total sample represented by species
S = number of species, = species richness
$H\ Max = I_n (S)$ = Maximum diversity possible
$E = evenness = \frac{H}{Hmax}$

APPENDIX 11: *DBH* MEASUREMENT

Tree species	Age	Indigenous trees	Exotic trees	*DBH* > 5”	M_1	M_2	M_3

APPENDIX 12: CULTURAL/TRADITIONAL FUNCTIONS OF DOMINANT TREE SPECIES

Dominant tree species	Cultural function
Eucalyptus SPP	Aromatic ingredient added to hot beverages
Ficus capensis	An excellent banana planting niche and judicial
Albizia coriaria	The leaves are used as banana ripening catalyst, Carvings of the traditional tools, equipment, and leadership regalia such as walking stick
Milicia excelsa	Ritual ceremonies, judicial grounds, educational center, and swearing purposes
Pinus patula	Religious functions, the bark (Ubani) is burnt during some religious proceedings
Markhamia lutea	Symbol of male dominance, the foundation tree of traditional homes, planted as gate pillars
Nandi flame	The tree is believed to act as lightning arrester
Euphorbia tirucalli	A sign of final settlement in boundary disputes. Planted under the ritual by male elders to solve land cases
Kigelia africana	Used in burial ceremonies in case the remains of the diseased is absolutely missing

APPENDIX 13: DESCRIPTIVE STATISTICS FOR WARDS

Descriptive Statistics: North Ugenya

	N	Minimum	Maximum	Mean	St
Percentage Tree Cover per Household in Ugenya sub-county (2021-2022)	110	3.20000000000000	4.3099999999998	3.763754545454536	.3
Average Tree Age per Household in Ugenya Sub-county (2021-2022)	110	5.00000000000000	54.00000000000000	9.819272727272757	8.
Average DBH Per Household in Ugenya Sub-county (2021-2022)	110	5.60000000000000	6.69000000000007	6.145000000000034	.3
Residential Area Size (Acres)	110	.240	.349	.29450	
Land Ownership (Acres)	110	1.680	1.898	1.78900	
Stocking Rate	110	3.00000000000000	8.4499999999998	5.724999999999989	1.
Tree Fodder Harvesting/month	110	10.00	11.09	10.5450	
Shannon Wiener's Diversity Index	110	2.43000000000000	2.4408999999997	2.435449999999988	.0
Species Richness	110	3.00	5.18	4.0900	
Species Evenness	110	.74000000000000	.750899999999999	.745449999999999	.0
Species Abundance	110	8.00000000000000	10.17999999999990	9.089909090909075	.6
Valid N (listwise)	110				

Descriptive Statistics: West Ugenya Ward

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Percentage Tree Cover per Household in West Ugenya Ward (2021-2022)	103	1.0197	4.3198	5.33999999999995	4.832621359223267	.296763460190122	.088
Average Tree Age per Household in in West Ugenya Ward (2021-2022)	103	1.0207	7.62000000000007	8.64000000000014	8.130000000000118	.298775277870640	.089
Average DBH Per Household in in West Ugenya Ward (2021-2022)	103	1.02000000000007	6.70000000000007	7.72000000000014	7.210000000000107	.298775277870642	.089
Residential Area Size (Acres)	103	.102	.350	.452	.40100	.029878	.001
Land Ownership (Acres)	103	.204	1.900	2.104	2.00200	.059755	.004
Stocking Rate	103	5.10000000000002	8.49999999999998	13.60000000000000	11.0500000000000017	1.493876389353099	2.232
Tree Fodder Harvesting/month	103	1.01999999999999	11.1000000000000	12.1199999999999	11.6100000000000010	.298775277870613	.089
Shannon Wiener's Diversity Index	103	.0101999999998	2.44099999999997	2.45119999999995	2.446099999999959	.002987752778702	.000
Species Richness	103	2.04	5.20	7.24	6.2200	.59755	.357
Species Evenness	103	.010199999999999	.750999999999999	.761199999999998	.756099999999998	.002987752778706	.000
Species Abundance	103	2.040000000000000	10.1999999999999	12.2399999999999	11.2199999999999915	.597550555741223	.357
Valid N (listwise)	103						

Descriptive Statistics: Ukwala Ward

	N	Minimum	Maximum	Mean	Std. Deviation
Percentage Tree Cover per Household in Ugenya sub-county (2021-2022)	70	2.30000000000000	7.02999999999992	6.331999999999946	.993390621828188
Average Tree Age per Household in Ugenya Sub-county (2021-2022)	70	9.66000000000021	10.35000000000030	10.005000000000217	.203510851471541
Average DBH Per Household in Ugenya Sub-county (2021-2022)	70	4.60000000000000	9.43000000000026	8.796857142857368	1.019730772734358
Residential Area Size (Acres)	70	.554	.623	.58850	.020351
Land Ownership (Acres)	70	2.308	2.446	2.37700	.040702
Stocking Rate	70	18.6999999999999	22.1499999999999	20.424999999999876	1.017554257357658
Tree Fodder Harvesting/month	70	13.1399999999999	13.8299999999999	13.484999999999907	.203510851471525
Shannon Wiener's Diversity Index	70	2.46139999999993	2.46829999999991	2.464849999999919	.002035108514710
Species Richness	70	9.28000000000001	10.66000000000000	9.969999999999995	.407021702943060
Species Evenness	70	.771399999999997	.778299999999996	.774849999999996	.002035108514715
Species Abundance	70	14.2799999999999	15.6599999999998	14.969999999999857	.407021702943023
Valid N (listwise)	70				

Descriptive Statistics: East Ugenya Ward

	N	Minimum	Maximum	Mean	Std. Deviation
Percentage Tree Cover per Household in Ugenya sub-county (2021-2022)	101	5.34999999999995	6.34999999999993	5.850693069306870	.293800127385072
Average Tree Age per Household in Ugenya Sub-county (2021-2022)	101	8.65000000000014	9.65000000000021	9.150000000000217	.293001706479671
Residential Area Size (Acres)	101	.453	.553	.50300	.029300
Land Ownership (Acres)	101	2.106	2.306	2.20600	.058600
Stocking Rate	101	13.6500000000000	18.6499999999999	16.149999999999980	1.465008532398308
Tree Fodder Harvesting/month	101	12.1299999999999	13.1299999999999	12.629999999999910	.293001706479658
Shannon Wiener's Diversity Index	101	2.45129999999995	2.46129999999993	2.456299999999938	.002930017064790
Species Richness	101	7.26000000000000	9.26000000000001	8.259999999999990	.586003412959356
Species Evenness	101	.761299999999998	.771299999999997	.766299999999997	.002930017064796
Species Abundance	101	12.2599999999999	14.2599999999999	13.259999999999879	.586003412959356
Valid N (listwise)	101				

APPENDIX 14: DESCRIPTIVE STATISTICS AND RAW DATA FOR UGENYA SUB-COUNTY

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Percentage Tree Cover per Household in Ugenya sub-county (2021-2022)	384	4.72999999999992	2.30000000000000	7.02999999999992	5.067533854166629	1.100051712005324
Average Tree Age per Household in Ugenya Sub-county (2021-2022)	384	49.00000000000000	5.00000000000000	54.00000000000000	9.223984375000132	4.424777849568489
Residential Area Size (Acres)	384	.383	.240	.623	.43150	.110995
Land Ownership (Acres)	384	.766	1.680	2.446	2.06300	.221991
Stocking Rate	384	19.14999999999990	3.00000000000000	22.14999999999990	12.575000000000080	5.549774770204570
Tree Fodder Harvesting/month	384	3.8299999999999	10.0000000000000	13.8299999999999	11.914999999999942	1.109954954040888
Shannon Wiener's Diversity Index	384	.03829999999991	2.43000000000000	2.46829999999991	2.449149999999956	.011099549540383
Species Richness	384	7.66000000000000	3.00000000000000	10.66000000000000	6.829999999999939	2.219909908081890
Species Evenness	384	.038299999999996	.740000000000000	.778299999999996	.759149999999998	.011099549540408
Species Abundance	384	7.65999999999980	8.00000000000000	15.65999999999980	11.829973958333245	2.219952190426499
Valid N (list wise)	0					

Percentage Tree Cover per Household in Ugenya sub-county (2021-2022)	Average Tree Age per Household in Ugenya Sub-county (2021-2022)	Average DBH Per Household in Ugenya Sub-county (2021-2022)	Residential Area Size (Acres)	Land Ownership (Acres)	Stocking Rate	Tree Fodder Harvesting/month	Shannon Wiener's Diversity Index ($H = [(P_i) \times I_n (P_i)$)	Species Richness	Species Evenness $\frac{H}{Hmax}$	Species Abundance
3.212	14.24	5.6	0.24	1.68	3	10	2.43	3	0.74	8
3.23	6.53	5.61	0.241	1.682	3.05	10.01	2.4301	3.02	0.7401	8.02
3.264	16	5.62	0.242	1.684	3.1	10.02	2.4302	3.04	0.7402	8.04
3.25	6.55	5.63	0.243	1.686	3.15	10.03	2.4303	3.06	0.7403	8.06
3.26	6.56	5.64	0.244	1.688	3.2	10.04	2.4304	3.08	0.7404	8.08
3.217	6.57	5.65	0.245	1.69	3.25	10.05	2.4305	3.1	0.7405	8.1
3.28	6.58	5.66	0.246	1.692	3.3	10.06	2.4306	3.12	0.7406	8.12

3.29	6.59	5.67	0.247	1.694	3.35	10.07	2.4307	3.14	0.7407	8.14
3.2	6.6	5.68	0.248	1.696	3.4	10.08	2.4308	3.16	0.7408	8.16
3.31	6.61	5.69	0.249	1.698	3.45	10.09	2.4309	3.18	0.7409	8.18
3.32	6.62	5.7	0.25	1.7	3.5	10.1	2.431	3.2	0.741	8.2
3.33	6.63	5.71	0.251	1.702	3.55	10.11	2.4311	3.22	0.7411	8.22
3.34	6.64	5.72	0.252	1.704	3.6	10.12	2.4312	3.24	0.7412	8.23
3.35	6.65	5.73	0.253	1.706	3.65	10.13	2.4313	3.26	0.7413	8.26
3.36	6.66	5.74	0.254	1.708	3.7	10.14	2.4314	3.28	0.7414	8.28
3.37	23	5.75	0.255	1.71	3.75	10.15	2.4315	3.3	0.7415	8.3
3.38	6.68	5.76	0.256	1.712	3.8	10.16	2.4316	3.32	0.7416	8.32
3.39	6.69	5.77	0.257	1.714	3.85	10.17	2.4317	3.34	0.7417	8.34
3.4	20	5.78	0.258	1.716	3.9	10.18	2.4318	3.36	0.7418	8.36
3.41	6.71	5.79	0.259	1.718	3.95	10.19	2.4319	3.38	0.7419	8.38
3.42	6.72	5.8	0.26	1.72	4	10.2	2.432	3.4	0.742	8.4
3.43	45	5.81	0.261	1.722	4.05	10.21	2.4321	3.42	0.7421	8.42
3.44	6.74	5.82	0.262	1.724	4.1	10.22	2.4322	3.44	0.7422	8.44

3.45	18	5.83	0.263	1.726	4.15	10.23	2.4323	3.46	0.7423	8.46
3.46	6.76	5.84	0.264	1.728	4.2	10.24	2.4324	3.48	0.7424	8.48
3.47	6.77	5.85	0.265	1.73	4.25	10.25	2.4325	3.5	0.7425	8.5
3.48	54	5.86	0.266	1.732	4.3	10.26	2.4326	3.52	0.7426	8.52
3.49	6.79	5.87	0.267	1.734	4.35	10.27	2.4327	3.54	0.7427	8.54
3.5	6.8	5.88	0.268	1.736	4.4	10.28	2.4328	3.56	0.7428	8.56
3.51	6.81	5.89	0.269	1.738	4.45	10.29	2.4329	3.58	0.7429	8.58
3.52	6.82	5.9	0.27	1.74	4.5	10.3	2.433	3.6	0.743	8.6
3.53	6.83	5.91	0.271	1.742	4.55	10.31	2.4331	3.62	0.7431	8.62
3.54	6.84	5.92	0.272	1.744	4.6	10.32	2.4332	3.64	0.7432	8.64
3.55	6.85	5.93	0.273	1.746	4.65	10.33	2.4333	3.66	0.7433	8.66
3.56	6.86	5.94	0.274	1.748	4.7	10.34	2.4334	3.68	0.7434	8.68
3.57	6.87	5.95	0.275	1.75	4.75	10.35	2.4335	3.7	0.7435	8.7
3.58	6.88	5.96	0.276	1.752	4.8	10.36	2.4336	3.72	0.7436	8.72
3.59	6.89	5.97	0.277	1.754	4.85	10.37	2.4337	3.74	0.7437	8.74
3.6	17	5.98	0.278	1.756	4.9	10.38	2.4338	3.76	0.7438	8.76

3.61	6.91	5.99	0.279	1.758	4.95	10.39	2.4339	3.78	0.7439	8.78
3.62	6.92	6	0.28	1.76	5	10.4	2.434	3.8	0.744	8.8
3.63	5	6.01	0.281	1.762	5.05	10.41	2.4341	3.82	0.7441	8.82
3.64	6.94	6.02	0.282	1.764	5.1	10.42	2.4342	3.84	0.7442	8.84
3.65	27	6.03	0.283	1.766	5.15	10.43	2.4343	3.86	0.7443	8.86
3.66	6.96	6.04	0.284	1.768	5.2	10.44	2.4344	3.88	0.7444	8.88
3.67	6.97	6.05	0.285	1.77	5.25	10.45	2.4345	3.9	0.7445	8.9
3.68	6.98	6.06	0.286	1.772	5.3	10.46	2.4346	3.92	0.7446	8.92
3.69	6.99	6.07	0.287	1.774	5.35	10.47	2.4347	3.94	0.7447	8.94
3.7	19	6.08	0.288	1.776	5.4	10.48	2.4348	3.96	0.7448	8.96
3.71	7.01	6.09	0.289	1.778	5.45	10.49	2.4349	3.98	0.7449	8.98
3.72	18	6.1	0.29	1.78	5.5	10.5	2.435	4	0.745	9
3.73	7.03	6.11	0.291	1.782	5.55	10.51	2.4351	4.02	0.7451	9.02
3.74	7.04	6.12	0.292	1.784	5.6	10.52	2.4352	4.04	0.7452	9.04
3.75	34	6.13	0.293	1.786	5.65	10.53	2.4353	4.06	0.7453	9.06
3.76	7.06	6.14	0.294	1.788	5.7	10.54	2.4354	4.08	0.7454	9.08

3.77	7.07	6.15	0.295	1.79	5.75	10.55	2.4355	4.1	0.7455	9.1
3.78	28	6.16	0.296	1.792	5.8	10.56	2.4356	4.12	0.7456	9.12
3.79	7.09	6.17	0.297	1.794	5.85	10.57	2.4357	4.14	0.7457	9.14
3.8	7.1	6.18	0.298	1.796	5.9	10.58	2.4358	4.16	0.7458	9.16
3.81	7.11	6.19	0.299	1.798	5.95	10.59	2.4359	4.18	0.7459	9.18
3.82	7.12	6.2	0.3	1.8	6	10.6	2.436	4.2	0.746	9.2
3.83	7.13	6.21	0.301	1.802	6.05	10.61	2.4361	4.22	0.7461	9.22
3.84	7.14	6.22	0.302	1.804	6.1	10.62	2.4362	4.24	0.7462	9.24
3.85	7.15	6.23	0.303	1.806	6.15	10.63	2.4363	4.26	0.7463	9.26
3.86	7.16	6.24	0.304	1.808	6.2	10.64	2.4364	4.28	0.7464	9.28
3.87	7.17	6.25	0.305	1.81	6.25	10.65	2.4365	4.3	0.7465	9.3
3.88	7.18	6.26	0.306	1.812	6.3	10.66	2.4366	4.32	0.7466	9.32
3.89	7.19	6.27	0.307	1.814	6.35	10.67	2.4367	4.34	0.7467	9.34
3.9	7.2	6.28	0.308	1.816	6.4	10.68	2.4368	4.36	0.7468	9.36
3.91	7.21	6.29	0.309	1.818	6.45	10.69	2.4369	4.38	0.7469	9.38
3.92	36	6.3	0.31	1.82	6.5	10.7	2.437	4.4	0.747	9.4

3.93	7.23	6.31	0.311	1.822	6.55	10.71	2.4371	4.42	0.7471	9.42
3.94	7.24	6.32	0.312	1.824	6.6	10.72	2.4372	4.44	0.7472	9.44
3.95	7.25	6.33	0.313	1.826	6.65	10.73	2.4373	4.46	0.7473	9.46
3.96	7.26	6.34	0.314	1.828	6.7	10.74	2.4374	4.48	0.7474	9.48
3.97	7.27	6.35	0.315	1.83	6.75	10.75	2.4375	4.5	0.7475	9.5
3.98	7.28	6.36	0.316	1.832	6.8	10.76	2.4376	4.52	0.7476	9.52
3.99	7.29	6.37	0.317	1.834	6.85	10.77	2.4377	4.54	0.7477	9.54
4	7.3	6.38	0.318	1.836	6.9	10.78	2.4378	4.56	0.7478	9.56
4.01	7.31	6.39	0.319	1.838	6.95	10.79	2.4379	4.58	0.7479	9.58
4.02	7.32	6.4	0.32	1.84	7	10.8	2.438	4.6	0.748	9.6
4.03	7.33	6.41	0.321	1.842	7.05	10.81	2.4381	4.62	0.7481	9.62
4.04	7.34	6.42	0.322	1.844	7.1	10.82	2.4382	4.64	0.7482	9.64
4.05	7.35	6.43	0.323	1.846	7.15	10.83	2.4383	4.66	0.7483	9.66
4.06	7.36	6.44	0.324	1.848	7.2	10.84	2.4384	4.68	0.7484	9.68
4.07	7.37	6.45	0.325	1.85	7.25	10.85	2.4385	4.7	0.7485	9.7
4.08	7.38	6.46	0.326	1.852	7.3	10.86	2.4386	4.72	0.7486	9.72

4.09	7.39	6.47	0.327	1.854	7.35	10.87	2.4387	4.74	0.7487	9.74
4.1	7.4	6.48	0.328	1.856	7.4	10.88	2.4388	4.76	0.7488	9.76
4.11	7.41	6.49	0.329	1.858	7.45	10.89	2.4389	4.78	0.7489	9.78
4.12	7.42	6.5	0.33	1.86	7.5	10.9	2.439	4.8	0.749	9.8
4.13	39	6.51	0.331	1.862	7.55	10.91	2.4391	4.82	0.7491	9.82
4.14	7.44	6.52	0.332	1.864	7.6	10.92	2.4392	4.84	0.7492	9.84
4.15	7.45	6.53	0.333	1.866	7.65	10.93	2.4393	4.86	0.7493	9.86
4.16	7.46	6.54	0.334	1.868	7.7	10.94	2.4394	4.88	0.7494	9.88
4.17	7.47	6.55	0.335	1.87	7.75	10.95	2.4395	4.9	0.7495	9.9
4.18	7.48	6.56	0.336	1.872	7.8	10.96	2.4396	4.92	0.7496	9.92
4.19	7.49	6.57	0.337	1.874	7.85	10.97	2.4397	4.94	0.7497	9.94
4.2	7.5	6.58	0.338	1.876	7.9	10.98	2.4398	4.96	0.7498	9.96
4.21	7.51	6.59	0.339	1.878	7.95	10.99	2.4399	4.98	0.7499	9.98
4.22	7.52	6.6	0.34	1.88	8	11	2.44	5	0.75	10
4.23	7.53	6.61	0.341	1.882	8.05	11.01	2.4401	5.02	0.7501	10.02
4.24	7.54	6.62	0.342	1.884	8.1	11.02	2.4402	5.04	0.7502	10.04

4.25	7.55	6.63	0.343	1.886	8.15	11.03	2.4403	5.06	0.7503	10.06
4.26	7.56	6.64	0.344	1.888	8.2	11.04	2.4404	5.08	0.7504	10.08
4.27	7.57	6.65	0.345	1.89	8.25	11.05	2.4405	5.1	0.7505	10.1
4.28	7.58	6.66	0.346	1.892	8.3	11.06	2.4406	5.12	0.7506	10.12
4.29	7.59	6.67	0.347	1.894	8.35	11.07	2.4407	5.14	0.7507	10.14
4.3	7.6	6.68	0.348	1.896	8.4	11.08	2.4408	5.16	0.7508	10.16
4.31	7.61	6.69	0.349	1.898	8.45	11.09	2.4409	5.18	0.7509	10.18
4.32	7.62	6.7	0.35	1.9	8.5	11.1	2.441	5.2	0.751	10.2
4.33	7.63	6.71	0.351	1.902	8.55	11.11	2.4411	5.22	0.7511	10.22
4.34	7.64	6.72	0.352	1.904	8.6	11.12	2.4412	5.24	0.7512	10.24
4.35	7.65	6.73	0.353	1.906	8.65	11.13	2.4413	5.26	0.7513	10.26
4.36	7.66	6.74	0.354	1.908	8.7	11.14	2.4414	5.28	0.7514	10.28
4.37	7.67	6.75	0.355	1.91	8.75	11.15	2.4415	5.3	0.7515	10.3
4.38	7.68	6.76	0.356	1.912	8.8	11.16	2.4416	5.32	0.7516	10.32
4.39	7.69	6.77	0.357	1.914	8.85	11.17	2.4417	5.34	0.7517	10.34
4.4	7.7	6.78	0.358	1.916	8.9	11.18	2.4418	5.36	0.7518	10.36

4.41	7.71	6.79	0.359	1.918	8.95	11.19	2.4419	5.38	0.7519	10.38
4.42	7.72	6.8	0.36	1.92	9	11.2	2.442	5.4	0.752	10.4
4.43	7.73	6.81	0.361	1.922	9.05	11.21	2.4421	5.42	0.7521	10.42
4.44	7.74	6.82	0.362	1.924	9.1	11.22	2.4422	5.44	0.7522	10.44
4.45	7.75	6.83	0.363	1.926	9.15	11.23	2.4423	5.46	0.7523	10.46
4.46	7.76	6.84	0.364	1.928	9.2	11.24	2.4424	5.48	0.7524	10.48
4.74	7.77	6.85	0.365	1.93	9.25	11.25	2.4425	5.5	0.7525	10.5
4.48	7.78	6.86	0.366	1.932	9.3	11.26	2.4426	5.52	0.7526	10.52
4.49	7.79	6.87	0.367	1.934	9.35	11.27	2.4427	5.54	0.7527	10.54
4.5	7.8	6.88	0.368	1.936	9.4	11.28	2.4428	5.56	0.7528	10.56
4.51	7.81	6.89	0.369	1.938	9.45	11.29	2.4429	5.58	0.7529	10.58
4.52	7.82	6.9	0.37	1.94	9.5	11.3	2.443	5.6	0.753	10.6
4.53	7.83	6.91	0.371	1.942	9.55	11.31	2.4431	5.62	0.7531	10.62
4.54	7.84	6.92	0.372	1.944	9.6	11.32	2.4432	5.64	0.7532	10.64
4.55	7.85	6.93	0.373	1.946	9.65	11.33	2.4433	5.66	0.7533	10.66
4.56	7.86	6.94	0.374	1.948	9.7	11.34	2.4434	5.68	0.7534	10.68

4.57	7.87	6.95	0.375	1.95	9.75	11.35	2.4435	5.7	0.7535	10.7
4.58	7.88	6.96	0.376	1.952	9.8	11.36	2.4436	5.72	0.7536	10.72
4.59	7.89	6.97	0.377	1.954	9.85	11.37	2.4437	5.74	0.7537	10.74
4.6	7.9	6.98	0.378	1.956	9.9	11.38	2.4438	5.76	0.7538	10.76
4.61	7.91	6.99	0.379	1.958	9.95	11.39	2.4439	5.78	0.7539	10.78
4.62	7.92	7	0.38	1.96	10	11.4	2.444	5.8	0.754	10.8
4.63	7.93	7.01	0.381	1.962	10.05	11.41	2.4441	5.82	0.7541	10.82
4.64	7.94	7.02	0.382	1.964	10.1	11.42	2.4442	5.84	0.7542	10.84
4.65	7.95	7.03	0.383	1.966	10.15	11.43	2.4443	5.86	0.7543	10.86
4.66	7.96	7.04	0.384	1.968	10.2	11.44	2.4444	5.88	0.7544	10.88
4.67	7.97	7.05	0.385	1.97	10.25	11.45	2.4445	5.9	0.7545	10.9
4.68	7.98	7.06	0.386	1.972	10.3	11.46	2.4446	5.92	0.7546	10.92
4.69	7.99	7.07	0.387	1.974	10.35	11.47	2.4447	5.94	0.7547	10.94
4.7	8	7.08	0.388	1.976	10.4	11.48	2.4448	5.96	0.7548	10.96
4.71	8.01	7.09	0.389	1.978	10.45	11.49	2.4449	5.98	0.7549	10.98
4.72	8.02	7.1	0.39	1.98	10.5	11.5	2.445	6	0.755	11

4.73	8.03	7.11	0.391	1.982	10.55	11.51	2.4451	6.02	0.7551	11.02
4.74	8.04	7.12	0.392	1.984	10.6	11.52	2.4452	6.04	0.7552	11.04
4.75	8.05	7.13	0.393	1.986	10.65	11.53	2.4453	6.06	0.7553	11.06
4.76	8.06	7.14	0.394	1.988	10.7	11.54	2.4454	6.08	0.7554	11.08
4.77	8.07	7.15	0.395	1.99	10.75	11.55	2.4455	6.1	0.7555	11.1
4.78	8.08	7.16	0.396	1.992	10.8	11.56	2.4456	6.12	0.7556	11.12
4.79	8.09	7.17	0.397	1.994	10.85	11.57	2.4457	6.14	0.7557	11.14
4.8	8.1	7.18	0.398	1.996	10.9	11.58	2.4458	6.16	0.7558	11.16
4.81	8.11	7.19	0.399	1.998	10.95	11.59	2.4459	6.18	0.7559	11.18
4.82	8.12	7.2	0.4	2	11	11.6	2.446	6.2	0.756	11.2
4.83	8.13	7.21	0.401	2.002	11.05	11.61	2.4461	6.22	0.7561	11.22
4.84	8.14	7.22	0.402	2.004	11.1	11.62	2.4462	6.24	0.7562	11.24
4.85	8.15	7.23	0.403	2.006	11.15	11.63	2.4463	6.26	0.7563	11.26
4.86	8.16	7.24	0.404	2.008	11.2	11.64	2.4464	6.28	0.7564	11.28
4.87	8.17	7.25	0.405	2.01	11.25	11.65	2.4465	6.3	0.7565	11.3
4.88	8.18	7.26	0.406	2.012	11.3	11.66	2.4466	6.32	0.7566	11.32

4.89	8.19	7.27	0.407	2.014	11.35	11.67	2.4467	6.34	0.7567	11.34
4.9	8.2	7.28	0.408	2.016	11.4	11.68	2.4468	6.36	0.7568	11.36
4.91	8.21	7.29	0.409	2.018	11.45	11.69	2.4469	6.38	0.7569	11.38
4.92	8.22	7.3	0.41	2.02	11.5	11.7	2.447	6.4	0.757	11.4
4.93	8.23	7.31	0.411	2.022	11.55	11.71	2.4471	6.42	0.7571	11.42
4.94	8.24	7.32	0.412	2.024	11.6	11.72	2.4472	6.44	0.7572	11.44
4.95	8.25	7.33	0.413	2.026	11.65	11.73	2.4473	6.46	0.7573	11.46
4.96	8.26	7.34	0.414	2.028	11.7	11.74	2.4474	6.48	0.7574	11.48
4.97	8.27	7.35	0.415	2.03	11.75	11.75	2.4475	6.5	0.7575	11.5
4.98	8.28	7.36	0.416	2.032	11.8	11.76	2.4476	6.52	0.7576	11.52
4.99	8.29	7.37	0.417	2.034	11.85	11.77	2.4477	6.54	0.7577	11.54
5	8.3	7.38	0.418	2.036	11.9	11.78	2.4478	6.56	0.7578	11.56
5.01	8.31	7.39	0.419	2.038	11.95	11.79	2.4479	6.58	0.7579	11.58
5.02	8.32	7.4	0.42	2.04	12	11.8	2.448	6.6	0.758	11.6
5.03	8.33	7.41	0.421	2.042	12.05	11.81	2.4481	6.62	0.7581	11.62
5.04	8.34	7.42	0.422	2.044	12.1	11.82	2.4482	6.64	0.7582	11.64

5.05	8.35	7.43	0.423	2.046	12.15	11.83	2.4483	6.66	0.7583	11.66
5.06	8.36	7.44	0.424	2.048	12.2	11.84	2.4484	6.68	0.7584	11.68
5.07	8.37	7.45	0.425	2.05	12.25	11.85	2.4485	6.7	0.7585	11.7
5.08	8.38	7.46	0.426	2.052	12.3	11.86	2.4486	6.72	0.7586	11.72
5.09	8.39	7.47	0.427	2.054	12.35	11.87	2.4487	6.74	0.7587	11.74
5.1	8.4	7.48	0.428	2.056	12.4	11.88	2.4488	6.76	0.7588	11.76
5.11	8.41	7.49	0.429	2.058	12.45	11.89	2.4489	6.78	0.7589	11.78
5.12	8.42	7.5	0.43	2.06	12.5	11.9	2.449	6.8	0.759	11.8
5.13	8.43	7.51	0.431	2.062	12.55	11.91	2.4491	6.82	0.7591	11.82
5.14	8.44	7.52	0.432	2.064	12.6	11.92	2.4492	6.84	0.7592	11.84
5.15	8.45	7.53	0.433	2.066	12.65	11.93	2.4493	6.86	0.7593	11.86
5.16	8.46	7.54	0.434	2.068	12.7	11.94	2.4494	6.88	0.7594	11.88
5.17	8.47	7.55	0.435	2.07	12.75	11.95	2.4495	6.9	0.7595	11.9
5.18	8.48	7.56	0.436	2.072	12.8	11.96	2.4496	6.92	0.7596	11.92
5.19	8.49	7.57	0.437	2.074	12.85	11.97	2.4497	6.94	0.7597	11.94
5.2	8.5	7.58	0.438	2.076	12.9	11.98	2.4498	6.96	0.7598	11.96

5.21	8.51	7.59	0.439	2.078	12.95	11.99	2.4499	6.98	0.7599	11.98
5.22	8.52	7.6	0.44	2.08	13	12	2.45	7	0.76	12
5.23	8.53	7.61	0.441	2.082	13.05	12.01	2.4501	7.02	0.7601	12.02
5.24	8.54	7.62	0.442	2.084	13.1	12.02	2.4502	7.04	0.7602	12.04
5.25	8.55	7.63	0.443	2.086	13.15	12.03	2.4503	7.06	0.7603	12.06
5.26	8.56	7.64	0.444	2.088	13.2	12.04	2.4504	7.08	0.7604	12.08
5.27	8.57	7.65	0.445	2.09	13.25	12.05	2.4505	7.1	0.7605	12.1
5.28	8.58	7.66	0.446	2.092	13.3	12.06	2.4506	7.12	0.7606	12.12
5.29	8.59	7.67	0.447	2.094	13.35	12.07	2.4507	7.14	0.7607	12.14
5.3	8.6	7.68	0.448	2.096	13.4	12.08	2.4508	7.16	0.7608	12.16
5.31	8.61	7.69	0.449	2.098	13.45	12.09	2.4509	7.18	0.7609	12.18
5.32	8.62	7.7	0.45	2.1	13.5	12.1	2.451	7.2	0.761	12.2
5.33	8.63	7.71	0.451	2.102	13.55	12.11	2.4511	7.22	0.7611	12.22
5.34	8.64	7.72	0.452	2.104	13.6	12.12	2.4512	7.24	0.7612	12.24
5.35	8.65	5	0.453	2.106	13.65	12.13	2.4513	7.26	0.7613	12.26
5.36	8.66	7.74	0.454	2.108	13.7	12.14	2.4514	7.28	0.7614	12.28

5.37	8.67	5	0.455	2.11	13.75	12.15	2.4515	7.3	0.7615	12.3
5.38	8.68	7.76	0.456	2.112	13.8	12.16	2.4516	7.32	0.7616	12.32
5.39	8.69	5	0.457	2.114	13.85	12.17	2.4517	7.34	0.7617	12.34
5.4	8.7	7.78	0.458	2.116	13.9	12.18	2.4518	7.36	0.7618	12.36
5.41	8.71	7.79	0.459	2.118	13.95	12.19	2.4519	7.38	0.7619	12.38
5.42	8.72	7.8	0.46	2.12	14	12.2	2.452	7.4	0.762	12.4
5.43	8.73	5.2	0.461	2.122	14.05	12.21	2.4521	7.42	0.7621	12.42
5.44	8.74	7.82	0.462	2.124	14.1	12.22	2.4522	7.44	0.7622	12.44
5.45	8.75	7.83	0.463	2.126	14.15	12.23	2.4523	7.46	0.7623	12.46
5.46	8.76	7.84	0.464	2.128	14.2	12.24	2.4524	7.48	0.7624	12.48
5.47	8.77	7.85	0.465	2.13	14.25	12.25	2.4525	7.5	0.7625	12.5
5.48	8.78	4.7	0.466	2.132	14.3	12.26	2.4526	7.52	0.7626	12.52
5.49	8.79	7.87	0.467	2.134	14.35	12.27	2.4527	7.54	0.7627	12.54
5.5	8.8	5	0.468	2.136	14.4	12.28	2.4528	7.56	0.7628	12.56
5.51	8.81	7.89	0.469	2.138	14.45	12.29	2.4529	7.58	0.7629	12.58
5.52	8.82	7.9	0.47	2.14	14.5	12.3	2.453	7.6	0.763	12.6

5.53	8.83	7.91	0.471	2.142	14.55	12.31	2.4531	7.62	0.7631	12.62
5.54	8.84	7.92	0.472	2.144	14.6	12.32	2.4532	7.64	0.7632	12.64
5.55	8.85	7.93	0.473	2.146	14.65	12.33	2.4533	7.66	0.7633	12.66
5.56	8.86	5	0.474	2.148	14.7	12.34	2.4534	7.68	0.7634	12.68
5.57	8.87	7.95	0.475	2.15	14.75	12.35	2.4535	7.7	0.7635	12.7
5.58	8.88	7.96	0.476	2.152	14.8	12.36	2.4536	7.72	0.7636	12.72
5.59	8.89	5.1	0.477	2.154	14.85	12.37	2.4537	7.74	0.7637	12.74
5.6	8.9	7.98	0.478	2.156	14.9	12.38	2.4538	7.76	0.7638	12.76
5.61	8.91	7.99	0.479	2.158	14.95	12.39	2.4539	7.78	0.7639	12.78
5.62	8.92	8	0.48	2.16	15	12.4	2.454	7.8	0.764	12.8
5.63	8.93	8.01	0.481	2.162	15.05	12.41	2.4541	7.82	0.7641	12.82
5.64	8.94	8.02	0.482	2.164	15.1	12.42	2.4542	7.84	0.7642	12.84
5.65	8.95	5.3	0.483	2.166	15.15	12.43	2.4543	7.86	0.7643	12.86
5.66	8.96	8.04	0.484	2.168	15.2	12.44	2.4544	7.88	0.7644	12.88
5.67	8.97	8.05	0.485	2.17	15.25	12.45	2.4545	7.9	0.7645	12.9
5.68	8.98	5.4	0.486	2.172	15.3	12.46	2.4546	7.92	0.7646	12.92

5.69	8.99	8.07	0.487	2.174	15.35	12.47	2.4547	7.94	0.7647	12.94
5.7	9	8.08	0.488	2.176	15.4	12.48	2.4548	7.96	0.7648	12.96
5.71	9.01	8.09	0.489	2.178	15.45	12.49	2.4549	7.98	0.7649	12.98
5.72	9.02	8.1	0.49	2.18	15.5	12.5	2.455	8	0.765	13
5.73	9.03	8.11	0.491	2.182	15.55	12.51	2.4551	8.02	0.7651	13.02
5.74	9.04	5.7	0.492	2.184	15.6	12.52	2.4552	8.04	0.7652	13.04
5.75	9.05	8.13	0.493	2.186	15.65	12.53	2.4553	8.06	0.7653	13.06
5.76	9.06	8.14	0.494	2.188	15.7	12.54	2.4554	8.08	0.7654	13.08
5.77	9.07	4,5	0.495	2.19	15.75	12.55	2.4555	8.1	0.7655	13.1
5.78	9.08	8.16	0.496	2.192	15.8	12.56	2.4556	8.12	0.7656	13.12
5.79	9.09	8.17	0.497	2.194	15.85	12.57	2.4557	8.14	0.7657	13.14
5.8	9.1	5.6	0.498	2.196	15.9	12.58	2.4558	8.16	0.7658	13.16
5.81	9.11	8.19	0.499	2.198	15.95	12.59	2.4559	8.18	0.7659	13.18
5.82	9.12	8.2	0.5	2.2	16	12.6	2.456	8.2	0.766	13.2
5.83	9.13	8.21	0.501	2.202	16.05	12.61	2.4561	8.22	0.7661	13.22
5.84	9.14	4,5	0.502	2.204	16.1	12.62	2.4562	8.24	0.7662	13.24

5.85	9.15	8.23	0.503	2.206	16.15	12.63	2.4563	8.26	0.7663	13.26
5.86	9.16	4.55	0.504	2.208	16.2	12.64	2.4564	8.28	0.7664	13.28
5.87	9.17	4,5	0.505	2.21	16.25	12.65	2.4565	8.3	0.7665	13.3
5.88	9.18	8.26	0.506	2.212	16.3	12.66	2.4566	8.32	0.7666	13.32
5.89	9.19	4.73	0.507	2.214	16.35	12.67	2.4567	8.34	0.7667	13.34
5.9	9.2	8.28	0.508	2.216	16.4	12.68	2.4568	8.36	0.7668	13.36
5.91	9.21	8.29	0.509	2.218	16.45	12.69	2.4569	8.38	0.7669	13.38
5.92	9.22	4.51	0.51	2.22	16.5	12.7	2.457	8.4	0.767	13.4
5.93	9.23	8.31	0.511	2.222	16.55	12.71	2.4571	8.42	0.7671	13.42
5.94	9.24	8.32	0.512	2.224	16.6	12.72	2.4572	8.44	0.7672	13.44
5.95	9.25	4.53	0.513	2.226	16.65	12.73	2.4573	8.46	0.7673	13.46
5.96	9.26	8.34	0.514	2.228	16.7	12.74	2.4574	8.48	0.7674	13.48
5.97	9.27	8.35	0.515	2.23	16.75	12.75	2.4575	8.5	0.7675	13.5
5.98	9.28	4.56	0.516	2.232	16.8	12.76	2.4576	8.52	0.7676	13.52
5.99	9.29	8.37	0.517	2.234	16.85	12.77	2.4577	8.54	0.7677	13.54
6	9.3	8.38	0.518	2.236	16.9	12.78	2.4578	8.56	0.7678	13.56

6.01	9.31	8.39	0.519	2.238	16.95	12.79	2.4579	8.58	0.7679	13.58
6.02	9.32	8.4	0.52	2.24	17	12.8	2.458	8.6	0.768	13.6
6.03	9.33	8.41	0.521	2.242	17.05	12.81	2.4581	8.62	0.7681	13.62
6.04	9.34	4.52	0.522	2.244	17.1	12.82	2.4582	8.64	0.7682	13.64
6.05	9.35	8.43	0.523	2.246	17.15	12.83	2.4583	8.66	0.7683	13.66
6.06	9.36	4.52	0.524	2.248	17.2	12.84	2.4584	8.68	0.7684	13.68
6.07	9.37	8.45	0.525	2.25	17.25	12.85	2.4585	8.7	0.7685	13.7
6.08	9.38	8.46	0.526	2.252	17.3	12.86	2.4586	8.72	0.7686	13.72
6.09	9.39	4.55	0.527	2.254	17.35	12.87	2.4587	8.74	0.7687	13.74
6.1	9.4	8.48	0.528	2.256	17.4	12.88	2.4588	8.76	0.7688	13.76
6.11	9.41	8.49	0.529	2.258	17.45	12.89	2.4589	8.78	0.7689	13.78
6.12	9.42	8.5	0.53	2.26	17.5	12.9	2.459	8.8	0.769	13.8
6.13	9.43	4.58	0.531	2.262	17.55	12.91	2.4591	8.82	0.7691	13.82
6.14	9.44	8.52	0.532	2.264	17.6	12.92	2.4592	8.84	0.7692	13.84
6.22	9.45	8.53	0.533	2.266	17.65	12.93	2.4593	8.86	0.7693	13.86
6.16	9.46	4.56	0.534	2.268	17.7	12.94	2.4594	8.88	0.7694	13.88

6.17	9.47	8.55	0.535	2.27	17.75	12.95	2.4595	8.9	0.7695	13.9
6.18	9.48	8.56	0.536	2.272	17.8	12.96	2.4596	8.92	0.7696	13.92
6.19	9.49	8.57	0.537	2.274	17.85	12.97	2.4597	8.94	0.7697	13.94
6.2	9.5	8.58	0.538	2.276	17.9	12.98	2.4598	8.96	0.7698	13.96
6.21	9.51	8.59	0.539	2.278	17.95	12.99	2.4599	8.98	0.7699	13.98
6.22	9.52	8.6	0.54	2.28	18	13	2.46	9	0.77	14
6.23	9.53	8.61	0.541	2.282	18.05	13.01	2.4601	9.02	0.7701	14.02
6.24	9.54	8.62	0.542	2.284	18.1	13.02	2.4602	9.04	0.7702	14.04
6.25	9.55	8.63	0.543	2.286	18.15	13.03	2.4603	9.06	0.7703	14.06
6.26	9.56	8.64	0.544	2.288	18.2	13.04	2.4604	9.08	0.7704	14.08
6.27	9.57	8.65	0.545	2.29	18.25	13.05	2.4605	9.1	0.7705	14.1
6.28	9.58	8.66	0.546	2.292	18.3	13.06	2.4606	9.12	0.7706	14.12
6.29	9.59	8.67	0.547	2.294	18.35	13.07	2.4607	9.14	0.7707	14.14
6.3	9.6	8.68	0.548	2.296	18.4	13.08	2.4608	9.16	0.7708	14.16
6.31	9.61	8.69	0.549	2.298	18.45	13.09	2.4609	9.18	0.7709	14.18
6.32	9.62	8.7	0.55	2.3	18.5	13.1	2.461	9.2	0.771	14.2

6.33	9.63	8.71	0.551	2.302	18.55	13.11	2.4611	9.22	0.7711	14.22
6.34	9.64	8.72	0.552	2.304	18.6	13.12	2.4612	9.24	0.7712	14.24
6.35	9.65	8.73	0.553	2.306	18.65	13.13	2.4613	9.26	0.7713	14.26
6.36	9.66	8.74	0.554	2.308	18.7	13.14	2.4614	9.28	0.7714	14.28
6.37	9.67	8.75	0.555	2.31	18.75	13.15	2.4615	9.3	0.7715	14.3
6.38	9.68	8.76	0.556	2.312	18.8	13.16	2.4616	9.32	0.7716	14.32
6.39	9.69	8.77	0.557	2.314	18.85	13.17	2.4617	9.34	0.7717	14.34
6.4	9.7	8.78	0.558	2.316	18.9	13.18	2.4618	9.36	0.7718	14.36
6.35	9.71	8.79	0.559	2.318	18.95	13.19	2.4619	9.38	0.7719	14.38
6.42	9.72	8.8	0.56	2.32	19	13.2	2.462	9.4	0.772	14.4
6.43	9.73	8.81	0.561	2.322	19.05	13.21	2.4621	9.42	0.7721	14.42
6.44	9.74	8.82	0.562	2.324	19.1	13.22	2.4622	9.44	0.7722	14.44
6.45	9.75	8.83	0.563	2.326	19.15	13.23	2.4623	9.46	0.7723	14.46
6.46	9.76	8.84	0.564	2.328	19.2	13.24	2.4624	9.48	0.7724	14.48
6.47	9.77	8.85	0.565	2.33	19.25	13.25	2.4625	9.5	0.7725	14.5
6.48	9.78	8.86	0.566	2.332	19.3	13.26	2.4626	9.52	0.7726	14.52

6.49	9.79	8.87	0.567	2.334	19.35	13.27	2.4627	9.54	0.7727	14.54
6.5	9.8	8.88	0.568	2.336	19.4	13.28	2.4628	9.56	0.7728	14.56
6.33	9.81	8.89	0.569	2.338	19.45	13.29	2.4629	9.58	0.7729	14.58
6.52	9.82	8.9	0.57	2.34	19.5	13.3	2.463	9.6	0.773	14.6
6.53	9.83	8.91	0.571	2.342	19.55	13.31	2.4631	9.62	0.7731	14.62
6.54	9.84	8.92	0.572	2.344	19.6	13.32	2.4632	9.64	0.7732	14.64
6.55	9.85	8.93	0.573	2.346	19.65	13.33	2.4633	9.66	0.7733	14.66
6.56	9.86	8.94	0.574	2.348	19.7	13.34	2.4634	9.68	0.7734	14.68
6.57	9.87	8.95	0.575	2.35	19.75	13.35	2.4635	9.7	0.7735	14.7
6.58	9.88	8.96	0.576	2.352	19.8	13.36	2.4636	9.72	0.7736	14.72
2.81	9.89	8.97	0.577	2.354	19.85	13.37	2.4637	9.74	0.7737	14.74
6.1	9.9	8.98	0.578	2.356	19.9	13.38	2.4638	9.76	0.7738	14.76
6.61	9.91	8.99	0.579	2.358	19.95	13.39	2.4639	9.78	0.7739	14.78
6.62	9.92	9	0.58	2.36	20	13.4	2.464	9.8	0.774	14.8
6.63	9.93	9.01	0.581	2.362	20.05	13.41	2.4641	9.82	0.7741	14.82
6.64	9.94	9.02	0.582	2.364	20.1	13.42	2.4642	9.84	0.7742	14.84

2.3	9.95	9.03	0.583	2.366	20.15	13.43	2.4643	9.86	0.7743	14.86
6.66	9.96	9.04	0.584	2.368	20.2	13.44	2.4644	9.88	0.7744	14.88
6.67	9.97	9.05	0.585	2.37	20.25	13.45	2.4645	9.9	0.7745	14.9
6.68	9.98	9.06	0.586	2.372	20.3	13.46	2.4646	9.92	0.7746	14.92
6.69	9.99	9.07	0.587	2.374	20.35	13.47	2.4647	9.94	0.7747	14.94
3.42	10	9.08	0.588	2.376	20.4	13.48	2.4648	9.96	0.7748	14.96
6.71	10.01	9.09	0.589	2.378	20.45	13.49	2.4649	9.98	0.7749	14.98
6.72	10.02	9.1	0.59	2.38	20.5	13.5	2.465	10	0.775	15
6.73	10.03	9.11	0.591	2.382	20.55	13.51	2.4651	10.02	0.7751	15.02
6.74	10.04	9.12	0.592	2.384	20.6	13.52	2.4652	10.04	0.7752	15.04
6.75	10.05	9.13	0.593	2.386	20.65	13.53	2.4653	10.06	0.7753	15.06
4.42	10.06	9.14	0.594	2.388	20.7	13.54	2.4654	10.08	0.7754	15.08
4.43	10.07	6.3	0.595	2.39	20.75	13.55	2.4655	10.1	0.7755	15.1
6.78	10.08	9.16	0.596	2.392	20.8	13.56	2.4656	10.12	0.7756	15.12
6.79	10.09	9.17	0.597	2.394	20.85	13.57	2.4657	10.14	0.7757	15.14
6.8	10.1	9.18	0.598	2.396	20.9	13.58	2.4658	10.16	0.7758	15.16

6.81	10.11	9.19	0.599	2.398	20.95	13.59	2.4659	10.18	0.7759	15.18
6.82	10.12	9.2	0.6	2.4	21	13.6	2.466	10.2	0.776	15.2
6.83	10.13	9.21	0.601	2.402	21.05	13.61	2.4661	10.22	0.7761	15.22
6.84	10.14	9.22	0.602	2.404	21.1	13.62	2.4662	10.24	0.7762	15.24
6.85	10.15	9.23	0.603	2.406	21.15	13.63	2.4663	10.26	0.7763	15.26
6.7	10.16	5.1	0.604	2.408	21.2	13.64	2.4664	10.28	0.7764	15.28
6.87	10.17	9.25	0.605	2.41	21.25	13.65	2.4665	10.3	0.7765	15.3
6.88	10.18	9.26	0.606	2.412	21.3	13.66	2.4666	10.32	0.7766	15.32
6.84	10.19	9.27	0.607	2.414	21.35	13.67	2.4667	10.34	0.7767	15.34
3.1	10.2	9.28	0.608	2.416	21.4	13.68	2.4668	10.36	0.7768	15.36
6.91	10.21	9.29	0.609	2.418	21.45	13.69	2.4669	10.38	0.7769	15.38
6.53	10.22	5.5	0.61	2.42	21.5	13.7	2.467	10.4	0.777	15.4
6.93	10.23	9.31	0.611	2.422	21.55	13.71	2.4671	10.42	0.7771	15.42
6.94	10.24	9.32	0.612	2.424	21.6	13.72	2.4672	10.44	0.7772	15.44
6.66	10.25	9.33	0.613	2.426	21.65	13.73	2.4673	10.46	0.7773	15.46
6.96	10.26	9.34	0.614	2.428	21.7	13.74	2.4674	10.48	0.7774	15.48

6.97	10.27	9.35	0.615	2.43	21.75	13.75	2.4675	10.5	0.7775	15.5
6.34	10.28	9.36	0.616	2.432	21.8	13.76	2.4676	10.52	0.7776	15.52
6.99	10.29	4.8	0.617	2.434	21.85	13.77	2.4677	10.54	0.7777	15.54
6.81	10.3	9.38	0.618	2.436	21.9	13.78	2.4678	10.56	0.7778	15.56
7.01	10.31	9.39	0.619	2.438	21.95	13.79	2.4679	10.58	0.7779	15.58
4.26	10.32	9.4	0.62	2.44	22	13.8	2.468	10.6	0.778	15.6
7.03	10.33	4.6	0.621	2.442	22.05	13.81	2.4681	10.62	0.7781	15.62
6.87	10.34	9.42	0.622	2.444	22.1	13.82	2.4682	10.64	0.7782	15.64
6.22	10.35	9.43	0.623	2.446	22.15	13.83	2.4683	10.66	0.7783	15.66

APPENDIX 15: CODED DATA ON HUMAN SETTLEMENT AND LIVESTOCK FARMING

Wards: North = 1, East = 2, West = 3, Ukwala = 4	Modern House	Traditional House	Gender: Female =1, Male = 2,	Ancient culture = 1, Modernity =2, undecided =3	Land Tenure: Private = 1, Communal = 2	Education Basic =1, Higher = 2	Livestock Breeds: Local = 1, Exotic = 2	Livestock Feeding Method: Traditional =1, Modern = 2	Livestock Farming System: Extensive = 1, Intensive = 2	Livestock Composition: single species = 1, mixed species = 2
1	2	0	1	2	1	2	1	1	1	2
1	1	0	2	2	1	1	1	2	1	2
2	3	0	2	2	1	1	1	1	1	2
4	4	0	1	1	2	1	2	1	1	2
3	2	0	1	2	1	1	1	1	1	2
3	1	0	1	2	2	1	1	1	1	2
1	3	0	1	1	1	2	1	1	1	2
1	5	0	2	1	1	2	1	2	1	2
2	7	0	2	1	1	2	1	1	1	2
3	2	0	2	2	1	1	1	1	1	2
1	1	0	2	2	1	1	1	1	2	2
4	0	3	1	3	2	1	1	1	1	2
2	3	0	1	2	2	2	1	1	1	2
3	3	0	1	2	1	1	2	1	1	2
1	0	4	2	2	1	1	1	2	1	2
1	1	0	2	1	1	1	1	1	1	2
2	2	0	1	3	1	1	1	1	1	1
4	4	0	1	2	2	1	2	1	1	2
3	2	0	1	2	1	2	1	1	1	2
3	1	0	1	2	2	2	1	1	1	1
1	3	0	2	1	1	2	1	2	1	1
1	4	0	2	2	1	1	1	1	2	2
2	2	0	2	2	1	1	1	1	1	1
3	1	0	2	1	1	1	1	1	1	2
1	3	0	1	1	1	2	1	1	1	2
4	5	0	1	1	2	1	1	1	1	2
2	7	0	1	2	2	1	1	2	1	2
3	2	0	2	2	1	1	2	1	1	2
1	1	0	2	3	1	1	1	1	1	2

3	0	2	1	1	1	2	1	1	2	2
3	1	0	2	3	2	1	1	2	1	2
1	2	0	2	2	1	1	1	1	1	2
1	4	1	2	2	1	1	1	1	1	2
2	2	0	2	2	1	2	1	1	1	2
3	1	0	1	1	1	1	1	1	1	2
1	3	0	1	2	1	1	1	1	1	2
4	4	0	1	2	2	1	1	2	1	1
2	2	0	2	1	2	1	1	1	1	2
3	1	0	2	1	1	1	2	1	1	2
1	3	0	1	1	1	2	1	1	1	1
1	5	0	1	2	1	2	1	1	2	1
2	7	0	1	2	1	2	1	1	1	2
4	2	0	1	3	2	1	2	2	1	1
3	1	0	2	2	1	1	1	1	1	2
3	0	0	2	2	2	1	1	1	1	2
1	3	0	2	2	1	2	1	1	1	2
1	3	0	2	1	1	1	1	1	1	2
2	0	0	1	3	1	1	1	1	1	2
3	1	3	1	2	1	1	1	1	1	2
1	2	0	1	2	1	1	1	2	1	2
4	4	0	2	2	2	1	1	1	1	2
2	2	4	2	1	2	2	1	1	2	2
3	1	0	1	2	1	2	2	1	1	2
1	3	0	1	2	1	2	1	1	1	2
1	4	0	1	1	1	1	1	1	1	2
2	2	0	1	1	1	1	1	2	1	2
4	1	0	2	1	2	1	2	1	1	2
3	3	0	2	2	1	2	1	1	1	2
3	5	0	2	2	2	1	1	1	1	2
1	7	0	2	3	1	1	1	1	1	1
1	2	0	1	2	1	1	1	1	1	2
2	1	0	1	2	1	1	1	2	1	2

3	0	0	1	2	1	1	1	1	2	1
1	3	0	2	1	1	2	1	1	1	1
4	3	0	2	3	2	2	1	1	1	2
2	0	0	1	2	2	2	1	1	1	1
3	1	1	1	2	1	1	2	1	1	2
1	2	0	1	2	1	1	1	1	1	2
1	4	0	1	1	1	1	1	2	1	2
2	2	2	2	2	1	2	1	1	1	2
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3	3	0	2	1	1	1	1	1	1	2
3	4	1	2	1	2	1	1	1	1	2
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1	1	0	1	2	1	1	1	2	1	2
2	3	0	1	2	1	2	1	1	1	2
3	5	0	2	3	1	2	1	1	1	2
1	7	0	2	2	1	2	1	1	1	2
4	2	0	1	2	2	1	1	1	1	2
2	1	0	1	2	2	1	1	1	1	2
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1	3	0	1	3	1	2	1	1	1	2
1	3	0	2	2	1	1	1	1	1	1
2	0	0	2	2	1	1	1	1	1	2
4	1	0	2	2	2	1	2	1	2	2
3	2	0	2	1	1	1	1	1	1	1
3	4	0	1	2	2	1	1	1	1	1
1	2	0	1	2	1	2	1	2	1	2
1	1	3	1	1	1	2	1	1	1	1
2	3	0	2	1	1	2	1	1	1	2
3	4	0	2	1	1	1	1	1	1	2

1	2	4	1	2	1	1	1	1	1	2
4	1	0	1	2	2	1	1	1	1	2
2	3	0	1	3	2	2	1	2	1	2
3	5	0	1	2	1	1	2	1	1	2
1	7	0	2	2	1	1	1	1	2	2
1	2	0	2	2	1	1	1	1	1	2
2	1	0	2	1	1	1	1	1	1	2
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1	2	0	1	1	1	2	1	1	1	1
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2	3	0	1	1	2	1	1	1	1	2
3	4	0	2	2	1	1	2	1	1	1
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2	3	0	2	2	1	2	1	1	1	1
4	5	1	1	2	2	2	2	2	1	2
3	7	0	1	2	1	2	1	1	1	2
3	2	0	1	1	2	1	1	1	1	2
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4	3	0	2	2	2	1	2	1	1	1
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3	1	0	2	2	1	2	1	1	1	2
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1	3	0	1	2	1	2	1	1	2	2
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3	2	4	1	2	1	1	1	1	1	2
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3	2	0	2	1	1	1	1	2	1	2
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2	3	0	1	2	2	2	1	1	1	2
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1	1	0	2	2	1	1	1	2	1	2

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3	1	0	1	3	2	2	1	1	1	2
1	3	2	1	2	1	2	1	1	1	1
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2	7	0	1	1	2	1	1	1	1	2
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2	2	0	1	1	2	1	1	2	1	1
3	1	0	2	2	1	1	2	1	1	2
1	3	4	2	2	1	2	1	1	1	2
1	5	0	2	1	1	2	1	1	1	1
2	7	0	2	1	1	2	1	1	2	1

4	2	0	1	1	2	1	2	1	1	2
3	1	0	1	2	1	1	1	1	1	1
3	0	0	1	2	2	1	1	2	1	2
1	3	0	2	3	1	2	1	1	1	2
1	3	0	2	2	1	1	1	1	1	2
2	0	0	1	2	1	1	1	1	1	2
3	1	0	1	2	1	1	1	1	1	2
1	2	0	1	1	1	1	1	1	1	2
4	4	0	1	3	2	1	1	2	1	2
2	2	0	2	2	2	2	1	1	1	2
3	1	0	2	2	1	2	2	1	2	2
1	3	0	2	2	1	2	1	1	1	2
1	4	1	2	1	1	1	1	1	1	2
2	2	0	1	2	1	1	1	1	1	2
4	1	0	1	2	2	1	2	2	1	2
3	3	2	1	1	1	2	1	1	1	2
3	5	0	2	1	2	1	1	1	1	2
1	7	0	2	1	1	1	1	1	1	2
1	2	1	1	2	1	1	1	1	1	1
2	1	0	1	2	1	1	1	1	1	2
3	0	0	1	3	1	1	1	1	1	2
1	3	0	1	2	1	2	1	2	2	1
4	3	0	2	2	2	2	1	1	1	1
2	0	0	2	2	2	2	1	1	1	2
3	1	0	2	1	1	1	2	1	1	1
1	2	0	2	3	1	1	1	1	1	2
1	4	0	1	2	1	1	1	1	1	2
2	2	0	1	2	1	2	1	2	1	2
4	1	0	1	2	2	1	2	1	1	2

3	3	0	2	1	1	1	1	1	1	2
3	4	0	2	2	2	1	1	1	1	2
1	2	0	1	2	1	1	1	1	1	2
1	1	0	1	1	1	1	1	1	2	2
2	3	0	1	1	1	2	1	2	1	2
3	5	3	1	1	1	2	1	1	1	2
1	7	0	2	2	1	2	1	1	1	2
4	2	0	2	2	2	1	1	1	1	2
2	1	4	2	3	2	1	1	1	1	2
3	0	0	2	2	1	1	2	1	1	2
1	3	0	1	2	1	2	1	1	1	2
1	3	0	1	2	1	1	1	2	1	2
2	0	0	1	1	1	1	1	1	1	1
4	1	0	2	3	2	1	2	1	1	2
3	2	0	2	2	1	1	1	1	2	2
3	4	0	1	2	2	1	1	1	1	1
1	2	0	1	2	1	2	1	1	1	1
1	1	0	1	1	1	2	1	2	1	2
2	3	0	1	2	1	2	1	1	1	1
3	4	0	2	2	1	1	1	1	1	2
1	2	0	2	1	1	1	1	1	1	2
4	1	0	2	1	2	1	1	1	1	2
2	3	0	2	1	2	2	1	1	1	2
3	5	1	1	2	1	1	2	2	1	2
1	7	0	1	2	1	1	1	1	1	2
1	2	0	1	3	1	1	1	1	2	2
2	1	2	2	2	1	1	1	1	1	2
4	0	0	2	2	2	1	2	1	1	2
3	3	0	1	2	1	2	1	1	1	2

3	3	1	1	1	2	2	1	1	1	2
1	0	0	1	3	1	2	1	2	1	2
1	1	0	1	2	1	1	1	1	1	2
2	2	0	2	2	1	1	1	1	1	2
3	4	0	2	2	1	1	1	1	1	2
1	2	0	2	1	1	2	1	1	1	2
4	1	0	2	2	2	1	1	1	1	1
2	3	0	1	2	2	1	1	2	2	2
3	4	0	1	1	1	1	2	1	1	2
1	2	0	1	1	1	1	1	1	1	1
1	1	0	2	1	1	1	1	1	1	1
2	3	0	2	2	1	2	1	1	1	2
4	5	0	1	2	2	2	2	1	1	1
3	7	0	1	3	1	2	1	2	1	2
3	2	0	1	2	2	1	1	1	1	2
1	1	0	1	2	1	1	1	1	1	2
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3	3	0	2	3	1	1	1	1	2	2
1	0	4	2	2	1	1	1	1	1	2
4	1	0	1	2	2	1	1	2	1	2
2	2	0	1	2	2	1	1	1	1	2
3	4	0	1	1	1	1	2	1	1	2
1	2	0	2	2	1	2	1	1	1	2
1	1	0	2	2	1	2	1	1	1	2
2	3	0	1	1	1	2	1	1	1	2
4	4	0	1	1	2	1	2	2	1	2
3	0	0	1	1	1	1	1	1	1	1
4	5	1	1	2	2	2	1	2	1	2

APPENDIX 16: THE DISTRIBUTION OF THE TREE SPECIES IN UGENYA SUB-COUNTY

Dominant Tree Species	Establishment: Planted = 1, Natural = 2	Varieties: Local=1, Exotic = 2	Tree Phobia: Phobia = 1, Non-phobia =2	Choice and Preference: Preference = 1, No preference = 2	Wards: North = 1, East = 2, West = 3, Ukwala = 4
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	1	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	1	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1

Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1

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Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
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Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1

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Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	1
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Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
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Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	3

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Eucalyptus SPP	1	2	2	1	1
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Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
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Eucalyptus SPP	1	2	2	1	2
Eucalyptus SPP	1	2	2	1	4
Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	3
Eucalyptus SPP	1	2	2	1	1
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Eucalyptus SPP	1	2	2	1	3
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Eucalyptus SPP	1	2	2	1	2
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Eucalyptus SPP	1	2	2	1	2

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Eucalyptus SPP	1	2	2	1	3
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Albizia zygia	2	1	2	1	1
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Albizia zygia	2	1	2	1	3
Albizia zygia	2	1	2	1	1
Albizia zygia	2	1	2	1	1
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Albizia zygia	2	1	2	1	3
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Cupressus lusitanica	1	2	2	1	2
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Diospyros abyssinica	2	1	2	1	1
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Kigelia africana	2	1	1	1	4
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Milicia excelsa	2	1	2	1	4
Milicia excelsa	2	1	2	1	3
Milicia excelsa	2	1	2	1	3

APPENDIX 17: CLEARANCE LETTER FROM THE SGS

MASENO UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Office of the Dean

Our Ref: MA/NS/00123/2014

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 23rd June, 2021 .

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR DAVID OCHIENG ODUOR — MA/NS/00123/2014

The above named is registered in the Master of Arts degree programme in the School of Arts and Social Sciences , Maseno University. This is to confirm that his research proposal tilted "*Effect of Land Use Practices on Dominant Tree Species Diversity in Ugenya Sub-County, Siaya County, Kenya.*" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

MASENO UNIVERSITY 23 JUN 2021

Prof. J. O. Agure
DEAN, SCHOOL OF GRADUATE STUDIES

APPENDIX 18 : CLEARANCE LETTER FROM THE MUERC

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

REF: MSU/DRPI/MUERC/00984/21

Date: 26th November, 2021

TO: David Ochieng Oduor
PG/MA/NS/00123/2014
Department of Geography and Natural Resource Management
School of Arts and Social Sciences
Maseno University
P. O. Box, Private Bag, Maseno, Kenya

Dear Sir,

RE: Effect of Land Use Practices on Dominant Tree Species Diversity in Ugenya Sub-county, Siaya County, Kenya

This is to inform you that **Maseno University Ethics Review Committee (MUERC)** has reviewed and approved your above research proposal. Your application approval number is MUERC/00984/21.The approval period is 26th November, 2021 – 25th November, 2022.

This approval is subject to compliance with the following requirements;

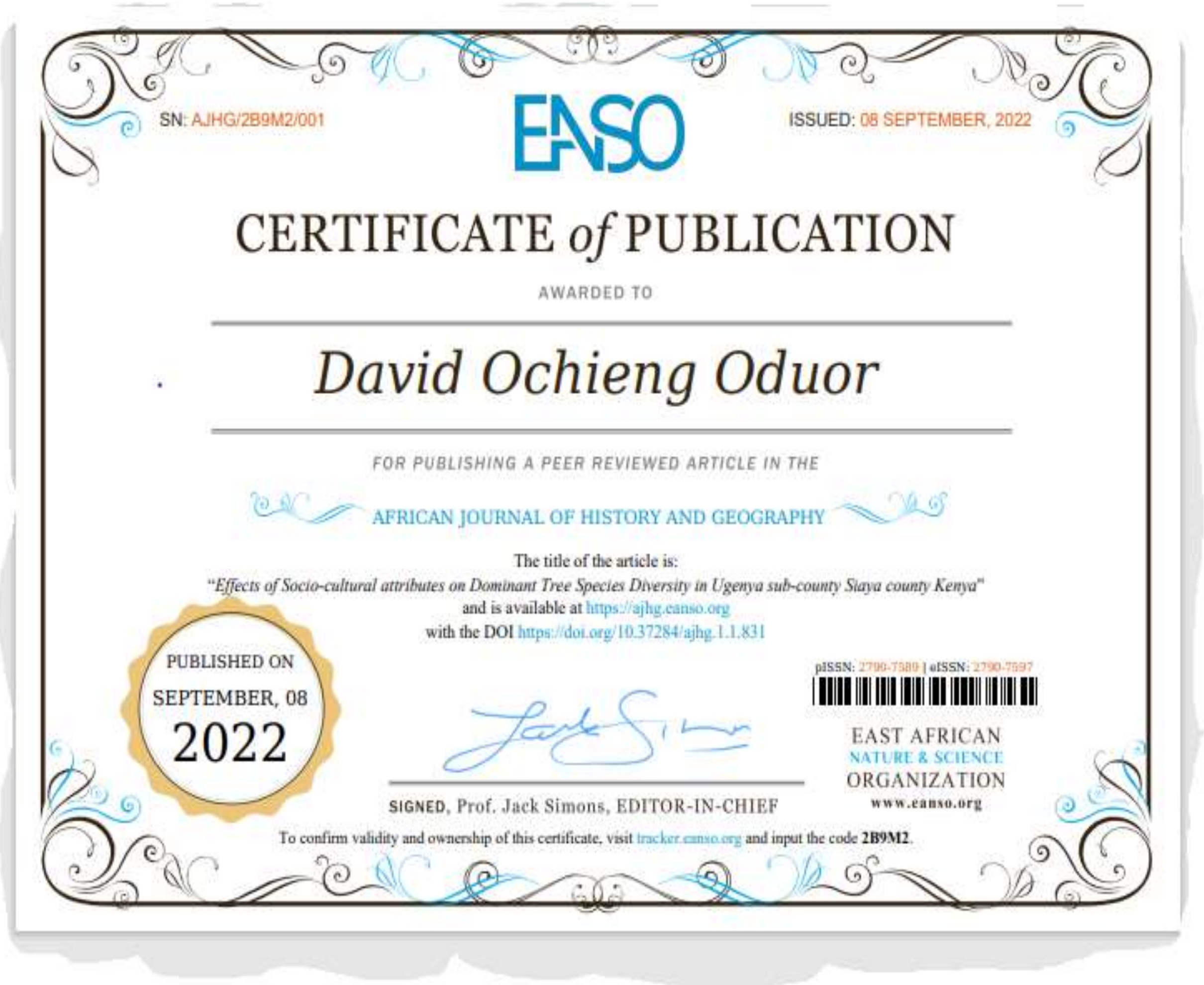
i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by Maseno University Ethics Review Committee (MUERC).
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to Maseno University Ethics Review Committee (MUERC) within 24 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to Maseno University Ethics Review Committee (MUERC) within 24 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to Maseno University Ethics Review Committee (MUERC).

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

MASENO UNIVERSITY
ETHICS REVIEW
26 NOV 2021

APPENDIX 19: THE PUBLICATION CERTIFICATE


SN: AJHG/2B9M2/001

EASO

ISSUED: 08 SEPTEMBER, 2022

CERTIFICATE *of* PUBLICATION

AWARDED TO

David Ochieng Oduor

FOR PUBLISHING A PEER REVIEWED ARTICLE IN THE

AFRICAN JOURNAL OF HISTORY AND GEOGRAPHY

The title of the article is:

"Effects of Socio-cultural attributes on Dominant Tree Species Diversity in Ugenya sub-county Siaya county Kenya"

and is available at https://ajhg.eanso.org

with the DOI https://doi.org/10.37284/ajhg.1.1.831

PUBLISHED ON SEPTEMBER, 08 2022

pISSN: 2790-7589 | eISSN: 2790-7597

SIGNED, Prof. Jack Simons, EDITOR-IN-CHIEF

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

www.eanso.org

To confirm validity and ownership of this certificate, visit tracker.eanso.org and input the code **2B9M2**.

APPENDIX 20: RESEARCH LICENSE NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 340954

Date of Issue: 03/December/2021

RESEARCH LICENSE

This is to Certify that Mr.. DAVID OCHIENG ODUOR of Maseno University, has been licensed to conduct research in Siaya on the topic: EFFECTS OF LAND USE PRACTICES ON DOMINANT TREE SPECIES DIVERSITY IN UGENYA SUB COUNTY SIAYA COUNTY KENYA for the period ending : 03/December/2022.

License No: NACOSTI/P/21/14790

340954

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

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