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Influence of Plant Species Richness on Rural Livelihoods in Kibwezi District of Makueni County, Kenya

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Abstract:
Scholarly work has much been done generally on ecosystem services but still there is dearth of knowledge and information on genetic resources specifically plant species richness and their contribution to people's livelihoods. Despite the presence of variant ecosystems in Kibwezi district, which support variety of plant species, 50.5% of the population lives below the poverty line. However, there is paucity of information on how plant species existing in these ecosystems contribute to the rural livelihoods in Kibwezi district. Therefore, this study focused on the contribution of higher species richness to rural livelihoods in Kibwezi district of Makueni county, Kenya. A Cross-sectional descriptive survey design involving use of purposive and simple random sampling was adopted. Structured questionnaires were used to interview a minimum of 384 households from a study population of 248,704. The results indicated that the district is endowed with 60 higher plant species with a significant high correlation between the higher plant species richness and the area dominated by the plant species and the number of livelihoods supported by the plant species respectively ($r=0.721$, $p<.05$; $r=0.896$,$p<0.5$) . The higher plant species contribute to various livelihoods with a significant high correlation in brick making ($r=.711$), wild fruit selling ($r=.638$) and handcraft selling ($r=.620$) while there was a weak relationship between higher plants species and livestock keeping ($r=.332$) herbal medicine selling ($r=.243$) timber selling($r=.212$) firewood selling ($r=.397$), planted fruit selling ($r=.230$) and charcoal burning($r=.159$). The study concluded that plant species richness enable the residents of Kibwezi district to sustain their livelihoods by getting income from which they acquire basic needs like food, shelter, clothing, paying school fees and other social obligations, hence improving their wellbeing.

Keywords: *Plant Species richness, dominance, Livelihoods, basic needs*

1. Introduction

The well being of every human population in the world is fundamentally and directly dependent on ecosystem services which are processes through which natural ecosystems, and the species that make them up directly or indirectly support humans' survival and quality of life. (De Groot *et al*. 2002; MEA, 2003). Scholarly work has much been done generally on provisioning services like food, fiber and fuelwood. However, little attention has been given on genetic resources which are provisioning services specifically plant species and their contribution to rural livelihoods. A study by Chaposa (2002) noted that the livelihood needs of local people demand for ecosystem services, for instance in dry Miombo forests in Eastern Tanzania, 50% of rural household income was derived from the sale of forest products such as fuel wood, honey, charcoal, and wild fruits. Specifically plant Species richness and the livelihoods derived from these species were not critically examined. WRI *et al*, (2007) and Monela *et al, (*2005), further noted that ecosystems provide services which may be sold for cash or used directly and can be used for performing rituals as customary for people. However, these studies did not clearly highlight how different plant species from these ecosystems can influence various livelihoods form the communities. Despite the variant plant species existing in Kenya's ecosystems, Kenya's poverty line is below the International standard (less than $ 1 a day) and is estimated that 12.6 million people live in rural areas below the poverty line (GoK, 2001). The livelihood needs of the local people demand for ecosystem services (MEA, 2003) like provisioning and yet little is

known on how genetic resources specifically plant species richness contribute to rural livelihoods of the Kenyans especially those living in rural areas. In addition, Kibwezi district, of Makueni county, has variety of plant species existing in the region and yet, there is no known study which has been conducted on the contribution of plant species richness on communities' livelihoods. Therefore, the objective of this study was to establish the contribution of plant species richness to rural livelihoods in Kibwezi district of Makueni county, Kenya.

2. Literature Review

In a fundamental sense, ecosystems are the planet's life-support systems - for the human species and all other forms of life. That is, ecosystems are essential to human well-being for provision of basic needs like food, water, clean air and shelter (WHO, 2005). Ecosystems play a major role in the conservation of biodiversity at the same time as they satisfy other social objectives particularly provision of livelihood benefits to users. For example forest ecosystems provide a great number of species of plants, animals, and microorganisms and the enormous diversity of genes in these species (Joshi, 2009). According to MEA, (2003) millions of people around the world depend partly or fully on natural products collected from ecosystems for medicinal purposes. Persha *et al.* (2009) carried out a study in India on species richness and livelihoods in human dominated landscapes focusing on forest commons and found out that tree species richness and livelihoods were positively and significantly correlated. The study concluded that forest commons in South Asia explicitly managed to contribute to livelihoods for local populations, for example, firewood, fodder and timber. Pantaleo *et al.*, (2011) conducted a research on valley bottoms wetlands as ecosystems which can serve for both biodiversity and local livelihoods improvements and the study concluded that ecosystems such as wetlands host variety of plant species which make appreciable contribution to rural livelihoods in terms of direct cash and contribution to food security. Giliba *et al.* (2011) carried out a study on species composition, richness and diversity in Miombo woodland of Bereku forest reserve in Tanzania focusing on the uses of the trees and shrubs to the villages living near the forest. The study concluded that the Miombo woodland plant species provided various products like wild fruits, firewood, timber, poles and other services to the surrounding communities, hence sustaining the communities livelihoods. However, similar studies needed to be done in Kenya specifically in Kibwezi forest to find out if the forest plant species contribute to the livelihoods of the communities. The fact that many parks today retain higher levels of biological resources than surrounding areas has led some prominent development groups to call on these areas to contribute substantially and directly to rural livelihoods *(Munthali, 2007).* Nasi *et al.,* (2008) found that in Central Africa, for example, bush meat from forest wildlife accounts for up to 80% of protein intake in rural households while in Africa, the livelihood needs of the local people rely on ecosystem services. For example, a study by BowenJones *et al*., (2003) concluded that in the humid and forested areas found in the West and Central parts of the continent, local communities rely mostly on food and raw materials such as non-timber forest products. Mithofer and Waibel (2003) further concluded that in Zimbabwe, improvements in tree yield create incentives for farmers to cultivate indigenous fruits and, that household vulnerability to hunger and poverty can be reduced by 33% during the critical period that occurs between August up to the month of March. Wild foods from various plant species are important locally in many developing countries, often bridging the hunger gap created by stresses such as droughts and civil unrest (Michaelidou *et al.*, 2002). However, it is fairly documented that natural resources are the basis of subsistence in many poor communities from developing countries (Degroot *et al*, 2012; UNEP, 2011). A study by Bennett *et al*. (2009) concluded that there is a strong interaction between human well-being and the state of ecosystem services in the region whereby, many elements of human well-being are directly dependent on the products of ecosystems. A study by McClean *et al*, (2003) on ecosystem services in Uganda showed that, an overwhelming majority of papyrus harvesters in Lake Bunyonyi wetlands sold raw papyrus or crafts made from papyrus to bridge income shortfalls for periodic high expenses such as school fees or end-of-the year festivities. Therefore, despite various researches on ecosystem services, little is unknown on how provisioning services specifically plant species richness influenced livelihoods. Thus, the current study sought to establish the influence of plant species richness on rural livelihoods in Kibwezi district of Makueni county, Kenya.

3. Method

3.1. Study Area

Kibwezi district is located in Eastern region of Kenya at 2°24'40" south of the equator and 37°57'54" east of the Prime Meridian. It is one of the five districts in Makueni county. It has five divisions namely; Mtito Adei, Kibwezi, Makindu, Tsavo west and Chyullu hills game reserve, and fourteen locations namely; Kambu, Mitot Andei, Masongaleni, Chyullu game reserve, Kikumbulyu, Makindu, Kiboko, Ngwata, Nguumo, Nthongoni, Nzambani, Tsavo West, Twaandu and Utithi. Tsavo west national park and Chyullu hills game reserve are found here. The study location falls between 2^0 30' and 2^0 0' and longitudinally falls between 37° 30' East and 38° East. It has an area of 3,985km^2

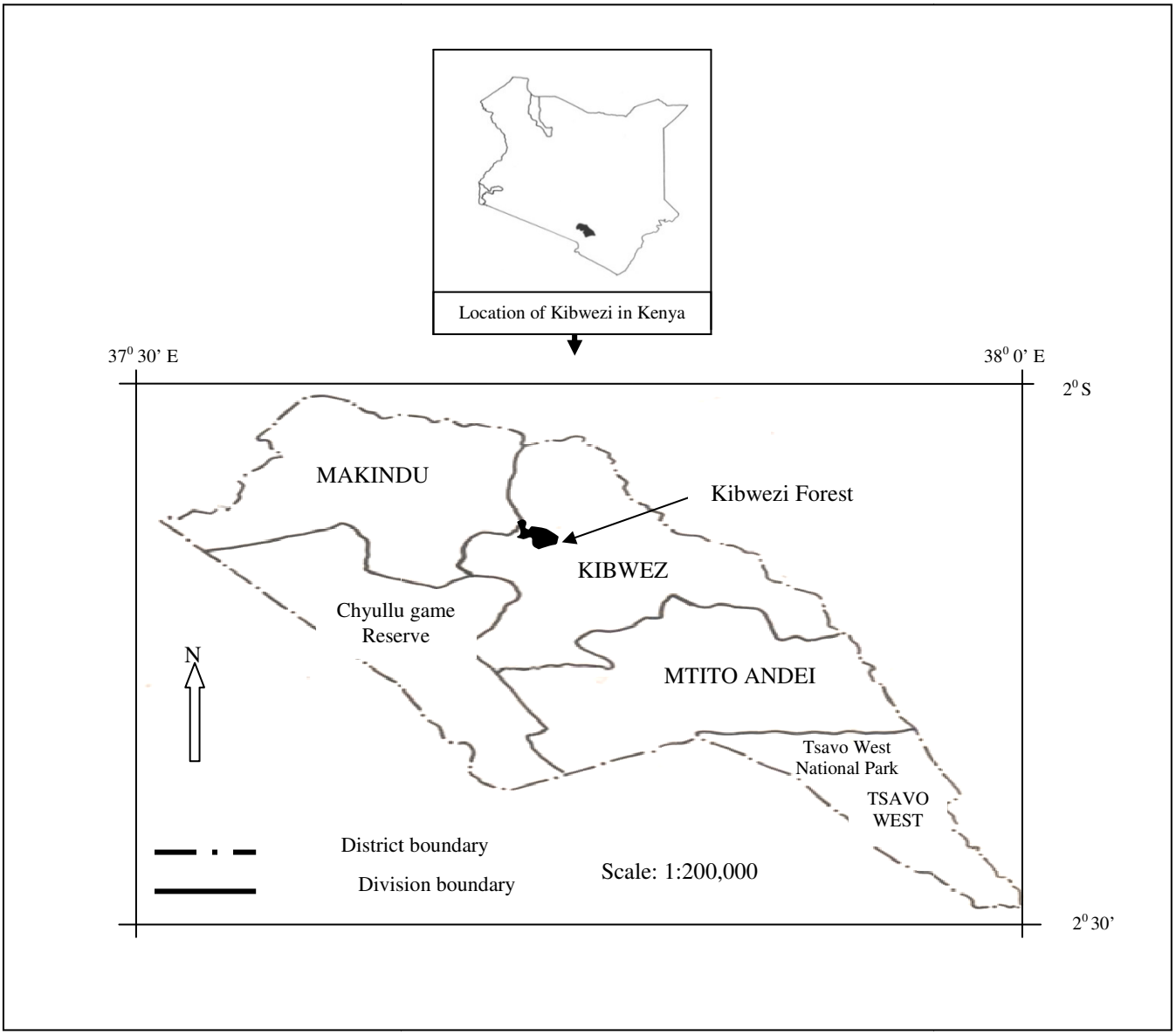

Figure 1: Map of Kibwezi District
Source: Republic of Kenya, 2009

3.2. Study Population, Sampling and Data Collection

A sample size of 384 household heads were selected from a study population of 247,843 persons for the study. The list was generated from a computer randomly. Quantitative data on plant species richness was collected using questionnaires and Key Informant Interviews of 12 persons who included two agricultural extension officers, four KWS officers from Tsavo west national park and Chyullu hills game reserve, two officers from the forest department, one hydrologist, one officer from KALRO, director civic education Kibwezi district and head of Kyai irrigation scheme. The higher plant species were listed in local names (*Kikamba*) while Maundu and Tengnas (2005), was used to identify the plants' scientific names. Field observation and Photograph taking were employed to enhance the quality of the study. Secondary data came from existing published and unpublished documentation.

3.3. Data Analyses and Results Presentation

Qualitative data on types of plant species, their uses, and livelihoods supported by the plant species was analysed by organizing and systematically creating themes, categories and patterns. The qualitative data was re-evaluated to determine the adequacy of the information, the credibility, consistency and the usefulness in answering the research questions. Correlation analysis coefficient (r) was used to establish the relationship between species richness, approximate area dominated by the plants and the livelihoods supported by the higher plant species. The significance level (α) was set at 0.05. The results on the contribution of ecosystem services on livelihoods were described and presented Tables, frequencies, percentages and discussions.

4. Results and Discussion

4.1. Higher Plant Species and Their Uses in Kibwezi District

The study established that Kibwezi district is endowed with species of plants which support the livelihoods of the people in the district. The results are summarised in Table 1 below.

Local Name	Botanical Name	Number of households with the species (%)	Higher Plant Uses
Ikuu	*Commiphora africana*	224 (59.3)	Firewood, poles, fodder for livestock
Itiithi	*Commiphora spp.*	130 (33.9)	Poles, firewood, fodder for livestock
Itula	*Commenila benghalensis*	219 (57.0)	Poles, firewood, fodder for goats and sheep
Kiamba/Muamba	*Adansonia digitata*	162 (42.2)	Fruits, medicine, reeds for basketry
Kiembe	*Magnfera spp.*	218 (56.8)	Fruits, fodder, firewood, charcoal
Kikwasu	*Berchmia spp.*	58 (15.1)	Fruits, hanging bee hives
Kilawa/Mulawa	*Grewia bocolor*	300 (78.1)	Firewood, forage for bees, fodder,fruits
Kiluli	*Boscia angustifolia*	30 (7.8)	Forage for bees, hanging bee hives, fodder for livestock
Kilului	*Balanites aegyptiaca*	176 (46.0)	Fruits, fodder for goats and sheep
Kiongoa	*Combretum paniculatum*	316 (82.3)	Fodder, timber, firewood, charcoal
Kisambalau	*Syzygium cuminii*	64 (16.7)	Fruits, firewood, hanging bee hives
Kisaya	*Bechrmia discolor*	30 (7.8)	Fruits, firewood, forage for bees
Kithea	*Cordia sinensis*	64 (16.7)	Fruits, firewood
Kithiia/Muthiia	*Acacia mellifera*	342 (89.1)	Fencing, posts, fodder for goats and sheep
Kitimu	*Citrus limon*	95 (24.7)	Fruits, medicine, firewood
Kitootoo	*Pachystigma schumannianum*	89 (23.2)	Fruits, firewood, fodder for goats
Kiusya	*Sterculia africana*	84(21.9)	Hanging bee hives, fodder, reeds for basketry, charcoal
Kivau	*Dombeya kirkii*	32 (8.3)	Firewood, reeds for basketry and building
Kivavai	*Asimina triloba*	36(9.4)	Fruits, medicine
Kyaa kyosi	*Combretum schumanii*	45(11.7)	Fodder, charcoal, firewood
Kyooa	*Albizia anthelmintica*	108(28.2)	Firewood, fodder for goats and sheep
Kyuasi	*Lannea schumanii*	113(29.5)	Posts,poles, firewood
Mbaiki/kikaiki	*Acacia thomasii*	98(25.5)	Fodder, firewood, burning charcoal
Mikuswi	*Acacia brevispica*	339(88.3)	Fodder for livestock
Moringa	*Moringa oleifera*	101(26.3)	Medicine, Firewood, fodder
Muange	*Delonita elata*	165(43.0)	Hanging bee hives, reeds for typing, firewood, leaves eaten by goats
Muangi/Baboo	*Delonix elata*	58 (15.1)	Making of tables and mats
Muatine/Kiatine	*Kigelia aricana*	11 (2.86)	Making illicit brew, firewood, hanging bee hives
Mukame	*Neutonia hildbrandii*	141 (36.7)	Making bee hives, hanging bee hives, fodder for goats, timber for carvings
Mukau	*Melia volkensii*	224 (58.3)	Firewood, Medicine, Timber, Fodder for livestock
Mukayau	*Salvadora persica*	275 (71.6)	Firewood, fodder for goats
Mukenea	*Xanthoxylum chalebem*	116 (31.3)	Medicine, charcoal, firewood
Mukokola	*Combretum exalatum*	235 (62.2)	Firewood, fodder for livestock
Mukomoa	*Vangueria volkensii*	57 (15.0)	Fruits, firewood, charcoal
Mukunasi	*Phoenix spp.*	27 (7.0)	Firewood
Mukuyu	*Ficus sycomorus*	26 (07.8)	Fruits, Hanging bee hives
Mulela	*Acacia xanthopholea*	89 (23.2)	Fodder, charcoal, forage for bees, hanging bee hives, firewood
Mung'uthe	*Lonchocarpus*	76 (19.8)	Herbal medicine, firewood

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Munina	*Acacia elator*	26 (07.8)	Charcoal, fodder for livestock, timber
Munoa Mathoka	*Dicrostachys cinerea*	35(09.2)	Firewood, charcoal
Musanduku	*Eucalyptus camaldulensis*	209(54.4)	Timber, firewood, posts
Musemei	*Acacia nilotica*	97 (25.3)	Charcoal, firewood, fodder
Musukulu/Muchola	*Delonita spp.*	180 (46.9)	Firewood, Timber, Charcoal
Muswaki	*Salvadora persica*	15 (04.0)	Medicine
Mutandi	*Ochna inermis*	57 (15.0)	Firewood
Muthuingi	*Ormacarpus kirkii*	65 (17.9)	Firewood
Mutungate	*Commiphora habessinica*	62 (16.1)	Medicine, firewood
Mutungu/Kitungu	*Commiphora africana*	154 (41.1)	Posts, charcoal, fodder for goats and sheep, firewood
Muuku	*Terminalia brownii*	47 (12.8)	Medicine, firewood
Muvingo	*Dalbergia melanoxylon*	124 (32.3)	Timber for carvings, Posts, firewood, charcoal
Muvuaia	*Steganotaenia spp.*	109 (19.4)	Medicine, firewood
Muvuavoi	*Steganotaenia eraliacea*	15 (04.0)	Fodder for goats and sheep
Mwaa	*Acacia tortillis*	337 (87.8)	Timber, Fuel, Fodder for livestock, medicine
Mwalandathe	*Cassia abbreviata*	165 (43.0)	Medicine, firewood
Mwalula	*Croton dichoca*	86 (22.7)	Firewood, charcoal, fodder for goats
Mwaluvaini	*Azadirachta indica*	176 (46.0)	Medicine, firewood, timber
Ndau	*Euphobia spp.*	367 (95.6)	Firewood, fencing poles, medicine
Pine	*Pinus patula*	125 (32.5)	Timber, posts, firewood
Yiulu/Iulu	*Commiphora spp*	342 (89.0)	Timber, Posts, fodder for goats and sheep
Yumbu	*Ficus spp.*	68 (18.4)	Firewood, fodder for goats

Table 1: Higher Plant Species in Kibwezi District in Local names and Botanical names, Households with the Species and Their Uses
Source: Field Data

The study established through household questionnaires and FGDs that the area is endowed with variety of trees and shrubs as shown in Table 1. A total of 60 higher plant species richness of trees were identified. The plant species include both indigenous and exotic majorly trees with few shrubs. Indigenous tree species include *Mwaa* (*Acacia fortillis)*, *Itula* (*Commiphora baluensis)*, *mukayau* (*Salvadora persica), Ndau (Euphobia spp.)Yuilu (Commiphora spp*.) *Kithiia (Acacia mellifera)*, *Mukame* (*Neutonia hildbrandii)*, *Mikokola* (*Combretum exalatum) Ikuu* (*Commiphora Africana) Kiembe (Magnfera spp*.) among other species as seen in Table 1. Exotic tree species include *Musanduku* (*Eucalyptus spp.),* Pine *(Pinus spp.)* and *Grevillea* species. The dorminant higher plant species identified from the study are represented by the highest number of households and they include *Kithiia/Muthiia* (89.1%), *Mwaa* (87.8%), *Ndau* (95.6%), *Yiulu* (89.0%), *Mikuswi* (88.3%), *Mukokola* (62.2%), *Mukau* (58.3%), Itiithi (66.1%) *Musanduku* (54.4%) and *Itula* (57.0%). This implies that the region is covered with variety of trees which are relied on by the residents. The general uses of these plant species include provision for firewood and charcoal, posts and timber for building and construction, wood for making handcrafts, reeds for making baskets for selling, forage for bees, fodder for cattle, goats, donkey and sheep, fencing, hanging of bee hives and provision of wild fruits for food and selling among other uses. The species richness (60) of trees and few shrubs identified in this study compares well with species identified form other regions for example, in a study by Luoga (2000) in Kitulanghalo Forest Reserve, a total of 79 species were identified while a study by Backaus *et al*.(2006) enumerated 86 species found in Ihombwa village in Tanzania.

The findings of this study concur with the findings by Niemeijir *et al.*, (2005) that although drylands ecosystems are sometimes viewed as 'wastelands' they contain species of immense economic and social value and are unique in that they are adapted to survive under extreme environmental conditions. Further, Cavendish (2000) posits that wild resources contribute to rural livelihoods in a number of ways, generally adding to a diversified livelihood portfolio. In support of earlier contentions, Shackleton *et al.* (2008) argued that wild resources can supplement livelihoods through direct provisioning, trade, and in times of hardship they can serve as safety nets. In addition, a study by Madzwamuse *et al.* (2007), concluded that although drylands have fewer species than the tropics or semi-tropics, they are characterised by a high degree of endemism and also contain wild resource products with high use and non-use values. However, these studies based conclusions on wild resources generally while the results of this study specifically revealed that the dry regions of Kibwezi district are endowed with 60 species of higher plants which are used by the local communities for firewood, charcoal burning, timber, herbal medicine, trees for hanging bee hives, forage for bees, fodder for livestock and wood for making handcrafts. Therefore, despite comparatively few plant species numbers from one area to another, the region has higher variety of plant species from which the local communities use them differently to sustain their lives.

4.2. Higher Plant species and Area Dominated by the Species in Acres

The study established that higher plant species dominate different areas of the household's lands in acres. The results are summarized in Table 2. The study established that an approximate acreage of 1-2 was dominated by 95% of the higher plant species with some species (16.6%) dominating large areas as represented by the highest number of the respondents for example *Ikuu* (157), *Kilawa* (177), *Kiongoa* (187), *Mukayau* (123), *Mikokola* (100), *Muthiia* (179) *Muutungu* (107*), Ndau* (241) and *Yiulu* (167). Few (46.6%) higher plant species covered approximate area of below 0.25 acres. This can therefore be interpreted that those higher plant species dominating large areas had more uses by the respondents hence implying that these higher plants supported more livelihoods. This is because the plant species were accessed by the highest respondents as seen from the table 2. House hold questionnaires revealed that those who lived near river Kiboko, Kibwezi and Maangi Uvungu had portions of their lands covered with *Muangi* (*Delonix elata)* species. Through observation, some higher plant species were seen to dominate certain areas than others. For example, *Kiamba/Muamba* (*Andasonia digitata*) species were seen in great numbers in Kinyambu region evenly distributed. The dorminant species observed at Kiboko sub location are *Itula* (*Commiphora baluensis)* which were highly concentrated along Mombasa- Nairobi highway. *Mwaa (Acacia spp.)* were more concentrated in Kathekani sub location in Mtito Andei location and sparsely distributed across the region. A study by Niemeijir *et al.* (2005) concur that plant species are usually low in most rural areas and mainly characterized by low density of species tolerant to arid soil conditions and their composition support variety of livelihoods of the local communities.

A correlation between higher plant species richness and the area in acreage dominated by the higher plant species was undertaken. The total number of plant species were coded on five point Likert scale as follows; **1**=0-11 plant species, **2**=12-23 plant species, **3**=24-35 plant species, **4**=36-47 plant species , **5**=48-59 plant species. This was then correlated with the area covered by plant species through data transformation on approximate areas covered by the species (Table 2) in acreage by assigning codes 1-5 on plant species acreage as follows; **1**= below 0.25 acres, **2**=0.25- 0.50 acres, **3**= 0.6-1.0, **4**=1-2 and **5**=2-3 and above. The results are presented in figure 2.

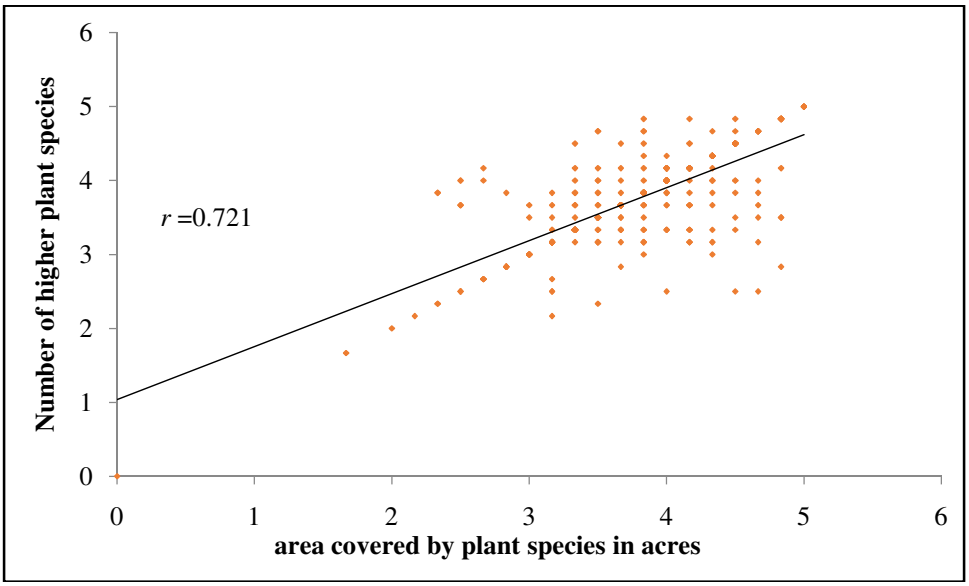

Figure 2: Correlation between Number of Plant Species and Area covered by Plant Species

From figure 2, the correlation analysis yielded to $r = 0.721$. This was high correlation between the area covered by the higher plants and the number of higher plant species richness, which was statistically highly significant at a significant level of 0.05 set for the analysis. According to Hopkins (2002), the effect size of a correlation of 0.7-0.8 is considered to be high. The correlation of r=0.721 established in this study can therefore be considered to have a high influence. Therefore, this implies that the area dominated by species influenced the species richness in that the larger the area dominated, the higher the plant species richness. This can be interpreted further that those households with higher plant species covering large acreages have more plant species, hence have high chances of getting income through various use of these plant species for example selling firewood, burning charcoal, more feeds for livestock, selling posts and timber. The findings of this study conform to the findings by Persha *et al.* (2009) who concluded that in India human dominated landscapes, tree species richness and livelihoods were positively and significantly correlated.

Appendices: Tables

Plant species	Area covered by plant species in acreages						Total number of households having the species F (%)
	Below 0.25 acres	0.25-5.0 acres	0.6-1.0 acres	1-2 acres	2-3 acres	Above 3 acres	
Ikuu	0	14	47	157	23	11	224(100)
Itiithi	5	15	57	77	85	15	254(100)
Itula	1	20	10	74	13	11	219 (75.0
Kiamba/Muamba	1	45	31	80	4	1	162(100)
Kiembe	1	20	109	64	13	11	218(100)
Kikwasu	1	10	18	24	5	0	58(15.1)
Kilawa/mulawa	0	7	25	177	36	55	300(100)
Kiluli	1	1	16	9	3	0	30(100)
Kilului	1	6	57	79	22	11	176(100)
Kiongoa	1	11	36	187	35	46	316(100)
Kisambalau	1	14	18	24	5	0	64 (16.7)
Kisaya	0	3	16	9	1	1	30(100)
Kithea	1	14	18	24	5	0	64 (16.7)
Kithiia/Muthiia	0	8	56	179	14	85	342(100)
Kitimu	0	7	39	32	11	6	95(100)
Kitootoo	0	9	46	24	6	4	89(23.2)
Kiusya	0	12	27	35	10	0	84(21.9)
Kivau	0	4	16	12		0	32(8.3)
Kivavai	1	2	14	16	1	2	36(100)
Kyaa kyosi	1	8	20	12	0	4	45 (11.7)
Kyooa	0	23	20	60	5	0	108(100)
Kyuasi	0	21	25	44	20	3	113(100)
Mbaiki/Kikaiki	2	8	40	32	11	5	98 (25.5)
Mikuswi	1	8	20	12	0	4	45(100)
Moringa	0	12	46	32	4	7	101(100)
Muange/Kiange	0	12	73	56	12	12	165 (43.0)
Muangi	1	10	18	24	5	0	58(100)
Muatine/Kiatine	0	6	5	0	0	0	11 (2.86)
Mukame	0	10	68	49	10	4	141(100)
Mukau	7	12	83	52	48	22	224(100)
Mukayau	2	28	76	123	21	25	275(100)
Mukenea	0	21	57	43	10	5	116(100)
Mukokola	3	30	82	100	12	8	235(100)
Mukunasi	0	1	17	8	1	0	27(100)
Mukuyu	0	15	3	7	1	0	26 (7.8)
Mulela	0	9	46	24	6	4	89(100)
Mung'uthe	0	1	19	31	26	8	76(100)
Munina	0	5	7	10	2	2	26(100)
Munoa mathoka	0	7	16	12	0	0	35 (09.2)
Musanduku	2	12	60	89	33	3	209(100)
Musukulu/Muchola	1	17	79	60	14	9	180(100)
Musemei	0	9	40	34	6	8	97(100)
Muswaki	2	12	1	0	0	0	15 (4.0)
Mutandi	1	10	18	24	5	0	57 (15.0)
Muthuingi	0	5	23	10	19	8	65(100)
Mutungu/Kitungu	0	6	28	107	5	8	154(100)
Muuku	1	5	21	12	8	0	47(100)
Muvingo	1	9	64	34	9	7	124(100)
Muvuaia	0	23	20	60	4	0	109(19.4)
Muvuavoi	2	10	3	0	0	0	15(4.0)
Mwaa	0	19	97	69	67	85	337(100)
Mwalula	0	12	27	36	10	1	86(100)
Mwalandthe	2	17	74	45	15	12	165(100)
Mwaluvaini	0	12	73	56	12	12	165(100)
Ndau	5	38	54	241	21	8	367(100)
Pine	1	9	64	35	9	7	125(32.5)
Yiulu/Iulu	0	14	25	167	51	85	342(100
Yumbu	0	5	26	10	19	8	68(18.4)

Table 2: Higher Plant Species and Area Dominated by the Species in Acres
Source; Field Data

4.3. Influence of Plant Species Richness on Livelihoods

The households were told to list the various activities supported by different types of plant species found in their lands which contributed to their livelihoods. Evidences from questionnaires, FGDs and observations identified several livelihoods supported by the plant species in Kibwezi district. Table 3 shows a summary of various livelihoods supported by the plant species richness in Kibwezi district**.**

Type of Livelihood	Total Number of Households	Percentage (%)
Brick Making	22	5.7
Wild Fruit Selling	31	8.1
Livestock Keeping	85	22.1
Bee Keeping	39	10.2
Timber/posts Selling	86	22.4
Planted Fruit Selling	26	6.8
Charcoal Burning	14	3.6
Firewood Selling	31	8.1
Herbal Medicine selling	14	3.6
Handcraft Selling	36	9.4
Total	**384**	**100**

Table 3: Livelihoods Supported by Plant Species in Kibwezi District
Source; Field Data

The study revealed that timber /post selling (22.4%) and livestock keeping(22.4%), are majorly supported by plant species, bee keeping (10.2%), firewood selling (8.1 %), hand craft selling (9.4%), planted fruit selling (6.8%), wild fruit selling (8.1%), brick making (5.7%), herbal medicine selling (3.6%) and charcoal burning (3.6%). This implies that the respondents in the study area rely on these plant species for various goods and services such as food, fodder, fibre, medicine which lead to various livelihoods from which they get income to acquire basic needs. A correlation between higher plant species richness and the types of livelihoods supported by these species was further undertaken. The results are summarized in table 4.

		1	2	3	4	5	6	7	8	9	10	11
1	Higher Plant Species	1	.711**	.638**	.332**	.233**	.243**	.212**	.230**	.159**	.620**	.397**
2	Brick Making	.711**	1	.258**	.358**	.158**	.162**	.294**	.346**	.123*	.439**	.360**
3	Wild Fruit selling	.638**	.258**	1	.127*	0.065	.110*	.170**	.162**	0.009	.378**	.173**
4	Livestock Keeping	.332**	.358**	.127*	1	.325**	.281**	.232**	.287**	.262**	.300**	.396**
5	Bee Keeping	.233**	.158**	0.065	.325**	1	.224**	.200**	0.04	.142**	.220**	.212**
6	Herbal Medicine	.243**	.162**	.110*	.281**	.224**	1	0.053	0.03	.167**	.181**	.183**
7	Timber/post Selling	.212**	.294**	.170**	.232**	.200**	0.053	1	.317**	.219**	.167**	.287**
8	Planted Fruit Selling	.230**	.346**	.162**	.287**	0.04	0.03	.317**	1	.182**	0.083	.484**
9	Charcoal Burning	.159**	.123*	0.009	.262**	.142**	.167**	.219**	.182**	1	.111*	.667**
10	Handcraft Selling	.620**	.439**	.378**	.300**	.220**	.181**	.167**	0.083	.111*	1	.251**
11	Firewood Selling	.397**	.360**	.173**	.396**	.212**	.183**	.287**	.484**	.667**	.251**	1
	**. Correlation is significant at the 0.01 level (2-tailed).											
	*. Correlation is significant at the 0.05 level (2-tailed).											

Table 4: Correlations between Higher Plant Species and Types of Livelihood Supported

The results in table 4 indicate that there is a significant high correlation between higher plant species and brick making (r=.711, p<.01), Wild fruit selling (r=.638, p<.01) and handcraft selling (r=.620, p<.01) while there was a weak relationship between higher plants species and livestock keeping (r=.332, p<.01), herbal medicine selling (r=.243, p<.01), timber selling(r=.212, p<.01), firewood selling (r=.397, p<.01), planted fruit selling (r=.230, p<.01) and charcoal burning(r=.159, p<.01). However, this relationship was statistically significant since the set significance level was 0.05 for the analysis. This therefore implies that higher plant species richness in the region supported the livelihoods done by the people in Kibwezi district. The findings of this study conform to the study by Persha *et al.* (2009) who found out that in India, tree species richness and livelihoods were positively and significantly correlated. Further correlation was established between the relationship between higher plant species and the number of livelihoods supported. The results are presented in the figure 3.

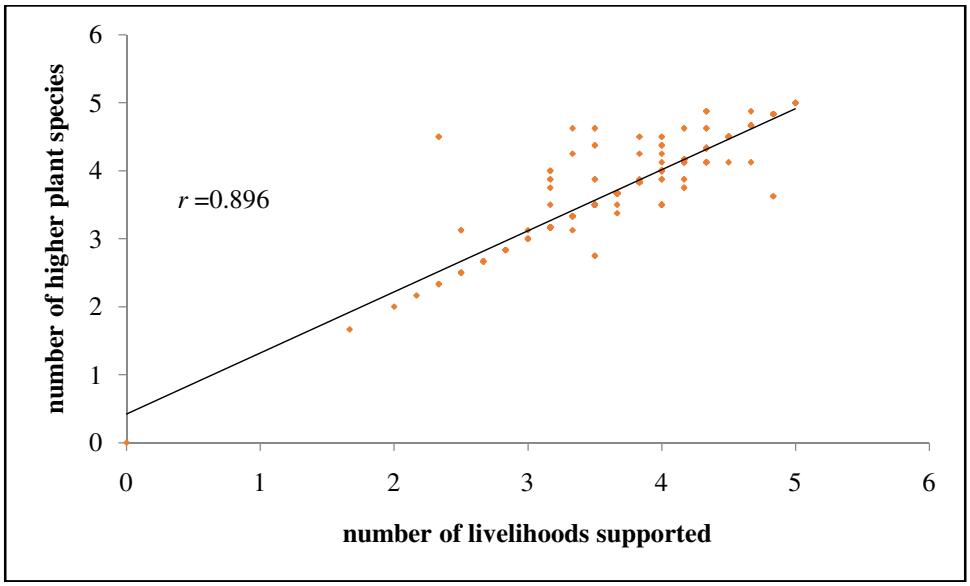

Figure 3: Correlation between Number of Higher Plant Species and Number of Livelihoods Supported.

Figure 3 shows that the dots are clustered along the line of best fit meaning that there is a high correlation between the number of higher plant species richness and the number of livelihoods supported. From the figure, the correlation analysis yielded to $r = 0.896$. This was a high relationship and was statistically significant in that, increase in the number of higher plant species richness led to increase in the number of livelihoods supported. Similarly, the correlation of $r = 0.896$ established in this study can therefore be considered to have a high influence. Therefore, this can be interpreted that higher plant species influenced the number of livelihoods supported in that the higher the number of higher plant species, the more the number of livelihoods supported. Thus, those households with high number of higher plant species richness could use them on several ways hence deriving more livelihoods from them.

The findings agree with the findings of Nyariki and Ngugi,(2005) that ecosystems in rural areas yield a wide variety of useful products such as timber, fuelwood, charcoal, wild fruits, gums, resins, honey, and traditional herbal medicines whereby the revenues collected from the sale of these products and services contribute significantly to livelihoods of the local people. Further Nyariki and Ngugi (2005), established that rural drylands support variety of livelihoods activities like apiculture, poultry keeping and the inherently or potentially extractive livelihoods, which include activities such as timber production, woodcarving, brick making, stove making, pottery making, sand scooping, and charcoal making. The various livelihoods are subsequently discussed below.

4.3.1. Fuelwood selling

The study revealed that 3.6% of the respondents confirmed that firewood is sold in the study area as a livelihood. Further, correlation analysis yielded r=.397, p<.01 and this was a low relationship which was statistically significant. This implies that higher plant species richness in the region influenced fuelwood selling. The study established that Firewood is collected from various plant species found in the region. Some of the species used for firewood include *muthulu (Croton megalocarpus) Mukame (Hildebrandtii*) *Ndau (Eucalyptus grandis)* and *Musanduku* (*Eucalyptus camaldulensis*) among others. Household interviews revealed that firewood in Kibwezi location is majorly collected in Kibwezi forest and only women are allowed to get inside the forest for only those with monthly firewood license. Each is supposed to carry dead fallen and dry trees. Each pays Kshs. 100 per month and is only allowed to carry 1 head load (for 5 days in a week) for consumption or local sale. One head load is sold at Kshs. 100. A total of Kshs. 500 is realized within 5 days and Kshs.2, 000 a month. Firewood is sold to customers from the market centres that operate hotel businesses and also to individual urban dwellers who are unable to purchase other sources of fuel for example kerosene, electricity and gas. Firewood is also sometimes sold inform of an ox-cart which sells at Khs.300 or 20 big pieces of wood tied together each costing Kshs. 5, totalling to Kshs. 100 per load. The income obtained is used to acquire basic family needs like food, clothing, shelter and medicine. Previous studies by Wuver and Attuguayefio (2006) and Ghana and Korem (1985) concur with this study that fuelwood is used by 81.7 % of people and is the energy source of choice for majority of rural and urban people because of its availability, relative cheapness and easier to use. Further, Amous (1997) concur that Fuelwood is used predominantly at the household level, for cooking and heating and may constitute a sizable proportion of the energy consumed in many dryland countries for example, 57% in Senegal in 1999. Therefore this study conclude that plant species in dry areas of Kibwezi contribute significantly to household income of the residents through selling of firewood from which income is obtained to supplement basic needs for the family.

4.3.2. Charcoal burning

The study revealed that charcoal burning is a livelihood done by the respondent in the study area (3.6%) and a correlation analysis yielded to r= .159, p<.01 (Table 4). This implies that there was a low relationship and was statistically significant. The study revealed that charcoal burning is also a source of wood fuel obtained though burning various plant species found in the region. Interviews revealed that some species for example Mwaa *(acacia tortilis*), Mukame *(hildebrandtii*) Muuku (*terminalia brownie*) Mukenea (*Zanthoxylum chalybeum*) Munina (*Acacia elator*) and Mulela (*Acacia xanthopholea*) are well known for a excellent

charcoal production. Figure 4 show charcoal being produced and packed charcoal for sell at Mbui Nzau market next to Makindu town along Nairobi Mombasa highway and charcoal burning at Masimbani sub location in Kibwezi location.

Figure 4: Charcoal ready for sell at Kinyambu market along Mombasa-Nairobi highway

Through observation, charcoal is majorly sold along the Nairobi –Mombasa highway to the travellors and also sold locally in the market centres of Makindu, Kiboko, Kibwezi, Mbui Nzau, Mtito andei and Kinyambu. The study established that a sack is sold at Kshs. 600 and in a day one is able to sell about 5 sacks realizing a total of Kshs. 3,000. The income raised is used to acquire family basic needs like food, clothing, paying school fees and other social obligations. Fuelwood collection is a known cause of environmental degradation (Khan *et al.,* 1994). However, interviews with Kibwezi forest Officer revealed that mechanisms have been put in place to ensure the environment is not degraded. For example, Kibwezi Charcoal Products Association is a self help group from Mikuyuni sub-location in Kibwezi location to bring people to benefit from charcoal production as they protect the environment. This association educates people how to grow trees and produce charcoal within their homes. It controls charcoal burning and tree destruction in the exciting natural forest. The group is legally established under forest Act on Charcoal Production Rules 2009.

The findings of this study agree with Arku *et al.* (2008) who reported that approximately 80% of households in two low income neighborhoods of Accra use charcoal and/or wood as their primary source of energy. Further, a study by Niemeijer *et al.* (2006) concur that where dryland ecosystems support woody vegetation especially in Africa, where open savanna predominates, they contribute to national economies by providing fuelwood and charcoal for energy which supports livelihoods of the people. For example, 70% of national energy in the Sudan; 74% of total energy consumption in Kenya, where charcoal is equal in value to horticultural products and only second to tea among marketed agricultural products. Further, a study by Mwakatobe *et al,* (2005) content that in Eastern African region charcoal is their main source of household energy , and it accounts for over 90% of their energy consumption. Therefore, charcoal burning is an income generating activity to some residents of Kibwezi district since the local people in Kibwezi district use charcoal as a source of energy and this charcoal is obtained from variety of plant species growing locally in the household farmlands and other ecosystems in the region.

4.3.3. Livestock keeping

Livestock keeping is a major source of livelihood in the study area as depicted in Table which is confirmed by 22.1% of the respondents and there was a moderate relationship between livestock keeping and higher plant species in the region($r=.332$, $p<.01$). The study established that indigenous species are kept by the households in the study area which include cattle, sheep, goats and donkeys. that these animals feed on various trees and shrubs for example *Mwaa* (*Acacia spp.)* a tree which bears fruit eaten by sheep, cattle, goats and donkeys, *Mukuswi* (*acacia brevispica*) *Mulului* (*balanites aegyptica*) a shrub which provides pods which are good fodder for goats and cattle while *Salvadora persica* leaves and fruits are important fodder for goats. *Kiamba (Adansonia digitata)* leaves are used as fodder for goats and cattle and *Muangi* (*Delonix elata*) provides for fodder all livestock. These animals are grazed freely in the household lands from morning and back to their sheds in the evening. These animals provide products like meat, milk, hides and skin which are sources of income to the keepers.

The findings agree with the findings by Niemeijir *et. al*. (2005) who concluded that the rural drylands in China are home to 78 million cashmere goats which supply 65-75% of the world's cashmere fibre; and in Mongolia, grazing of livestock in the dry lands support pastoralism which provide 30% of GDP. Further, Niemeijir (2005) found that in Kenya, 50% of the land is too dry for farming but suitable for livestock where over 60% of the national livestock herd is found with the sector employing about 50% of the labour force who get income to acquire basic family needs like food, clothing and shelters and other social expenses like medical and educational costs. Further, the findings conform to the assertion by FAO (2002) that in the region of Niger, on the border of the Sahara, the rangeland ecosystems support livestock production which contributes 46% of local household income. Many tree and shrub species are also important feed resources in dry areas, especially for goats. Kidane (2005) also found that major species browsed for forage in Ethiopia are *Acacia senegal (*Wild), *Acacia tortilis* (Forsk.), *Balanites aegyptiaca (*Hayne), *Bauhinia rufescens (*Delile), *Combretum aculeatum (*Lam) and *Colophospermum mopane (*Vent*).*

4.3.4. Timber/Posts selling

The study established that 22.4 % of the respondents sell timber/ posts as a livelihood and there was a low relationship between this livelihood and the higher plant species richness in the region which yielded $r=.212$, $p<.01$ (Table 4). This implies that despite the low correlation, the species richness in the study area influenced timber/post selling as a livelihood. The study established that some of the

species use to produce timber include *Muthiia* (*Acacia mellifera*), Mulului (*Balanites aegyptica)* which is known a termite resistant timber. House hold questionnaire revealed that *Muvingo* (*Dalbergia melanoxylon)* is known to be an excellent hard wood which produces very valuable timber for furniture while *Muuku* (*Terminalia brownie*) which provides hard durable timber and poles and *Terminalia prunioides,* is a hard and durable wood for building house which is resistant to termites. Selling of timber depends on the type of species and the size of the tree. Interviews with a timber seller revealed that approximately timbers are sold by measuring with a foot which costs Kshs. 16 – 30 depending on the type of the wood. Hard wood costs higher that the soft woods while the sawdust is sold at Ksh. 50 per bag. Further interviews with an agricultural officer in Makindu revealed that products such as timber suffer little seasonal price fluctuations compared to crops or livestock and tree products such as poles and timber can be stored easily and hence offer less risks compared to perishables such as most agricultural products. Figure 5 shows a farm planted with a hard wood species *Mukau* (*Melia volkensii*) for timber production.

Figure 5: Plant species of Mukau (Melia Volkensii) planted for Timber harvesting in Kibwezi sub-location

The Figure above show *Mukau* (*Melia volkensii*) which is an indigenous tree found in most parts of Kibwezi location. Interviews with officer from KEFRI in Kibwezi revealed that in Kenya, the tree grows naturally in several districts such as Makueni, Taita, Taveta, Kitui, Mwingi, Mbeere, Tharaka and Mandera where it is known by different common names such as *Mpenda bure* (Kiwsahili), *Kirumbutu* (Taita), and *Mukau* (Kamba, Mbeere, Tharaka). Further interviews revealed that *Melia* is a high value timber tree whose timber compares favourably with camphor and Meru oak. The timber is close grained, termite resistant and mostly used for making high value furniture, window and door frames, rafters and poles**.** The approximate gross income in Kshs. from 1 ha of *Melia volkensii* is 3million shillings. Although some farmers do not have title deeds to their lands, still due to relatively low population density, farmers have large tracts of land which can be used for establishment of *Mukau* woodlots. Further green grams, beans and cowpeas are easily intercropped in to *Mukau* woodlot to ensure food security. Some farmers have planted on more than 25acres (10 hectares).
This study conform to the assertion by Mwaburi and Musyoki (2011) that economic empowerment for the people living in the drylands lies in diversification and investment in low risk high return economic activities adaptable to climatic conditions of the area and that high value trees are a sound investment in the drylands and can be used in time of need. Ndengwa (2013) content that some indigenous plant species in dry areas of Kenya currently major sources of household income since the net present value of investing in an acre of *Mukau* woodlot stands at Ksh112,789 or US$ 1,327 with the internal rate of return of 42%. This is 1.6 to 4 times higher than the net present values of growing major crops every year which have the high probability of failure.

4.3.5. Wild Fruit Selling

The study revealed that gathering of wild fruits for food and selling is a livelihood in the study area as asserted by 8.1 % of the respondents. The correlation analysis yielded to r=.638. This was a high significant relationship with a set significance level of 0.01 for the analysis. This implies that the higher plant species influenced wild fruit selling as a livelihood in the study area. The study established that wild fruits are gathered from various plant species which include *Kiamba/* Baobab (*Adasonia digitata*) which provides fruits locally known as *Namba* (*Kikamba*) and *Mabuyu (Kiswahili*), *Mulului* (*Balanites aegyptiaca)* provides fruits locally known as *Ndului, Kisaya (Bechrmia discolour)* provides fruits known as *Nzaay*a (Kikamba), *Kithea* (*Cordia sinensis)* provides fruits known as *Nthea* (Kikamba), *Kithumula* (*Tamarindus indica*) provides *Nthumula* and *Kikwasu* which provides *Ngwasu.* Figure 6 shows *Namba* fruits being displayed for sell in Mtito Andei Town.

Figure 6: Namba Fruits (Adasonia digitata) displayed for sell at Mtito Andei town in Kibwezi district

These fruits are fed and sold locally by the locals especially during dry spells. House hold questionnaires revealed that Baobab (*Adansonia digitata*) locally called *Muamba/Kiamba* is the most widespread of the *Adansonia* species in most parts of the district and county at large. Interviews with Mtito Andei ward representative revealed that the species is mostly spread in parts of Eastern and Coast provinces of Kenya. Interviews further reported that the tree is well know but under estimated tree which is long living like 3,000 years. The tree bears fruit that is 15 to 20 cm long and has twice as much calcium as milk, is high in anti-oxidants, iron and potassium and has six times more vitamin C than orange. The leaves can be eaten as relish, while the fruit powder dissolved in milk or water and used as a drink. The powder is also dissolved in porridge to make it taste sour. The seeds also produce edible oil.
The findings agree with findings that wild harvesting of fruits from forests and semi domesticated trees growing on-farm and homesteads can substantially boost rural income and employment opportunities in Africa (Leakey *et al.*, 2005; Ruiz-Perez *et al.*, 2004). Market and financial analyses in southern Africa show that indigenous fruits contribute to household income, and women and children are the major beneficiaries (Ramadhani, 2002). Indigenous fruits form a staple food during the hunger periods in the agricultural cycle. Another study in Malawi, Mozambique and Zambia revealed that 26-50% of rural households relied on indigenous fruits as a coping strategy during critical seasonal hunger period which usually lasts for three to four months per year. The fruit trees ripen at different times of the year and can be targeted to meet the food needs of rural household (Akinnifesi *et al.* 2004). The Marula tree (*Sclerocarya birrea*) in the Miombo ecosystem of Southern Africa is the source of a popular product known as *Amarula cream* which is sold to 63 countries in the world while in Zibambwe, the share of market margins for selling *U. kirkiana* fruits was estimated at 32-45% for collectors, 53% for retailers, and 2% for wholesalers. Therefore, wild gathering of fruits and selling is a livelihood which support the residents of Kibwezi area with some specific plant species being of significant use to the people.

4.3.6. Hand Craft Selling

The study established that 9.4% of the respondents confirmed that plant species in Kibwezi district support craft making activities and the contribution of the higher plant species richness on handcraft selling was highly significant in ($r=.620, p<.01$). This implies that higher plant species influenced highly hand craft selling as a livelihood in the study area. Figure 7 below display various handcrafts for selling.

Figure 7: Carvings displayed for sell at Mtito Andei Town in Kibwezi Location.

The suitable species include *Dalbergia melanoxylon* also referred to as African black wood locally called *Muvingo,* or black ebony. Trees for carvings are harvested when they are mature and according to one of the handcrafts respondent, certain species are

designated for specific uses to prevent overexploitation for example, *Mellia volkensii* is harvested for mortar while *Dolbergia melanxylon* for carving trophies. Others species like *Newtonia hildebrandtii* locally known as *Mukame* provides red wood for carvings, while *Delonita elata* locally known as *Muange,* and *Zanthoxylum chalybeum* locally known as *Mukenea* are best for home furniture like Table and chairs. Previous study by Yilma and Kim (2003) in Ethiopia concur that that some people form Ethiopian communities make a living from collecting craft materials from the wetlands an making carvings from trees from forests in Western Highlands which they either sell or use to make craft items for sell hence generating income for their families. Therefore, plant species found in the various ecosystems of Kibwezi are used to for carvings which are sold locally or to highway tourists leading to generation of household income.

4.3.7. Bee Keeping

Beekeeping is a livelihood practiced by some respondents in Kibwezi region as asserted by 10.2% of the respondents (Table 4) and has a low statistically significant relationship with plant species ($r=.233. p<.01$). This implies that the higher plant species support this livelihood this livelihood in the region. Bee keeping is done in forests and bushes around the homes and those with permit practise it in Kibwezi forest. The bees suck nector from different flowers of various plant species in these forests. Though household interviews, the study established that various plant species are used for making the beehives for example *Mukame (Neutonia hildbrandii) Muange (Delonita elata)* and *Mwala Ndathe* (*Cassia abbreviata*) while the preferred species for hanging the beehives are Mwaa (*Acacia spp.), Mukuyu* (*Ficus spp.), Kiusya (Sterculia Africana),* Mukame (*Neutonia hildbrandii), Kiluli (Boscia angustifolia*) and *Kikwasu (Berchmia spp.)* because these trees are huge and the nector from their flowers is highly preferred by bees. Acacia trees are also preferred because they occur in some regions in high density. The Figure below displays bee hives hanged on a Mukame (*Neutonia hildbrandii)* species.

Figure 8: Bee hives hanged on a Mukame (Neutonia hildbrandii) Species in Kathekani sub-location

Whether sold fresh at village level or in sophisticated packaging, honey generates income to households. One Kg of honey is sold at Kshs.500 (1000 mls), half Kg at Kshs.250 (500 mls) and a quarter Kg at Kshs.120 (250 mls). House hold interview with a honey seller revealed that a minimum Kshs. of 5, 000 to Kshs. 8,000 is realised in a good day (many customers). The income raised is used to cater for the family needs like paying school fees, health care and other basic wants. Honey harvested in Kibwezi district is generally liked for its good quality and organic nature i.e. lack of chemicals.

A study by Timilsina (2007) concur that ecosystems services play a critical role in sustaining natural resources and livelihoods of local people and Mwakatobe, and Mlingwa, (2005) also content that in Malawi an estimate of US $ 1.7million was generated each year from the sale of honey and bee wax which also employs about 2 million rural people. Further the study conform to the assertion by Lemessa (2007) reported that the farmers in Somali Regional states in Filtu and Dollo Ado districts also boldly mentioned that beekeeping contributes about 4% to their livelihoods. Thus beekeeping activity relies much on ecosystem services in the sense that the whole process can not be achieved without having logs for making of beehives, hanging site, flowers and bees which all are either products or services from the ecosystem. Wild or cultivated areas, wasteland and even areas where there may be land mines all are ecosystems and have value for beekeeping.

4.3.8. Brick Making

Brick making is another livelihood practised by 5.7% of the respondents in the study area with a high significant relationship with higher plant species ($r=.711, p<.01$). this implies that higher plant species influenced brick making as a livelihood in the region. The study revealed that brick making takes place near the water points especially the along the riverbanks. The process involves preparing soil using shovels and jembes then adding water to make the soil sticky. This mixture is them left for 2-3 days and on top is covered with vegetation which includes tree leaves, grass, and twigs which are all obtained from the environment. The sticky soil model is moulded using a rectangular wooden box joined by wooden scapers of different sizes which is prepared using wood from *Mukame* (*Neutonia hildbrandii*) or *Mukau* (*Melia volkensii*) and sometimes *Itula* (*Commiphora baluensis)* . The moulded bricks are

lefts to dry under the sun for 5-6 days while still covered with the vegetation. Finally a kiln is built which burns the bricks until they turn red colour. The brick are burned using maize husks and firewood. The study established that for the bricks to turn red in colour which ensures durability, firewood is preferred which include indigenous species like *Mukokola (Combretum exalatum*), *Itungu* (*Lannea alata), Mukalawa* (*Grewia spp) and Mbaiki (Acacia thomasii) and Muthiia (Acacia mellifera*) which are strong enough to burn for 5 days when wet. All these species are cut from the bushes and forests of individual households. More firewood is added depending on the intensity of wind. Brick making is done for income generation. Each brick is sold at Ksh.4 and the amount collected is used to cater for family essential needs. The study revealed that each brick is sold at Kshs. 5 and one brick furnace produces around 20,000 bricks. Therefore a total of Kshs.100, 000 is realised by the end of the process. These brick are sold to customers within the community and in towns which they use to build permanent houses. Interview further revealed that the brick makers are encouraged to reveal the holes they scoop soil and plant more trees so as to protect the environment and use these trees when mature to burn the bricks

The findings of this study therefore concur with Yilma and Kim (2003) that wetland ecosystems are preferred areas for brick making for household income generation for example in Jimma Zone where urban growth is most rapid and bricks are in demand for construction of permanent buildings. This study therefore established that brick making is a livelihood which relies on various plant species in the region from which income is raised for essential needs in the family.

5. Conclusion

Higher plant species found in Kibwezi forest, and resident's farmlands are the major sources of income generating activities (livelihoods) for the people of Kibwezi district. These livelihoods include livestock keeping, wild fruit selling, handcraft selling, bee keeping, timber and posts selling, charcoal burning and firewood selling. Based on the results and subsequent discussion, these ecosystems provide services which play a key role on maintaining local people's lives and wellbeing since the local people earn some cash/ income which they need to support their daily lives. This cash is used for buying food, clothes (basic human needs), paying for school fees and other accompanied expenses in human daily life.

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7. References

i. Akinnifesi, F.K., Kwesiga, F., Mhango, J., Chilanga, T., Mkonda, A., Kadu, C.A.C., Kadzere, I., Mithofer, D., Saka, J.D.K., Sileshi, G., Ramadhani, T. and Dhliwayo, P. (2006). Towards the development of miombo fruit trees as commercial tree crops in southern Africa, Forests, Trees and Livelihoods 16:103-121.
ii. Amous, S. (1997) "The Role of Wood Energy in Africa", Forestry Department, Food and Agricultural Organization of the UN (Website of the FAO, 1997).
iii. Arku R.,E, Vallarino J, Dionisio K., L, Willis R, Choi H, Wilson J.,G, Hemphill C. and AgyeiMensah S. (2008). Characterization of air pollution in two low income neighborhoods in Accra, Ghana. Science of the Total Environment, 402(23), pp 217 – 231
iv. Backeus I, Pettersson B, Strömquist L, Ruffo C. (2006). Tree communities and structural dynamics in Miombo (Brachystegia-Julbernadia) Woodland, Tanzania. Forest Ecology and Management, 230: 171 - 178.
v. Bennett, E. M., Peterson, Garry D. and Gordon, Line, J. (2009) "Understanding relationships among multiple ecosystem services." Ecology Letters 12: 1394-1404.
vi. BowenJones, E., D. Brown, D., and E.J. Robinson, E.J. (2003) Economic commodity or environmental crisis? An interdisciplinary approach to analyzing the bush-meat trade in central and West Africa Area, 35 (2003), pp. 390–402
vii. Cavendish, W. (2000). Empirical irregularities in the poverty-environment relationships of rural households: Evidence from Zimbabwe. World Development, 28 (11): 1979-2003
viii. Chaposa, M. (2002). Charcoal Potential in Southern Africa. Final report. EU/Sida. 304:47-77
ix. De Groot, R., Brander, L., vanderPloeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C, Tenbrink, P., Vanbeukering, P. (2012). Global estimates of the value of ecosystems and their services in monetary units. EcosystemServices1:50–61.
x. De Groot, Rudolf S., Matthew A. Wilson, Roelof M.J. Boumans (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services; The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives, Ecological Economics; 41: pp 394-404.
xi. Egoh, B. N., Patrick J., Charef A., Josephine G., Koellner T., Henry N.A., Egoh M., and willemen L. (2012). An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods; Ecosystem Services vol.2:71-81
xii. Giliba, R. A., Boon ,E. K., Canisius, J. K., Musamba,E.,B., Kashindye, A, M., and Philipina, F. S., (2011) Species Composition, Richness and Diversity in Miombo Woodland of Bereku Forest Reserve, Tanzania. Journal of Biodiversity J Biodiversity, 2(1): 1-7
xiii. Government of Kenya, (GoK) (2001). National Poverty Eradication Plan 1999-2015 Nairobi; Kenya

xiv. Khan, M. S., Haq, E., Rahman, A.A., Rashid, S.M., and Ahmed, H.(eds), (1994). Wetlands of Bangladesh. BSCAS, Dhanmondi.

xv. Korem A. (1985). Bushfire and agricultural development in Ghana. Ghana Publishing Corporation, Tema.

xvi. Leakey, R.R.B., Tchoundjeu, Z., Schreckenberg, K., Shackleton, S.E. and Shackleton, C.M. (2005) Agroforestry Tree Products (AFTPs): Targeting poverty reduction and enhanced livelihoods. International Journal for Agricultural Sustainability 3, 1-23.

xvii. Lemessa D., (2007) Beekeeping: A Livelihood Strategy In Pastoral And Agro–Pastoral Dry Land Areas of Southern Oromia (Liban District) and Somali Regional States (Filtu And Dollo Ado Districts), M.Sc. Thesis. Wondo Genet College of Forestry, School of Graduate Studies, Hawasa University, Hawassa, Ethiopia.

xviii. Luoga E.J., (2000). The Effect of Human Disturbances on Diversity and Dynamics of Eastern Tanzania Miombo Arborescent Species. Ph.D. Thesis, Unpublished. Johannesburg: University of Witwaterrand.

xix. Maclean, I. M. D., R. Tinch, M. Hassal & R. Boar, (2003). Towards Optimal Use of Tropical Wetlands: An Economic Valuation of Goods Derived From Papyrus Swamps in Southwest Uganda. CSERGE Working Paper ECM 03-10. University of East Anglia, Norwich.

xx. Madzwamuse, M., Schuster, B. and Nherera, B. (2007). The Real Jewels of The Kalahari: Drylands Ecosystem Goods and Services in Kgalagadi South District, Botswana. IUCN, Gland, Switzerland.

xxi. Maundu, P. and Tengnas B. (2005) Useful trees and Shrubs of Kenya; World Agroforestry Centre, Eastern and Central Africa Regional Programme, Nairobi-Kenya.

xxii. Michaelidou, M., Decker, D. and Lassoie, J. (2002). The interdependence of ecosystem and community viability: a theoretical framework to guide research and application. Society and Natural Resources 15:599-616.

xxiii. Millennium Ecosystem Assessment. (2003). Ecosystems and human well-being; a framework for assessment. Island Press, Washington, D.C., USA.

xxiv. Millennium Ecosystems Assessment (MEA) (2005). Ecosystems and human well-being: synthesis. Island Press, Washington, DC.

xxv. Mithöfer, D. and Waibel, H. (2003) Income and labour productivity of collection and use of indigenous fruit tree products in Zimbabwe. Agroforestry Systems 59: 295-305.

xxvi. Monela, G. C., Chamshama,S.A, Mwaipopo, R., and Gamassa D.M., (2005). A Study on the Social, Economic and Environmental Impacts of Forest Landscape Restoration in Shinyanga Region, Tanzania: Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism, United Republic of Tanzania , and IUCN - The World Conservation Union Eastern Africa Regional Office, Dar-es- Salaam , Tanzania.

xxvii. Munthali S.M. (2007). Transfrontier conservation areas: integrating biodiversity and poverty alleviation in Southern Africa; Natural Resources Forum 31(1, 2007: 51-60)

xxviii. Mwakatobe, A. and Mlingwa, C. (2005). The status of Tanzanian honey Trade- Domestic and International Markets Tanzania. Wildlife Research Institute.

xxix. Mwamburi A. and Musyoki, J. (2011) Investing in Trees; Information Leaflet No. 1 Kenya forest research Institute, Nrb, Kenya.

xxx. Nasi, R., D. Brown, D. Wilkie, E. Bennett, C. Tutin, G. van T., and Christophersen T. (2008). Conservation and use of wildlife-based resources: the bushmeat crisis. CBD Technical Series Number 33. Secretariat of the Convention on Biological Diversity, Montreal, Canada, and Center for International Forestry Research, Bogor, Indonesia. Available online at: www.cbd.int/doc/publications/cbd-ts-33-en.pdf.

xxxi. Ndengwa G. (2013) The Promise of Drylands; Kenya Forestry Research Institute, Karura Regional Research Centre Miti April-June 2013.

xxxii. Niemeijer, D., Puigdefabregas, J.,White, R., Lal, R., Winslow, M., Ziedler, J.,Prince, S., Emma Archer, E. and King, C. (2005). Dryland Systems. In R. Hassan, R. Scholes, & N. Ash (Eds.), Ecosystems and Human Well-being: Current State and Trends.: Findings of the Condition and Trends Working Group. (Vol. 1, pp. 623-662). Island Press.

xxxiii. Nyariki, D.M. and R.K. Ngugi (2002). A review of African pastoral production system: Approaches to their understanding and development. Journal of Human Ecology, 13(3):137-250.

xxxiv. Pantaleo, K.T., Munishi, Nice, N. W., Nshare, J.S., Stein, R. M, Deo, D. S. and Halima, H. K., (2011). Valley Bottom Wetlands Can Serve for Both Biodiversity Conservation and Local Livelihoods Improvements, Ecosystems Biodiversity, PhD. Oscar Grillo (Ed.), ISBN: 978-953-307-417-7, Intech, Available from: http://www.intechopen.com/books/ecosystems-biodiversity/valley-bottom-wetlands-can-serve-for-bothbiodiversity-conservation-and-local-livelihoods-improvement

xxxv. Persha, L., Harry, F. B., Ashwini, C. B., Arun, A. A., and Catherine, B. (2009). Biodiversity conservation and livelihoods in human-dominated landscapes: Forest commons in South Asia. Biological Conservation 143 (2010) 2918–2925.

xxxvi. Ramadhani, T. (2002) Marketing of indigenous fruits in Zimbabwe. Socio-economic Studies on Rural Development, Vol 129. Wissenschaftsverlag Vauk. Kiel, Germany.

xxxvii. Republic of Kenya (RoK) (2009). Makueni County Development Plan 2008-2012. Kenya Vision 2030. Towards a globally competitive and prosperous Kenya. Ministry of Planning and Development, Nairobi, Kenya.

xxxviii. Ruiz-Perez, M., Belcher, B., Achdiawan, R., Alexiades, M., Aubertin, C., Caballero, J., Campbell, B., Clement, C., Cunningham, T., Martinez, A., Jong, W. de, Kusters, K., Kutty, M.G., Lopez, C., Fu, M., Alfaro, M.A., Nair, T., Ndoye, O.,

Ocampo, R., Rai, N., Ricker, M., Schreckenberg, K., Shakleton, S., Shanley, P., Sun, T. and Young, Y-C. (2004) Markets Drive the Specialization Strategies of Forest Peoples. Ecology and Society 9,1-9.

xxxix. Shackleton, S., Campbell, B., Lotz-Sisitka, H. and Shackleton, C. (2008). Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. World Development, 36 (3): 505-526.

xl. The Economics of Ecosystems and Biodiversity (TEEB), (2008). The Economics of Ecosystem and Biodiversity: An Interim report. Available online at www.teebweb.org, accessed on 21 October 2014.

xli. Timilsina, L.B. (2007). Contribution of Buffer Zone Management on Livelihood Support. A case study from Chitwan National park, Nepal. A master thesis submitted in partial fulfilment of the requirements for the degree of Master of Science (M.Sc.) in Management of Protected Areas at the University of Klagenfurt, Austria.

xlii. UNEP, (2012). The Role and Contribution of Montane Forest and Related Ecosystem Services to the Kenyan Economy; Nairobi, Kenya. UNEP.

xliii. United Nations Environment Program (UNEP) (2011). Ecosystems for water and food security, Boelee E. (ed) Nairobi: United Nations Environment Programme; Colombo: International Water Management Institute.

xliv. World Health Organization (WHO) (2005). Ecosystems and Human Well- Being: Health Synthesis: A report of the Millennium Ecosystem Assessment; WHO Press, 20 Avenue Appia, 1211 Geneva, Switzerland.

xlv. World Resources Institute; Department of Resource Surveys and Remote Sensing, Ministry of Environment and Natural Resources, Kenya; Central Bureau of Statistics, Ministry of Planning and National Development, Kenya; and International Livestock Research Institute. (2007). Nature's Benefits in Kenya, An Atlas of Ecosystems and Human Well-Being. Washington, DC and Nairobi: World Resources Institute. Published by: World Resources Institute, 10 G Street NE, Washington, DC 20002, USA. The full report is available online at www.wri.org

xlvi. Wuver, A., and Attuquayefio, D. (2006). The Impact of Human activities on Biodiversity Conservation in a Coastal Wetland in Ghana; West Africa Journal of Applied Ecology (WAJAE) - ISSN: 0855-4307 Volume 9.