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Contribution of Forestry Provisioning Ecosystem Services to the Household Income of Small Holder Farmers Adjacent Chyulu Hills Forest, Makueni County, Kenya

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Abstract

This study set out to investigate contribution of forestry provisioning ecosystem services (FPES) to the household income of small holder farmers living adjacent Chyulu Hills Forest and assess factors influencing utilization of the FPES. A survey research design was used and a sample size of 60 households was randomly selected from two study sites which were purposely selected to enable a comparative analysis. The study area was stratified into the two sites on the basis of ease of access to the forest. Mang'elete and Kiu sub-locations were consequently selected. Mang'elete was separated by a fence from the forest while there was no barrier between Kiu sub-location and the forest. An interview schedule having closed, and open-ended questions was used to elicit responses from the respondents on the issue of FPES. Results indicated that FPES contributed a significant amount of income to the respondents. The total mean monthly income from FPES in the two study sites was Ksh 811.36, constituting 8.4% of the total household income against Ksh 8,622.33 (91.40%) from other sources such as farming. An independent samples t-test was conducted to compare the mean monthly incomes accruing from the sale of forest products between the two sub-locations. There was a significant difference between the mean monthly incomes (Mang'elete (M= 355.56, SD= 1,252.04) and Kiu (M= 1,267.17, SD=3,085.60, t (58) = -2.26, $p<0.05$) accrued from the sale of forest products. Logit regression results showed that occupation of the household head, distance from Chyulu hills forest and presence of fence significantly ($p<0.05$) influenced utilization of FPES in the two Sub locations. The study concludes that FPES contributes to household income and recommends forest managers to prioritize activities and interventions in the forests conservation in order to maximize the opportunities for limited livelihood opportunities in rural areas through FPES utilization in the view of the fact that the hills are of great importance to their livelihoods in regard to supplementing their household products and incomes..

Keywords: Forestry provisioning ecosystem services; Household income; Small holder farmers; Chyulu hills forest

Introduction

Globally, empirical evidence has quantified and qualified the proportion of forest dependency from the entire household livelihood matrix. The seminal work by Vedeld et al. [1] drawing upon 51 case studies across 17 developing countries revealed that the contribution of forests, mainly through forest income accounted for about 22% of the total household income. In North and South America, the contribution of forest income ranged between 14 and 20% of the total household income. In Asia, forest income varied from 10 to 20% of the total household income [2]. While in sub-Saharan Africa, forest income ranged from 30 to 45% of the total household income [3]. These studies demonstrated the significant contribution of forests towards household economies.

It has been estimated that there are more than 60 million highly forest dependent people in Latin America, West Africa, and Southeast Asia, with an additional 400-500 million people directly dependent on these natural products [4]. Subsistence use of non-timber forest products (NTFP) represents the greater part of its value to households. However, they are also source of cash income such income seldom appears to account for a large share of a household's total income, but complements other livelihood activities [5]. Some people depend solely on forests as their only source of subsistence, with its contribution sometimes being found to offset other household livelihood portfolios such as agriculture [6]. Formally measuring and accounting for forest

ecosystem services is a necessary first step toward properly valuing them, and various efforts toward this goal have been ongoing in recent decades at the global level. One of the earliest studies of ecosystem value at a global level estimated their total worth at $33 trillion per year, with forests making up a significant portion ($4.7 trillion) of this total [7].

Although difficult to calculate systematically, forests play a significant economic role at the continental, regional, national and local levels in Africa. Previous studies have shown that the importance of natural capital in the total stock of capital tends to vary inversely with the level of income per head [8]. Globally, the forested area dedicated to the production of wood and non-wood products dropped from 1.16 billion hectares to 1.13 billion hectares over the 2000-2010 period [9]. This decline evident at the regional level is due largely to the deforestation associated with the expansion of the agricultural frontier, poor forest management practices, fire, excessive firewood extraction and illegal cutting. The land area covered by tree farms, however, grew more rapidly in Latin America between 2000 and 2010 (3.23% annually) than in any other region of the world [10]. Nationally, the present annual consumption of wood fuel is 7.2 million tons, of which two-thirds are used as fuel wood and charcoal in rural areas and one-third is used as charcoal in urban areas [11]. Household food security improves from the collection of forest resources such as fruits, mushrooms, honey, roots and tubers, caterpillars, termites, grasshoppers, and other small-game animals [11]. Forests serve as subsistence safety nets for the rural poor, essentially mitigating poverty for its users [12]. Forests can function "as a source of permanent increases in income, assets, services and political rights particularly in well-functioning community-managed forests. Often, economic valuation of any goods and services is based on the concept of total economic value which is based on use values and non-use values. Use values can be further divided into direct use values, indirect use values and option values. Direct use values can be derived from the actual price paid for an ecosystem goods or service, for instance paying for timber, firewood and others forest products. Economic valuation is very important to make vulnerability assessment of ecosystems [13]. Thus, this study provides more insight while developing the national adaptation and mitigation strategies against the climate change. Market based approach can be applied for valuation of provisioning services such as timber or water. Individual products provide inputs and income to huge numbers of rural and urban households.

Forests continue today to provide the high levels of commercial benefits to households, companies, and governments that formed the initial impetus for protective statutes and policies. NTFPs indeed play a very significant role in the rural economy in terms of providing employment, income potential and life support sustenance [14]. World Bank [15] estimates that one out of four of the world 's poor depend directly or indirectly on forests for their livelihood. It is estimated that 20–25% of rural peoples' income is obtained from environmental resources in developing countries [1] and act as safety nets in periods of crisis or during seasonal food shortages [4]. The FAO estimates that forest industries contribute more than US450 billion to national incomes, contributing nearly 1 percent of the global GDP in 2008 and providing formal employment to 0.4% of the global labor force [16].

Forests also provide other sources of incomes and subsistence benefits, generate informal work opportunities, and constitute reservoirs of economic values that help ameliorate shocks to household incomes – particularly in rural areas in poor countries [17]. In many areas, forest and trees and the related environmental services play a major role for household income and livelihood security. While forests and trees are widely important among smallholders, dependency on them varies substantially. In some cases, forest and tree products are the principal source of income for families, as shown by Padoch & de Jong [18] for Peru, and Henkemans [19] for Bolivia. Evidence from Bolivia and Peru suggests that forest dependency increases when communities are located further away from urban centers [20].

Forests contribute enormously to the global energy supply as well as providing food, fodder, medicines, building materials and paper products. In recent years, attention has also been focused on the importance of non-wood forest products which include plants for food and medicinal purposes, fibers, dyes, animal fodder and other necessities. Indonesia, for example, earns an estimated US$120 million a year from rattans, resins, sandalwood, honey, natural silk and pharmaceutical and cosmetic compounds [21], while the local production of bidi cigarette from the tendu leaf *(Diospyros melanoxylon)* in India provides part-time employment for up to half a million women (FAO, 1993). In South Africa, according to valuations carried out by Dlamini and Geldenhuys (2011), the value of NTFPs is somewhere around $49.38 million. Medicinal plants are valued at $32.1 million and fuel wood at $13.5 million. Babulo et al. [22] in Ethiopia noted that in a sample of 360 households from 12 villages forest environmental resources contribute the second largest share of income after crops ahead of livestock. An IIED/Forest Connect Report on Nepal (2012) found that one-third of rural people in Nepal collect and trade forest products, which generated US7.66 million in 2010 and benefitted 78,828 participants. In this connection, it has been estimated that more than 200 million people in the tropics live in the forests and in some parts of Africa as much as 70 per cent of animal protein comes from forest games such as birds and rodents [23]. In the case of Uganda, forest-based cash is raised first and foremost from the sale of fuel wood and charcoal (36% of all sales), followed by the sale of house-building materials (30%) and forest foods (21%). Money raised from the forest as well as from other sources is used to invest in livestock (a rapid multiplier of wealth if droughts and wars do not intervene) and school-fees [24]. These investments

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increase shorter-term and longer-term resilience to shocks. Ingram et al. [25] suggest average annual household income from NTFP trade in Central Africa ranges between 25 and 40% and goes up to 80%. For under-story lianas sold for food, women harvesters can earn $98-110 per month while wholesalers can make $429 in Brazzaville and retailers in Central African Republic make $132 on average per month.

Income from forest resources is common strategy of the poor to complement agricultural income from small and marginal land holdings [26]. It is coping strategy by the poor to mitigate the risk inherent in the subsistence agriculture. WCFSD [27] noted that estimated 350 million people "depend almost entirely for their subsistence and survival needs on forests" and that another 1 billion depend on forests and trees for fuel wood, food and fodder. Estimated amount of 1.6 billion rural people are dependent on forests to some extent, 1 billion out of 1.2 billion extreme poor depend on forest resources for all or part of their livelihoods and 300- 350 million people are highly dependent on forests and live within or adjacent to dense forests on which they depend for their subsistence and income [28]. Billions more, including people in cities, depend on forest resources for food, traditional and modern medicines, construction materials, and energy sources. Studies suggest that ecosystem services and other non-marketed goods account for between 47% and 89% of the total source of livelihood for rural and forest-dwelling poor households (TEEB, 2010). Forest resources are crucial for rural livelihoods as well as for industrial income as a contributor to the national economic growth. Such industry is estimated to generate $40million annually and employs 80 000 people (Nield et al. 1999). Money earned from the sale of forest products has been shown to complement agricultural income and provide financial cost of health, and household expenses [29]. Godoy et al. [30] had also noted in a study in Honduras, that although NTFP extraction has a low annual value, it can provide insurance in the case of unexpected losses. Forest products are extracted in order to smooth the household's consumption in case of low crop returns [4]. In a study attempting an understanding of the ways in which households cope and adapt under increasingly evident and significant economic changes and agro-climatic events in Central Kenya, Kauti [31] partitioned households into four groups with reference to the sectoral composition of their annual net incomes and revealed that all the four livelihood strategy clusters comparatively employed one dominant sector/activity with percentage contribution to annual net total income being above average and other sectors/activities playing a secondary role. These were referred to as forest product extractors, non-farm activity entrepreneurs, diversified livestock keepers and agriculturists.

It is, however, sometimes difficult to recognize ecosystem services and to quantify them accurately, partly because they often provide indirect benefits, meaning that they remain poorly understood in relation to their importance [32]. Consequently, the World Bank (2004) declared that the continued inability to determine and clearly project the monetary value of ecosystem goods and services is likely to result in the continued loss of valued ecosystems which is detrimental for world societies and the economy.

Chyulu hills forest is one of the most unique forests in Kenya. The forest is home to numerous plants and animal species. It is a dry land fragile ecosystem most vulnerable to climate change. Droughts impact negatively on water availability, agricultural production and rural livelihoods for the communities neighboring the forest. Communities living adjacent heavily derive their livelihood from it and most of them practice small-scale rain-fed agriculture and thus the change in seasonality attributed to climate change leads to certain food products becoming scarcer at certain times of the year. In recent past, the Chyulu hills forest has been subjected to rampant vegetation degradation through illegal logging, firewood harvesting, charcoal burning and frequent fires [33]. The problem is that the resultant increased extraction and intensity of use of tree products have complicated the conservation of the Chyulu hills forest. Despite the essential products and services offered by Chyulu hills forest, its actual value in terms of contribution to the local and external community livelihoods has neither been synthesized nor economically quantified. FPES especially to the forest adjacent dwellers have long tended to be underestimated by economic planners and decision makers. The forest is seen as having little economic importance, because national income and development estimates focus on only one part of forest value- the output of commercial timber industries (KFMP, 1994). The monetary value of natural ecosystems is extremely important because it enables policy makers and natural resource managers to make more informed decisions. De Groot et al. [34] noted that the level of familiarity with ecosystem capital and its role in conservation policy formulation is still low hence the continued degradation of fundamental natural assets such as forests. The ability of forests to generate resources and other economic benefits to the local community users has been less recognized and emphasized by economic planners. The economic valuation of production and service functions of the ecosystem would be paramount in attempting to gauge the actual contributions of these production and service functions in the per capita income of the communities vis a vis the degradation trend of the forest. A study therefore is required to bridge this gap by looking at the potential of forestry sector towards economic and social development more so to the forest adjacent dwellers. It is on this basis that this study set out to investigate contribution of forestry provisioning ecosystem services (FPES) to the household income of small holder farmers living adjacent Chyulu Hills Forest and assess factors influencing utilization of the FPES. This is premised on the realization that lack of awareness of the importance of forest ecosystems to the livelihoods of small-scale farmers may hinder or bring challenges for its conservation especially when the communities around the forest are poor.

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Materials and Methods

Profile of the study area; topography and climate

(Figure 1) The study area lies in Makueni County which covers an area of 8,034.7Km^2. The County borders Kajiado to the West, Taita Taveta to the South, Kitui to the East and Machakos to the North. It lies between Latitude 1º 35´ and 30º 00´ South and Longitude 37º10´ and 38º 30´East. The average land holding in Makueni area is between 2-5 acres per household (Kenya National Bureau of Statistics, 2010). Most of the people live below poverty line, and as a result, they greatly rely on natural resources to improve their livelihood which affects their activities and conservation. The Chyulu Hills forest is made up of a series of hills of varying altitude, and form a narrow chain of quaternary volcanoes with a Northwest to Southeast elongation covering nearly 100km long and up to 30km wide, between Emali and Mtito Andei townships which lie along the Nairobi-Mombasa highway [35]. The general landscape in the Chyulu Hills forest is characterized by an arid to semi-arid environment, with an annual rainfall of 500mm to 1200mm, and evaporation ranging between 1800mm and 2200mm [36]. The region however has a history of high-density squatter settlements, many of whom still lived in squatter camps in 2008/2009. Absorbing illegal settlers from all the major ethnic groups in Kenya, it has a track record of stark confrontations between land hungry peasants, the Kenya Wildlife Service, civil administration and local politicians [37]. Contestations over land use between squatters and the Kenya Wildlife Service became protracted after gazetting of Chyulu Hills National Park [38]. This was done in two phases, with the lower Chyulu Hills being upgraded to national park status in 1983 (400Km^2), followed by the upper Chyulu Hills extension (380Km^2) in 1995. Both were done without adequate consultation with the surrounding community, and without providing for adequate compensation for displaced households. Between 1988 and 1990 many squatters were violently evicted from the Chyulu Hills National Park by the Kenya Wildlife Service and apprehended for illegal occupation and harvesting sandalwood (*Osyris lanceolata*), a protected herb [37].

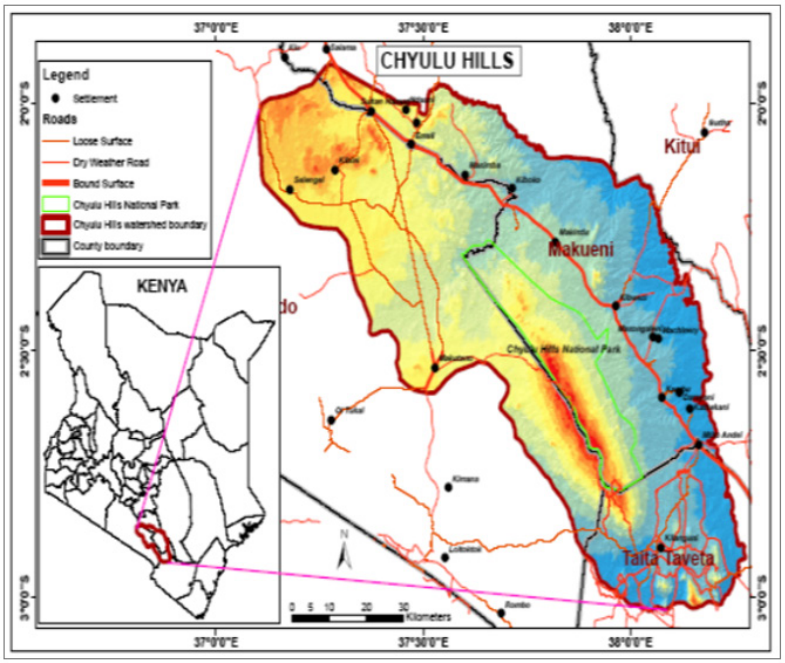

Figure 1: Spatial location of the Chyulu Hills in South Eastern Kenya.

Source: Kiringe J et al. (2015).

The study was undertaken within approximately 0-12Km distance from Chyulu forest. The study covered two sub- locations, Mang'elete of Mtito Andei division and Kiu of Makindu Division where both divisions lie in Makueni County. The two sub locations were purposively selected as they both border the hills on the part covering the Chyulu National park. Mang'elete is on the fenced border of the Chyulu National park while Kiu is on the side lacking electric fence to separate the park from the rest of private land therefore a comparison on community- park interactions was to be done between the two sub-locations. The area mainly comprised of small-scale subsistence agriculture with almost all the natural habitat having been cleared. The area surrounding the park is densely populated and intensively used for farming with almost no permanent grassland or forest. There is widespread dependence on the park by the local people who obtain firewood, thatch grass, medicinal plants and also graze in the forest. There

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are incidences of illegal logging, charcoal burning and hunting of small animals in the hill forest.

Research design, data collection and data analysis

A survey design was used and multistage sampling which involved purposive, stratified and random sampling. A three-level sampling procedure was employed. First, the hills adjacent area was stratified on the basis of being adjacent to the hills Forest. Secondly, the area was stratified on the basis of sub-locations directly adjacent to the park; two sub-locations were selected, and these are Mang'elete sub-location which lie on the fenced border and Kiu lieng in the unfenced border. Thirdly, through systematic random sampling, the households for sampling were selected from within the two sub-locations. This involved identification of two main routes running from the Nairobi-Mombasa highway to the forest one in each sub-location. A transect walk in the farmlands was done selecting the fifth household alternately on either side of the route. On the understanding that the forest adjacent populations in the area are similar in many aspects, the survey drew a sample size of 60 households from the two sub-locations 30 from each sub-location. The decision over the total number of respondents selected was influenced by the fact that the households are densely placed. It was also guided by World Agroforestry Centre procedural guidelines [39] for characterization of studies at household level. They suggest that a sample size of 40 to 80 households spread over two or three communities which have populations with similar characteristics and attitudes is adequate to make inferences about a larger population. The quantitative data from the survey was sorted, coded and analyzed using the Statistical Package from Social Sciences (SPSS) version 22 and Microsoft Excel 2013. Data were displayed using frequency distribution tables so as to establish various patterns that characterize the phenomena in the study area [40].

Results and Discussions

Monthly income accrued from sale of different forest resources in Kiu and Mang'elete sub-locations, Makueni County

Table 1: Mean monthly income accrued from sale of different FPES in Kiu and Mang'elete Sub-Locations (In Kshs).

		Sub-location of the Household Head			
		Mang'elete	**Kiu**	**p-value**	**Totals**
Forestry provisioning ecosystem services extracted	Charcoal	366.67(1190.87)	2,086.67(5172.86)	0.06	496.67
	Firewood	366.67(1188.55)	626.67(1256.14)	0.57	1,226.67
	Poles and posts	166.67(647.72)	673.33(1256.14)	0.02*	420
	Khat	1233.33(4485.10)	2833.33(7390.32)	0.36	2,033.33
	Calving wood	0.00(0.00)	766.33(1568.04)	0.02*	383.17
	Bush meat	0.00(0.00)	616.67(1633.71)	0.04*	308.33
	Mean	**355.56(1,252.04)**	**1,267.17(3,085.60)**		**811.36 (2445.99)**
Income from other sources	Rent from land	933.33(3463.44)	0.00(0.00)	0.15	466.67
	Crop sale	12,843.33(12242.54)	12,450.00(11504.38)	0.9	12,646.67
	Livestock sale	16,150.00(11575.20)	18,916.67(12990.77)	0.39	17,533.33
	Livestock products	5,533.33(7793.60)	11,383.33(11124.44)	0.02*	8,458.33
	Regular employment	6,066.67(17587.09)	1,946.67(6048.30)	0.23	4,006.67
	Mean	**8,305.33(6106.85)**	**8,939.33(7852.61)**		**8622.33 (6772.13)**
	GRAND TOTAL	**8660.89**	**10,216.62**		**9,889.50**

Note: 1. *Significant at 0.05 significance level.

2. Figures in parenthesis shows standard deviation.

Results presented in Table 1 shows average monthly income obtained from sale of different forest resources. In Mang'elete sub-location, respondents obtained an average of Kshs 366.67 from the sale of firewood, Kshs 366.67 from charcoal and Ksh 166.67 from poles and posts. Sale of Khat, wood curving and bush meat attracted Kshs 1233.33, 0.00 and 0.00, respectively. However, in Kiu sub-location, respondents obtained an average of Kshs 626.67 from the sale of firewood, Kshs 2086.67from charcoal, Kshs 673.33 from poles and posts, Kshs 2833.33 from Khat, kshs 766.33 from curving wood and Kshs 616.67 from bush meat. Table 2 further shows independent samples t-test p-values comparing the incomes accruing from the sale of each forest product between the two sub-locations. Results indicated that means of poles and posts (p-value=0.02), calving

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wood (p-value=0.02), bush meat (p-value=0.04) and livestock products (p-value=0.02) were significantly different, with more of these provisioning services being extracted in Kiu compared to Mang'elete sub-location. However, means of charcoal (p-value=0.06), firewood (p-value=0.57), khat (p-value=0.36), rent from land (p-value=0.15), crop sale (p-value=0.90), livestock sale (p-value=0.39) and regular employment (p-value=0.23) were not significantly different.

Table 2: Proportion of monthly income (Kshs) from FPES in Mang'elete and Kiu Sub-locations

Sub-location	Mang'elete	Kiu	Total (Kshs)
Income from FPES	64,000.20	228,090	**292,090.20**
Income from other sources	1,245,799.80	1,340,900.10	**2,586,699.90**
Total income	1,309,800	1,568,990.10	**2,878,790.10**
Proportion of income from FPES (%)	4.9	14.5	**19.4**

Table 3: Factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services by residents in Kiu and Mang'elete Sub-locations, Makueni County

Factor	Coefficient	P Value	Odds Ratio
Occupation	-3.316	0.001*	0.36
Gender	0.79	0.451	2.203
Age	-0.013	0.73	0.987
Household size	-0.081	0.716	0.922
Marital status	0.02	0.964	1.02
Education level	-0.057	0.865	0.945
Land size	-0.228	0.217	0.796
Distance to the forest	-0.427	0.013*	0.653
Average monthly income	0	0.301	1
Presence of fence	-2.109	0.020*	0.121
Constant	12.438	0.03	252165.4

Note: *Significant at 0.05 significance level.

Results presented in table 1 indicated that the average monthly income obtained from sale of different forest resources showed that in both Mang'elete and Kiu sub-locations khat sale accrued the highest average monthly income with ksh 1,233.33 in Mang'elete and Ksh 2,833.33 in Kiu giving a mean total of Ksh 2,033.33. Overall, firewood sale comes second with a total of Ksh 1,226.67 followed by charcoal sale with Ksh 496.67. Sale of khat attracted highest income due to the fact that its majorly extracted for sale but the rest of products are mainly for subsistence use. This is in line with existing literature that rural livelihoods income from the sale of FPES is an important contributor to overall household income for rural residents [41]. In Mang'elete, bush meat and calving wood is purely for subsistence use. This is likely due to the challenges experienced in accessing the forest hence one will only collect resources enough for use without any surplus for sale therefore saving money that would have been used to buy the same from the market. This supports previous research done by Shackleton & Shackleton [4] that those households that employ FPES for direct household consumption save cash resources, which would have otherwise been used to purchase the products. It is further shown that the total mean income from FPES in the two sub-locations was Ksh 811.36 (8.60%) while that from other sources was Ksh 8622.33(91.4%). The FPES contributed a significant amount of income to the respondents. This result was similar to what one would expect that free forest utilization by households are additional sources of income in rural areas and fuel woods as they are the main source of energy [42]. In Central Africa, forest communities generate 67% of their total income from hunting and gathering, and only 33% from agriculture, labour and employment; which illustrates how vulnerable forest communities can be to changes in forest access [43] hence the findings of this study are in agreement with similar findings elsewhere and corroborate the importance of forest resources to households. It is estimated that 90% of the world's poor depend on forests for at least a portion of their income [44]. Forest foods, charcoal, firewood, poles and posts, khat and medicinal plants were the most important contributors to both cash and non-cash income, but in terms of relative importance to the household other items such as calving wood and bush meat also score high in Kiu sub-location for cash income. The food materials extracted from the forest are honey, bush meat, vegetables and wild fruits with honey being the most extracted in kiu and vegetables in Mang'elete. Kiu has the highest number of households extracting all food materials as compared to Mang'elete and therefore evident that lack of electric fence contributes to more forest utilization.

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Results presented in table 2 Indicated that the total monthly income from FPES in Mang'elete sub-location was Ksh 64,000.20 (4.9%) while that from Kiu sub-location was Ksh 228,090 (14.5%). The FPES contributed a significant amount of income to the respondents. This is a clear indication that the forest resources obtained from Chyulu is a major boost to the livelihoods of farmers and more so to their non-cash income and so they rely on the hills forest for their survival regardless of whether the extraction is illegal or not the reason being attributed to the fact that forest-adjacent communities operate behind a background of limited economic opportunities [45]. Also, Yemiru [46] noted that most of the poor people in rural areas maintain diversified livelihood strategies because they cannot obtain sufficient income from any single strategy and also to reduce risks. Many small-scale farmers are therefore not solely small agriculturists, but they include forest products in their livelihood systems. The results of this study however does not agree with findings by Fisher [41] that forest income contributed about 39% of the household income in Ethiopia highlands and nearly equaled combined livestock and agricultural incomes as in this present case forest cash income is too low compared to other farm sources of income.

Contribution made by forestry provisioning ecosystem services obtained from the Chyulu forest can be categorized into household cash income and non-cash household income. Non-cash income refers to the income which could have been got from sale of those products utilized for subsistence use. Non-cash uses of forests continue even where there are no cash sales of forest products at all. From this study it is deduced that non-cash values make a larger contribution to overall household income than do cash values in the two sub-locations. The findings are in agreement with similar study done in Ethiopia where considerable portion of forest income benefits were found to be in-kind benefits associated with the subsistence use of forest goods and services, for example the value added of wood fuel production provided very large in-kind income benefits because many households collected wood fuel and fodder themselves rather than purchasing it in the market [47]. An independent samples t-test was conducted to compare the mean incomes accruing from the sale of forest products between the two sub-locations. The two means were found to be significantly different, with Kiu sub-location having a higher income (Mang'elete (M= 355.56, SD= 1,252.04) and Kiu (M= 1,267.17, SD=3,085.60, t (58) = -2.26, p<0.05).

Table 3 Factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services by residents in Kiu and Mang'elete Sub-locations, Makueni County

Results of Logistic regression analysis (Table 3) showed that occupation of the household head (coefficient=-3.316; p= 0.001; odds ratio=0.036), distance from Chyulu (coefficient=-0.427; p=0.013; odds ratio=0.653) and presence of fence (coefficient=-2.109; p=0.020; odds ratio=0.121) had a significant influence (p<0.05) on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations. These variables have a negative coefficient meaning that they are negatively associated with utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations.

Occupation correlates negatively to forest utilization implying that those employed extract fewer resources as they do not have time for going to the forest and again they already have a source of income hence are able to provide for their needs .The results are supported by findings by Illukpitiya and Yanagida (2008) who stated that forest dependency decreased for households with more diversified income sources. Distance is also negatively correlated in the current study. Respondents living within a short distance from the forest edge collect more FPES than those living far from the forest. This agrees with the findings of a similar study carried out in Sri Lanka (Brockhus, 1996). Presence of electric fence also correlated negatively with extraction of resources. Those on the fenced border were found to extract fewer resources due to the fence barrier as access to the forest means they have to improvise ways of accessing the forest. Other studies by Mungai et al. (2011) in Arabuko sokoke forest found out that fencing of the forest has limited access of the humans into the forest. However, they sneak through informal inlets in search of livelihood. This is mainly done by men because they sometimes decide to jump over and women are not able to jump high.

Further examination of the results showed that gender of the household head, (coefficient=0.790; p=0.451; odds ratio=2.203), age of the household head (coefficient=-0.013; p=0.730; odds ratio=0.987), household size (coefficient=-0.081; p=0.716; odds ratio=0.922), marital status (coefficient=0.020; p=0.964; odds ratio=1.020), education level (coefficient=-0.057; p=0.865; odds ratio=0.945), size of land (coefficient=-0.228; p=0.217; odds ratio=0.796), average income (coefficient=0.000; p=0.301; odds ratio=1.000) did not have a significant influence on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations. Education is negatively correlated to extraction of resources. Hence the higher the level of education the fewer the resources extracted. This agrees with findings by Parry et al. (2009) who stated that higher education attainment is associated with less reliance on forest resources. This is because a higher level of education provides a wider range of job options hence making fuel wood collection unprofitable due to greater opportunity costs of collection (Dolisca et al. 2006). The results however contradict the findings of another similar study which indicated that education was positively correlated with forest resources extraction (Masozera, 2002).

In addition, the size of the land was negatively related with forest resources extraction. Respondents with large plots of land depended less on the forest for FPES. The results are in concurrence with findings of Babulo et al. [22] who found that households with large plots of land were less likely to engage in forest extraction as their dominant livelihood strategy.

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Average income in this study includes the monthly earnings from sale of agricultural produce and monthly salary for those employed. Average income (coefficient=0.000; p=0.301; odds ratio=1.000) had a negative relationship with forest resources extraction and utilization and, therefore, households with higher income depended less on the forest resources. This implies that poor households engage in more extraction of forest resources compared to the well-off ones. The results contradict the findings of Kamanga et al. (2008) who found that households with lower agricultural income engage less in communal forest income generation. In Ranomafana National Park, Madagascar, wild sources of food and income accounted for a larger share of household incomes among the poor, so restriction to access of the park was likely to affect these households the most, possibly increasing the size of loans during times of food deficit (Ferraro, 2002).

Household size and forest resources extraction and utilization had a negative relationship. The result contradicts what one would expect because as the number of family members' increases, the demand for more food to be cooked and more houses to be built also increases. The bigger the family size, the more labor is available to gather forest products. It also contradicted findings by Mamo et al. (2007) who found out household size to be positively associated with forest dependency. Larger families have higher subsistence needs which necessitate them to depend more on forest resources. The contradiction was likely because demand for a particular resource from the forest did not necessarily lead to extraction of that resource from the forest since extraction of all the resources was illegal. Age is positively correlated with the FPES extraction from the forest implying that the skills and knowledge of forest resources extraction and utilization increased with age. The results agree with findings by Godoy et al. [30] who states that age of household head is positively related with forest dependency, albeit with diminishing effect after reaching a peak of physical growth. However, older people might possess strong ecological knowledge about their proximate environment, a phenomenon which might increase their likelihood of being more dependent on forest resources.

The study findings do, however, contradict those of Kideghesho and Msuya (2010) in Tanzania who reported that labor-demanding activities, such as charcoal production, are more common among young men. Gender and marital status had a positive relationship with forest resources extraction. Male headed households depended more on the forest as men find it easier to enter the forest even at night because they do it illegally hence, they have to hide themselves. The results do not concur with research findings of similar studies. Households headed by females have been reported to rely more on forest products in Cameroon (Fonjong, 2008) and southern Ethiopia [46], while in South Africa, studies have indicated a negligible gender effect (Cocks et al. 2008).

Other studies suggest that women are the primary users of forests, for example, in a study in Uttar Pradesh, India, women derived 33 to 45% of their income from forests and common land, whilst men derived only 13% (FAO, 2006). Whilst women have access to and substantial labor and management responsibilities for forest resources, they are much less likely to own land than men, and it is often men who control the use and marketing of the products and incomes (Lastarria-Comhiel, 1995) [48-50].

Conclusion and Recommendations

The survey indicated that Chyulu hills forest plays a significant role in contributing to rural household incomes. Results indicated that the total monthly income from FPES in Mang'elete sub-location was Ksh 64,000.20 (4.9%) while that from Kiu sub-location Ksh 228,090 (14.5%). Most of the communities in the study area, however, derive a greater proportion of their livelihood from agriculture but also depend on the forest for certain products aiming at supplementing what they earn from other livelihood means. The present study has revealed that the principle sources of income for the majority of households were from farming. Forest utilization is a supplementary source of income to farming. The study recommended forest managers to prioritize activities and interventions in the forests conservation in order to maximize the opportunities for limited livelihood opportunities in rural areas through FPES utilization in the view of the fact that the hills are of great importance to their livelihoods in regard to supplementing their household products and incomes.

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