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Forest Plantation Establishment: A Question of Subsistence or Commercial Farming in Gathiuru and Hombe Forests

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Abstract:

Plantation establishment under community participation is an age-old concept first applied as a formal forest plantation establishment method in Myanmar in 1856 under the name taungya. Under this system farmers were permitted to produce crops while tending forest plantation tree seedlings over a period of three to four years. The paper analyses the crop farming dynamics of this system that was introduced in Kenya at the turn of 1900 under code name shamba (farm) system but currently known as plantation establishment and livelihood system (PELIS). Initially the system targeted involvement of illiterate, poor, unemployed, landless rural peasants so as to produce subsistence food. In contrast, currently farmers are educated with their own land. The results of the study indicate that 91% and 93% of PELIS farmers in Gathiuru and Hombe forests respectively produced agricultural food crops under the program for commercial purposes. Only less than 1% of the farmers produced food crops for subsistence. The farmers invested an average of Ksh 56,050 (USD5,44.18) per hectare over a period of three years and earned an average of Ksh 164,680 (USD 1,598.84) over the same period a return of 292%. This indicates the transformation from peasant farming for subsistence to commercial engagement in PELIS. Thus, there is need to revisit the plantation establishment legislative framework. Farmers participating in PELIS should no longer be perceived as poor peasants whose goals are only subsistence but rather should be viewed as forest management partners interested in investments and profits making.

Keywords: *Plantation establishment, livelihood improvement, communities, cash-crops, subsistence-crops, sustainability*

1. Background

The conventional methods of forest plantation establishment include direct seed sowing, establishment through raising seedlings in tree nurseries or through natural regeneration followed by coppice management. Each of the methods may apply permanent departmental laborers or intermittent casual labour. Another option is 'concessions' where a timber company establishes and manages forest plantations under an agreement. These are options that have been shown to increase the cost of forest plantation establishment prompting departments to involve communities in a bid to reduce the costs (Chapman and Allan 1981, Kagombe and Gitonga 2005). In Kenya, the most commonly used approach to establish forest plantations through community's participation is the plantation establishment and livelihood improvement scheme (PELIS) formerly known as shamba (farm) system where peasant farmers lived in villages within the forest land (Kagombe and Gitonga 2005, Imo 2008). At some time in the early 2000 due to changing socio-economic and political system, the forest resident farmers were evicted from the forest land and the system became known as non-residential cultivation (NRC) (Imo, 2008). Globally, it is a method that has evolved over the years since it was first applied as the taungya system to establish teak plantations in Myanmar and subsequent spread in Asia and African in the 1800s (Jordan et al., 1992; Ojo 2014; Ndomba et al., 2015). In its initial application, the main aim of the system was to establish forest plantations but allowing the workers to produce agricultural food crops in cycles of three to five years in small plots of land as a secondary benefit aimed at addressing the farmers' subsistence food needs (Ojo, 2014). Apparently, the people that participated in the implementation of the system in the past have been the poor, landless, unemployed and often illiterate members of communities living around the forests. This characterization was considered a pre-requisite for the success of the shamba (farm) system and became entrenched in the philosophy of the system (Evans and Turnbull 2006, Witcomb and Doward 2009). There was therefore little expectation

that the communities' contributions in the agricultural food crop activities would amount to any impactful outputs beyond the subsistence production (Chamshama, 1992, Ojo, 2014).

The governments' objectives therefore were to provide land for peasants or forest workers for subsistence food production and sometimes to provide casual employment for the rural people with little attention towards the food crop production (King, 1987; Jordan et. al., 1992, Ndomba et al., 2015). This paper seeks to explore dynamics of farming by the communities engaging in participatory plantation establishment. In addition, analyze the proportion in terms of commercial and subsistence food production.

2. The Study Area

2.1. Biophysical Characteristics

Gathiuru and Hombe forests are located at the South-western slopes of Mt Kenya about 290 Km from the capital city of Nairobi and about 45 Km from Nanyuki town. Gathiuru forest station is located at latitude -0.0500° and longitude 37.0833° . The two forests are a part of Mt Kenya ecosystem in Central Kenya Highlands conservancy; one of the ten Country's forest management zones. Mt Kenya ecosystem has been under state management since 1943 (Logie and Dyson 1962). The ecosystem consists of three sub-ecosystems, which include a national park occupying 71,510 ha, a natural forest reserve covering over 2,000 km² and gazetted plantation forests measuring 8,994 ha (Emerton, 1999; KFS 2010b; KWS, 2010).

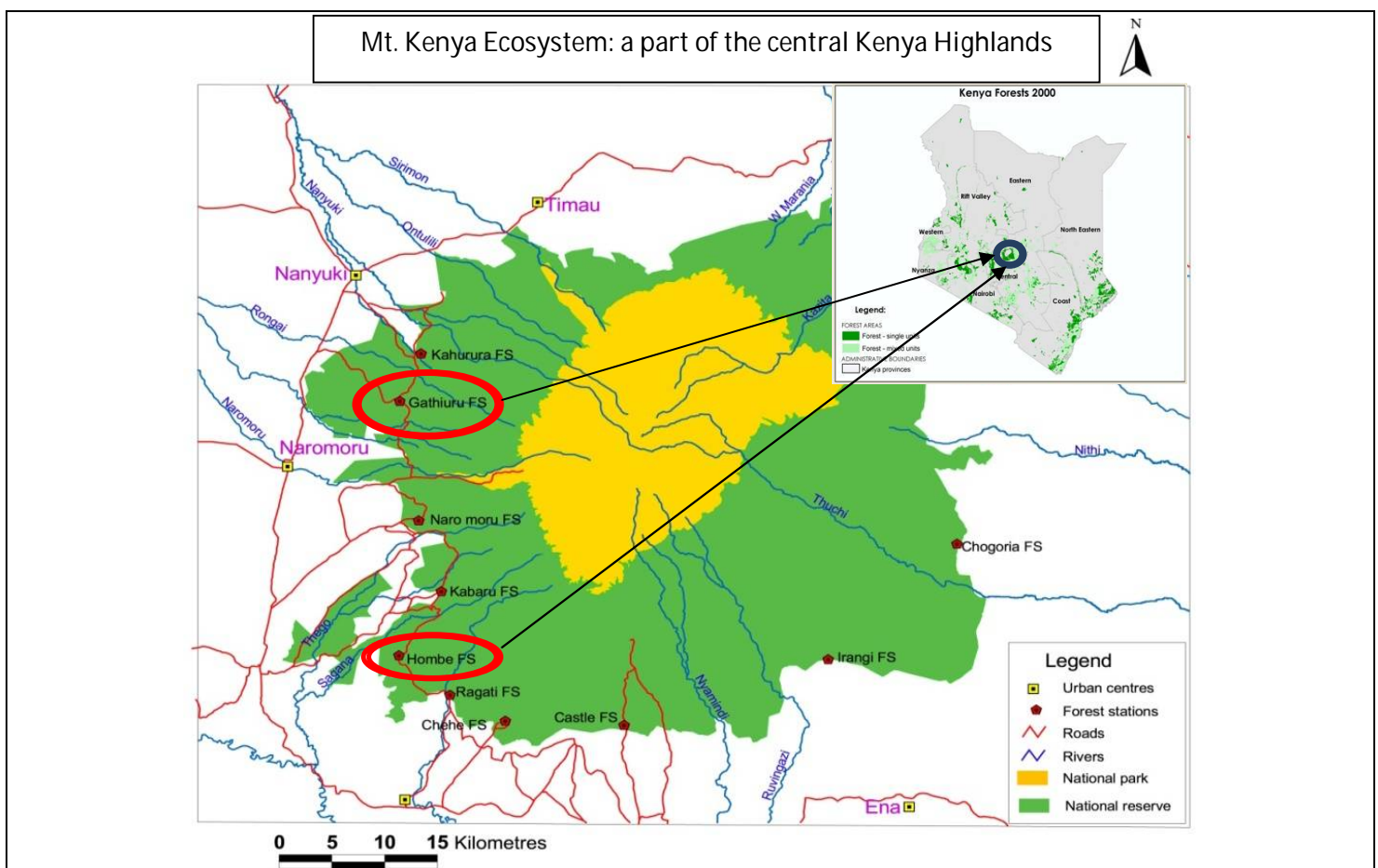


Figure 1: The Location of Gathiuru and Hombe forest in Mt Kenya Ecosystem.

Source: Kenya Forest Service

The vegetation in Gathiuru and Hombe forests include forest plantations, indigenous forests, bushland, grassland and bamboo. The natural forest covers 10,319.6 ha while plantations occupy 3,500 ha in both forests. Gathiuru forest holds 2,365 ha of plantations while about 1,150 ha are in Hombe forest. By 2013 a total of 969 ha in Gathiuru and 761 ha in Hombe were under PELIS. The main forest plantation tree species in the two forests are *Cupressus lusitanica*, *Pinus patula*, *Pinus radiata* and *Eucalyptus salignii*. Small areas are also under planted indigenous tree species for example *Vitex keniensis* (KFS, 2010a, KFS, 2010b).

2.2. Socio- Economic Characteristics

The main ethnic groups around Gathiuru and Hombe forests are Kikuyu and Meru communities, which have important cultural links to Mt Kenya, which is believed to be the home of god (Kariuki, 2007). The area around the two forests, which rises to between 1,500-2,500 m ASL is mainly used for mixed farming including dairy cattle, goats, sheep, poultry, potatoes, vegetables, carrots, peas, small scale irrigation, and few large scale arable farming. In addition, cash crops both coffee and tea is cultivated. The average land sizes vary from ½ an acre to 5 acres. Many households have a history of engaging in farming in the forest under PELIS).

3. Study Methodology

3.1. Sampling and Data Collection

The study used a sample size of 321 respondents computed at 95% confidence level with a margin error of 5%. This was drawn from the PELIS population of 1947 out of which (70%) of the sample were drawn from farmers in Gathiuru forest and (30%) from farmers cultivating in Hombe forest. The respondents were picked using the number allocated to plots in the PELIS area. For example, if 30% of the population was allocated plots in compartment 'A', 30% of the sample was drawn from the number of farmers allocated plots in that compartment and every sixth plot was systematically selected (Table 1).

Name of Forest	(PELIS Unit) Compartment	No of units in each block	No of farmers allocated plots in each unit.	Sample from each PELIS unit	% of sample
Gathiuru	Station	1	30	5	1.6%
	Burgret	9	468	79	24.6%
	Mugeria	8	840	141	43.9%
	Gathiuru total	18	1338	225	70.1%
Hombe	Polytechnique	1	48	6	1.9%
	Gathunya	1	172	27	8.4%
	Kiori	4	389	63	19.6%
	Hombe Total	6	609	96	29.9%

Table 1: The samples drawn from each PELIS unit

3.2. Data Analysis

Primary data was collected by use of questionnaires. The study applied descriptive statistical tools such as frequencies and percentage to determine characteristics of variables. Assessment and comparison of relationships between variables of agricultural inputs and outputs was analyzed using cross-tabulation. Secondary data was analyzed based on KFS plantation development plans, areas available for planting, harvesting and replanting over a period of 3 years (Table 2). The location of plantations in the forest maps of Gathiuru and Hombe forests are shown on figures 2 and 3.

Gathiuru forest summary of plantation areas scheduled for harvesting 2017-2020	
Species	Area planned for clear felling (Ha)
Cypress (<i>C. lusitanica</i>)	272
Eucalyptus (<i>E. saligna</i>)	135
<i>Acacia mearnsii</i>	2
Total	409
Hombe forest summary of plantation areas scheduled for harvesting 2016-2020	
Species	Area planned for clear felling (Ha)
<i>Cupressus lusitanica</i>	372
<i>Eucalyptus saligna</i>	16
<i>Pinus patula</i>	14
Total	402
Total area planned for clear fell in both forests	811

Table 2: Extracted from the five-year plantation felling plans for Gathiuru and Hombe forests (2015 to 2020)
Source KFS: Forest plantation management plans for Gathiuru and Hombe

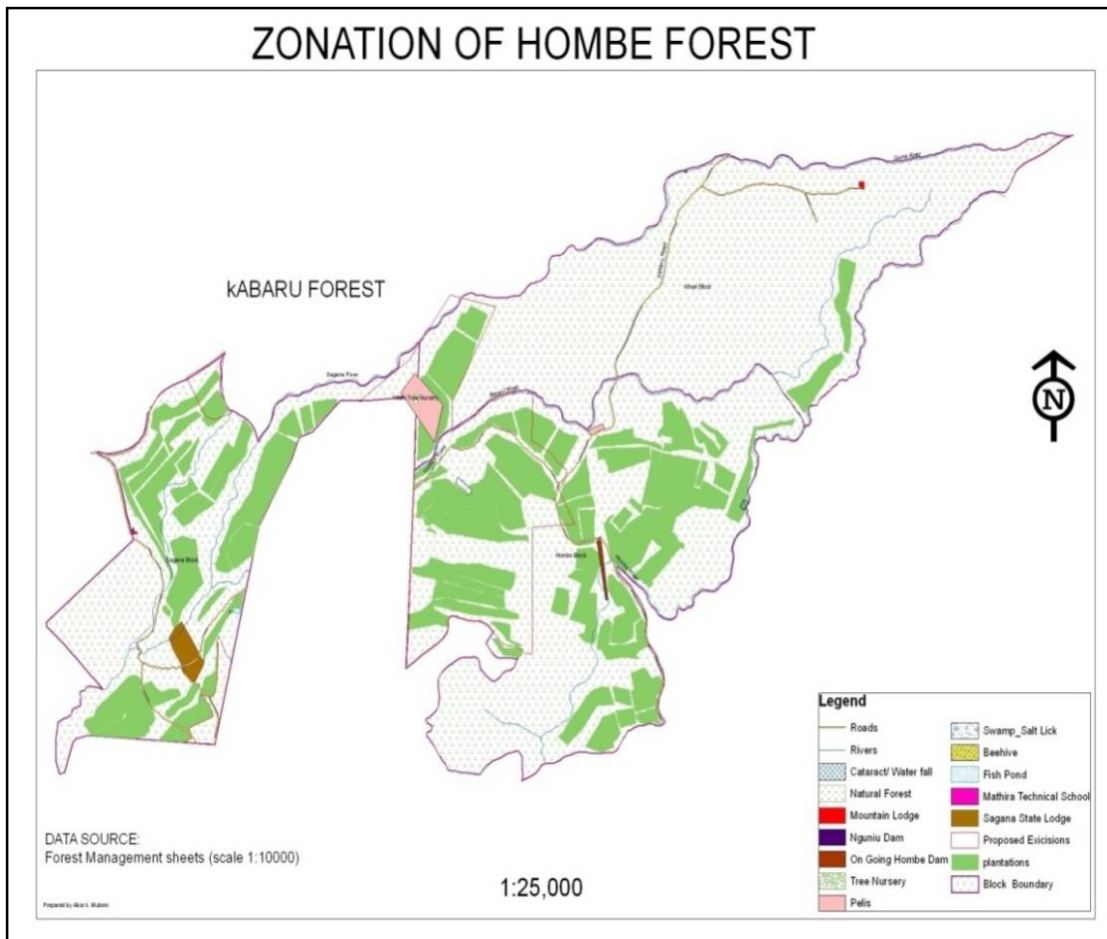


Figure 2: Hombé forest management map showing location of plantations. (Source KFS)

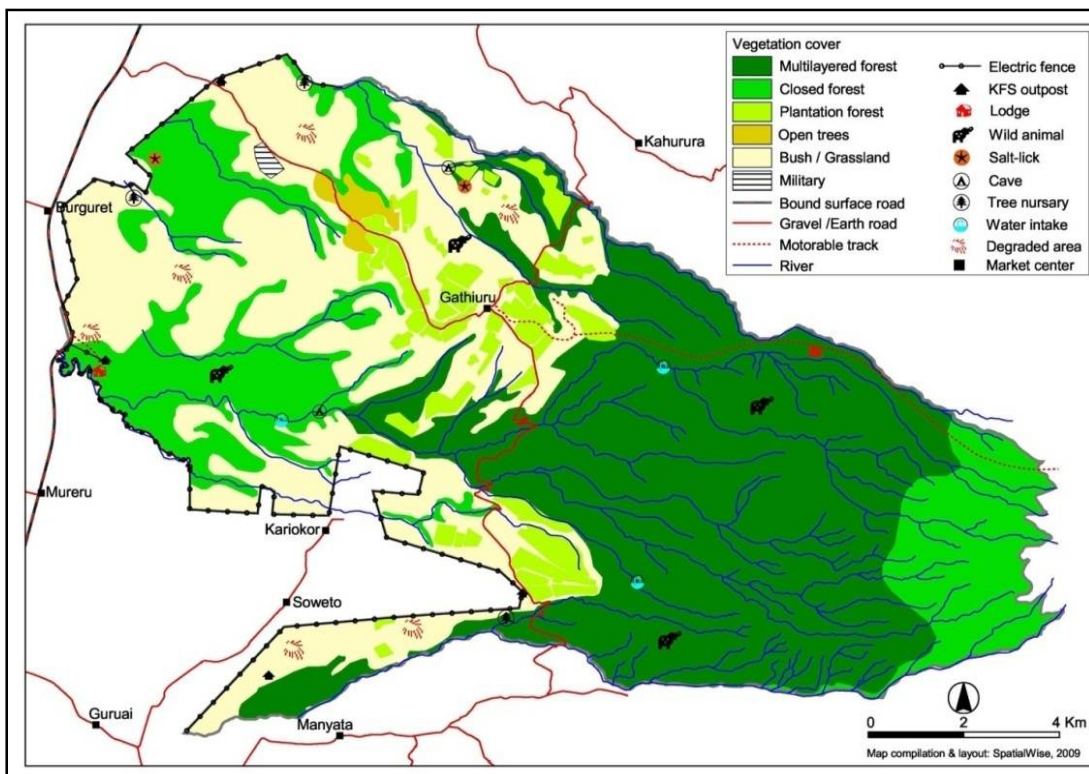


Figure 3: Gathiuru forest map showing areas of forest plantations (Source KFS)

3.3. *Felling plan for plantations in Gathiuru and Hombe forests:* According to the felling plans for Gathiuru and Hombe forests a total of 811 ha are scheduled for clear felling between 2017 and 2020. If the area is sub-divided into ¼ hectare plots it implies there are available over 3,244 plots to be allocated to farmers for a period of 3 years. If the plots were spread equally, it means about 1,081 plots would be available for cultivation each year.

4. Results

4.1. Household Characteristics and Literacy levels

The total population of farmers participating in PELIS by 2015 in the two forests was 1,947 with 68.7% cultivating in Gathiuru forest and 31.3% in Hombe forest. Out of the entire sample 64.9% were male and 31.8% female respondents. The analysis on levels of literacy indicates that most of the respondents (64%) in both areas of study had attained primary school education, 28% had secondary level education while only 5 % had tertiary education. Relatively, a small percentage (2%) had no education at all while 6.6% of the respondents reported having obtained tertiary level of education. Comparing education levels against age classes, 30-40% of the people between 30 and 50 years had attained secondary school education. The proportion that attained tertiary education decreased with increasing age and those that had no education though few (below 10%) were in the older age brackets beyond 59 years.

4.2. Types of Crops Cultivated under PELIS

In general, between 2012 and 2014, 84.8% of the farmers cultivated food crops within *Cupressus lusitaniaca* plantations, 10.9% in the *Eucalyptus saligna* plantations while 4.5% cultivated crops together with other tree species. The main agricultural food crops cultivated were potatoes and legumes (peas and beans). A few farmers produced different varieties of vegetables mainly for household use (Table 3). On average 91.0% and 93.1% of the respondents cultivated potatoes regardless of whether for cash or subsistence in Gathiuru and Hombe forests respectively within the three years of the study. Less than 3% were involved in production of each of the other crops such as beans, peas and vegetables (Table3).

Food crops grown in Gathiuru Forest in 2012, 2013 and 2014								
Year crop cultivated	Potato	Beans	Peas	French beans	Courgette	Maize	Spinach	No response
Year 2012	87.8%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	10.0%
Year 2013	89.9%	0.5%	0.0%	0.0%	0.0%	0.0%	4.0%	5.5%
Year 2014	95.2%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	4.0%
Average	91.0%	0.2%	0.0%	0.0%	0.0%	0.0%	2.5%	6.5%
Food crops grown in Hombe forest in 2012, 2013 and 2014								
Year crop cultivated	Potato	Beans	Peas	French beans	Courgette	Maize	Spinach	No response
Year 2012	93.1%	0.0%	1.0%	1.0%	0.0%	0.0%	2.9%	2.0%
Year 2013	94.1%	1.0%	1.0%	0.0%	1.0%	0.0%	2.2%	0.7%
Year 2014	92.2%	0.0%	2.9%	1.0%	1.0%	1.0%	2.0%	1.0%
Average	93.1%	0.3%	1.6%	0.7%	0.7%	0.3%	2.4%	1.2%

Table 3: Agricultural food crops cultivated in Gathiuru & Hombe forests between 2012 and 2014 under PELIS

An assessment of the disaggregated data in terms of cash or subsistence crop production indicates that in both forest areas, between 85% and 95% of the respondents respectively cultivated food crops for commercial purposes while only less than 1% of the respondents cultivated the forest plots purely for subsistence use (Table 4). It is observed that 3.8% and 5.5% of farmers in Gathiuru and Hombe forests respectively cultivated crops both for cash and for subsistence (Table 4).

Forest	Year crop cultivated	Respondents cultivating cash crops only	Respondents cultivating subsistence crops only	Respondents producing both Cash & Subsistence crops	No response
Gathiuru forest	Year 2012	85.2%	0.4%	4.4%	10.0%
	Year 2013	88.5%	0.3%	5.7%	5.5%
	Year 2014	94.0%	0.8%	1.2%	4.0%
	3 yr Average	89.0%	0.5%	3.8%	6.6%
Hombe forest	Year 2012	90.1%	0.7%	7.2%	2.0%
	Year 2013	93.9%	0.4%	5.0%	0.7%
	Year 2014	92.0%	0.8%	6.4%	0.8%
	3 yr Average	93.0%	0.6%	5.5%	1.2%

Table 4: Cash and subsistence agricultural food crops cultivated in Gathiuru and Hombe forests

4.3. Community Inputs and Outputs in Agricultural Production under PELIS

Inputs analyzed include labour costs both during actual physical work and time spent during PELIS engagements such as trainings and meetings. Financial inputs related to equipment materials, farming tools and seeds were also taken into account. Outputs analyzed covered both earnings from cash crops and subsistence food crops.

Inputs: Between 2012 and 2014, farmers in Gathiuru forest cultivated a total of 383 hectares giving an average of 128 ha each year (Table 5). The farmers combined total inputs were in the tune of Ksh 38,338,335 equivalent to USD 372,217 with an annual average of Ksh 6,647,791 (USD. 64,542). Over the three-year period, the total community input in Gathiuru forest was Ksh 19,943,373 (USD 193,625) while for Hombe it was lower at Ksh 17,783,457 (USD 172,655),

The average annual cultivated area in Gathiuru was 128ha at an average annual input of 51,936 (USD 504) while for Hombe the average cultivated area was 100 with average input of Kh 59,278 (USD 576). On average, the area cultivated in both forests was 114 ha annually with an average input of Ksh 56,050 (USD 544) (table 5)

Forest	year	Area cultivated each year (In Hectares)	Total inputs for agricultural food crop production (Ksh)	*Total inputs in Dollar equivalent	Inputs (Ksh per ha)	*Inputs per ha in Dollars equivalent
			Inputs include labour, materials, equipment & seeds		Total inputs divided by area cultivated	
Gathiuru forest	2012	113	5,229,143	50,768.38	46,276	449.28
	2013	128	5,954,248	57,808.23	46,518	451.63
	2014	142	8,759,982	85,048.37	61,690	598.93
	3 yrs Total	383	19,943,373	193,624.98	154,483	1,499.83
Annual average		128	6,647,791	64,541.66	51,936	504.23
Hombe forest	2012	99	6,150,520	59,713.79	62,126	603.17
	2013	102	5,194,520	50,432.23	50,927	494.44
	2014	99	6,438,417	62,508.90	65,035	631.41
	3yrs Total	300	17,783,457	172,654.92	178,088	1,729.01
Annual average		100	5,927,819	57,551.64	59,278	575.51
Annual total for both forests	2012	212	11,598,544	112,607.22	54,710	531.17
	2013	230	11,231,919	109,047.76	48,834	474.12
	2014	241	15,507,872	150,561.86	64,348	624.74
3yrs' total for both forests		683	38,338,335	372,216.84	167,893	1,630.03
Annual average for both forests		114	6,389,723	62,036.15	56,050	544.17

Table 5: Community Inputs for agricultural food crop cultivation under PELIS.

* Exchange rate USD 1= Ksh 103

Outputs: In case of farmers in Gathiuru forests, the total annual earnings from agricultural food crops ranged from a high of Ksh 31 Million (USD 300,644) in 2012 to Ksh 20 Million (USD 202,682 in 2014 (Table 6), while in Hombe forest farmers earned between Ksh 9 Million (USD 94,329 the lowest in the year 2012 and highest Ksh15 million (USD 143,801) in 2014. The total community earnings from PELIS in both forests were about Ksh 112,476,600 (USD 1,092,006) which give an average of individual earning of Ksh 386,518 (USD 3,753) for the entire three years (Table 6). On average Gathiuru farmers cultivated 128 ha each year and earned Ksh 199,792 equivalent to USD1,940 per hectare while Hombe farmers cultivated an average of 100 ha and earned an average of Ksh 119,188 (USD 1,157) per ha per year. Each farmer earned an average of Ksh 3,431 (USD 33) per month based on the ¼ hectare allocation and 12 month computation.

Forest and year of cultivation		Earnings (outputs) in Ksh and area in hectares								
		Area farmed	Total earnings Potatoes + legumes		Average earnings per individual (total earnings /No of respondents)		Average earnings per ha per year (Total earnings/area cultivated)-		Average earnings per month per 1/4 ha (average earnings per ha/4/12 months)	
		in Ha	in Ksh	In USD	in Ksh	In USD	in Ksh	In USD	in Ksh	In USD
Gathiuru Forest	2012	113	30,966,300	300,644	163,843	1,591	274,038	2,661	5,709	55
	2013	128	24,877,700	241,531	131,628	1,278	194,357	1,887	4,049	39
	2014	142	20,876,200	202,682	110,456	1,072	147,015	1,427	3,063	30
	3 yrs Total	383	76,720,200	744,856	405,927	3,941	615,411	5,975		
Averages		128	25,573,400	248,285	135,309	1,314	199,792	1,940	4,162	40
Hombe forest	2012	99	9,715,900	94,329	95,254	925	98,140	953	2,045	20
	2013	102	11,229,000	109,019	110,088	1,069	110,088	1,069	2,294	22
	2014	99	14,811,500	143,801	145,211	1,410	149,611	1,453	3,117	30
	3 yrs Total	300	35,756,400	347,150	350,553	3,403	119,188	1,157		
Averages		100	11,918,800	115,717	116,851	1,134	119,188	1,157	2,483	24
Annual total earnings for both forests	2012	212	40,682,200	394,973	139,801	1,357	191,897	1,863	3,998	39
	2013	230	36,106,700	350,550	124,078	1,205	156,986	1,524	3,271	32
	2014	241	35,687,700	346,483	122,638	1,191	148,082	1,438	3,085	30
	Study period totals-3yrs	683	112,476,600	1,092,006	386,518	3,753	164,680	1,599		
Averages		114	18,746,100	182,001	64,420	625	164,680	1,599	3,431	33

Table 6: Earnings from agricultural investments under PELIS

4.4. Sustainable Availability of Land for Cultivation

Analysis of secondary data from KFS indicates that 409 ha and 402 ha in Gathiuru and Hombe forests are scheduled for clear felling an indication of the land that is available for allocation under PELIS between 2017 and 2020. The number of quarter ha plots available are therefore $409 \times 4 = 1,636$ in Gathiuru and $402 \times 4 = 1,608$ in Hombe. These plots distributed equally over a three-year period gives 545 and 536 plots per year in Gathiuru and Hombe forests. Thus, in total 1080 farmers can be assured of farming land each year over the next three years.

5. Discussion

The shamba (farm) system now known as PELIS in Kenya was adopted in plantation management with the main objective of being to reduce the costs for plantation establishment. Overall, the method was thought to be innovative since in practice it provided an opportunity for farmers to cultivate subsistence food crops for a short period while they provided labour in the forest plantations establishment. It was believed that the system would only work well in an environment of landlessness, poverty and unemployment thus the peasant participants were allocated small plots as a means of addressing these challenges. This conceptualization became entrenched in policies and practices of the approach and the characterization of the communities as peasants became a prerequisite to application of the system (Ojo 2014).

While it is appreciated that the system has contributed to the establishment of plantations in most countries and particularly in Kenya (Kagombe and Gitonga 2005; Khalumba et al., 2015). It is noted in this paper that the socio-economic dynamics of communities participating in PELIS has changed overtime. Results indicate that while the initial aim was to support subsistence supply of food for the peasant farmers, through the shamba (farm), under the PELIS system, between 2012 and 2014, over 85% of the farmers in Gathiuru forest and 95% in Hombe forest are engaged in the program for commercial motivations rather than for subsistence reasons. Only less than 1% of the respondents in both cases produced food crops purely for subsistence. For example, between 2012-2014, farmers input per hectare was on average Ksh 56,050 (USD 544) to produce agricultural food crops, which earned Ksh 164,680 (USD 1,599) per hectare, indicating a return of 300% over this period. This is a departure from the initial participation where farmers were engaged in the scheme more for subsistence rather than for commercial gains (Ongugo et al 2008, Imo 2008). From the analysis, it is observed that PELIS has positively impacted on community household incomes and community livelihoods have improved. Given this status where more farmers are engaged in PELIS for commercial purposes, there is need to change perception of the community

participants engaged in PELIS from viewing them as peasants whose interests are mainly subsistence to viewing them as partners driven by commercial motivations.

These results support the view that PELIS is an approach that contributes to national, community and household food security (Kagombe and Gitonga 2005; Khalumba et al., 2015). However, there are limitations since the forest land is limited and thus it cannot ensure sustainable food production due to its limited capacity to continuously provide land for cultivation. The desired continuity may be achieved through synchronization of the harvesting and replanting cycles carefully planned with respect to a given number of participants. Data on available land for harvesting, planting and replanting in the study area indicates availability of 811 hectares for a period of three years. Such land can support about 1080 farmers each year for three years but this is insufficient to guarantee sustainability of the process.

To sustainably use this available land, there might be need to review legislation guiding PELIS so as to match forest harvesting and farming. This would ensure integrating sustainability in PELIS based on the principle of sustained yield commonly applied in forest plantation management but which does not consider food production. The principle of sustained yield following the rotational age of tree species requires that every year the scheduled allowable cut is harvested and replanted until the plantation production cycle is complete (Elbakidze, et al 2013). In so doing, sustainable food production under PELIS program can be achieved. However, the static nature of the areas harvested and replanted may be limited in its capacity to address changing demands for forest products. This can present an impetus for on farm development of plantations to meet such demands.

6. Conclusion

While the initial goal of PELIS was to meet subsistence needs, this paper concludes that commercialization of PELIS is taking precedence over subsistence farming. It asserts that the socio-economic reality of communities living adjacent to the forests and also involved in the plantation establishment scheme in the recent development dispensation is different from the earlier perceived status. This change of view calls for a change in perception of communities from a low rating to an elevated level that considers communities as partners in participatory forest management and investors interested in profits rather than subsistence as the end goal. Such a view has implications on policy and the management approaches, which require recasting of interest towards PELIS farmer needs in the evolving socio-economic dispensation. The study also concludes that farmers involved in plantation establishment are increasingly keen on commercial food production, thus the need for revising policies on the PELIS approach that enhance food production but at the same time ensure quality forest plantations are established.

Thus, PELIS implementation processes should integrate flexibility that allows the system to address emerging challenges and take advantage of developing opportunities. In this context, the study recommends that rather than consider the agricultural crop production as a by-the-way benefit, it should be viewed as an important part of PELIS in terms of food production thus a change in policy is necessary in the long run.

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