IS CROP DIVERSIFICATION GENDERED? EMPIRICAL ANALYSIS OF TWO COUNTIES IN KENYA

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ABSTRACT
The question of sustainable income and employment in the rural areas seems to be very much dependent on the degree of diversification of land use towards cultivating various crops. In view of this, crop diversification is an important issue in agricultural development not only in Kenya but also in other parts of the world. Efforts are being made in different parts of Kenya to cultivate crops which are remunerative and environmentally friendly. Using data from Africa Intensification (Afrint) Project, this study examines crop diversification trends in two counties of Kenya (Nyeri and Kakamega). The paper addresses the question whether crop diversification is gendered. The paper intensively looks at the nature and extent of crop diversification disaggregating this by the gender of the farm manager in order to understand which of the farms are more diversified. The Herfindahl and the Simpson indices have been computed to depict the level of crop diversification across the three counties and farm types over the period of study. The study findings show that though farmers in the three counties are diversifying their agricultural practices, female managed farms (FMFs) are more diversified than male managed farms (MMFs). Results for FMFs showed a higher and significant degree of crop diversification. The study recommends that more agricultural support services be directed to FMFs which seem to have embraced crop diversification more than MMFs so that sustainable income and employment can be enhanced. This will indeed help in achieving not only the Sustainable Development Goal on poverty reduction but also one of the Kenya Government big four agenda on food security.
Keywords: Afrint, Crop diversification, Herfindahl indices, Simpson indices

INTRODUCTION

Kenya like other Sub-Saharan African countries, displays the hallmarks of a developing economy. Agriculture remains the backbone of the Kenyan economy. It is the single most important sector in the economy, contributing approximately 25% of the GDP, and employing 80% of the national labour force (Wambugu et al. 2011). Seventy four per cent of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from agriculture (World Bank, 2015). Given its importance, the performance of the sector is therefore reflected in the performance of the many other sectors of the economy. The development of agriculture is also important for poverty reduction since most of the vulnerable groups like pastoralists, the landless, and subsistence farmers, also depend on agriculture as their main source of livelihood. Growth in the sector is therefore expected to have a greater impact on a larger section of the population than any other sector. The importance of the sector in the economy is reflected in the relationship between its performance and that of the key indicators like GDP and employment.

The question of sustainable income and employment in the rural areas seems to be very much dependent on the degree of diversification of land use towards cultivating various crops (De and Chattopadhyay, 2010). In view of this, crop diversification is an important issue in agricultural development not only in Kenya but also in other parts of the world (Kimenju and Tschirley, 2011). Efforts are being made in different parts of Kenya to cultivate crops which are remunerative and environmentally friendly. Diversification is an integral part of the process of structural transformation. According to Vyas (1996) diversification in agriculture can mean any of these three scenarios: (i) using resources in diverse but complementary activities; (ii) a shift from farm to non-farm activities and (iii) a shift from less profitable crops (or enterprises) to more profitable crops (or enterprises). The first type of diversification is concerned with efficient allocation of resources. The second type is essentially diversification of the rural economy *per se.* The third type can be viewed as the commercialized farmers' response to relative price signals to adjust to market conditions.

This paper doesn't look at agricultural diversification as a whole, but is mainly concerned with the diversification of the crop sector, which dominates the agricultural sector in most of the rural areas of Kenya. The broad rationale for crop diversification emanates from the opportunities it offers to reduce production

and price risks, increasing yields, natural resources sustainability, maintaining ecological balance, increasing flexibility and sustaining productivity and growth. It also creates opportunities for more employment and higher incomes through more efficient use of resources and exploitation of comparative advantage (World Bank, 1990). On the whole crop diversification is a process; which on one hand helps the farmer to improve the per capita income and diffuse risk and on the other hand provides more diversified food items to the family and other consumers. It minimizes the risk associated with the production of one or a few crops and helps the farmer to escape from the poverty trap (Deshpande et al. 2007). Hence crop diversification can be seen as a risk mitigating strategy under unpredictable circumstances. However, the relative level of diversification across regions within a country will depend upon agro-climatic conditions, resource endowments and infrastructure (Rao et al. 2004).

Crop diversification has been studied by many scholars in Kenya from different perspectives, however, one aspect which seems to have been less examined is diversification across farm types defined by the gender of the farm manager. Studies which look at which farm types are more diversified are few and give mixed conclusions. The question of which farm types male managed farms (MMFs) or female managed farms (FMFs) are more diversified from a cropping perspective has not been given adequate attention. That is, the gendered aspects of crop diversification have not received adequate empirical investigation. These are aspects that this paper tries to address. While the findings presented in this chapter are specific to the particular setting in two counties in Kenya, they might also contribute to a better general understanding of the underlying issues and linkages. Given this backdrop, the objectives of this paper are: a) to analyze the general crop diversification trends over the study period in two counties of Kenya (Nyeri and Kakamega) and b) to examine which farm types, defined by gender of the farm manager are more diversified.

MATERIALS AND METHODS

Research Design and Study Areas

This study uses a descriptive study design. Well-designed questionnaires were used to collect data on among other aspects crops grown and the area under different crops. The paper examines crop diversification trends using panel data collected during three Afrint rounds (Afrint 1 in 2002, Afrint II in 2008 and Afrint III in 2013) in two counties of Kenya (Nyeri and Kakamega) and in ten villages. Afrint stands for Africa intensification and it is a multi-disciplinary research project that brings together researchers from nine African countries and researchers from Lund University, Sweden. The project website is https:www.keg.lu.se/en/research-projects/current-research-projects/afrint. The two counties and the ten villages in Kenya were purposively sampled in accordance with certain criteria such as gradation in agro-ecological potential, market access, population density among other factors. Crops types were divided into three major categories namely maize (the major staple food crop), other food crops and vegetables (bananas, cassava, sorghum, beans, peas, irish potatoes, sweet potatoes, cabbages, kales, tomatoes, etc.) and non-food cash crops (sugarcane, coffee, tea, etc.).

Data Analysis

A number of analytical techniques were employed in this study. These include the Herfindahl and the Simpson indices of diversification and correlation analysis. Also descriptive statistics were used to explain the salient variables used in the study. The extent of crop diversification at a given point in time may be examined by using several indices namely, (1) Herfindahl Index (HI), (2) Simpson's Index (SI), (3) Ogive Index (OI), (4) Entropy Index (EI), (5) Modified Entropy Index (MEI), (6) Composite Entropy Index (CEI) among others. Among these indices, the HI, SI and the EI are widely used in the literature of agricultural diversification (Mukherjee, 2012; De & Chattopadhyay, 2010). All these indices are computed on the basis of proportion of gross cropped area under different crops cultivated in a particular geographical area. It should be noted that the HI is an index of concentration and thus high values are an indication of specialization of crop activities. To obtain the index of diversification, the HI is subtracted from one, which is the simplified form of the SI of diversification.

To check whether the ranking pattern of the villages on the basis of these different indices are consistent or not, we have computed the spearman's rank correlation coefficient by taking the pairs of different indices and tested their levels of significance. Here, the rank correlations are observed to be positive though not very significantly high for each pair of observations. Thus, without any loss of generality, any one of the indices can be used to describe the intensity of diversification. However, in the present study, analysis is made on the basis of computed HI indices so that the results can be compared with the earlier studies, which have, by and large, used either HI or SI. Since HI or SI assumes a very large (almost infinite) alternative of production choices, there exist a large number of crops, which can be accommodated in measuring diversity by this index. Thus if the total area is equally shared among the large number of alternative crops, it means that the share of

each crop would be exceedingly small and almost equal to zero. The higher the value of HI, the lower the diversification and the vice versa holds true.

The HI and the SI of diversification, as applied by Mukherjee (2012) and De and Chattopadhyay (2010) were used to quantify the amount of crop diversification at various levels in Nyeri and Kakamega crop sectors. The HI of diversification is given by the formula:

$$H = \sum_{i=1}^{n} p_i^2$$

Where, p_i is share of each crop defined as,

$$p_i = \frac{A_i}{\sum_{i=1}^{n} A_i}$$

Here, A_i is acreage area under each crop; P_{ni}=1 Ai is total acreage area and the value of HI ranges from 0 to 1. While, unity implies complete specialization, zero implies high diversification. Hence as the HI increases, crop diversification in a particular region decreases and as it decreases diversification in that region increases.

RESULTS AND DISCUSSION

General crop diversification trends

The mean cultivated area, the different types of crops grown and the area devoted to the growing of different crops are some of the general indicators of crop diversification. These aspects are discussed below.

Mean cultivated area in hectares

The cultivated hectares per household increased marginally from .94 hectares during the Afrint 1 to .99 during Afrint II and III (Table 1). This can possibly be attributed either to households opening more land for cultivation where the land frontier has not been exhausted or renting land. Chegulo village has the highest cultivated hecterage, while Shikomoli has the lowest. In addition to other factors, the area under cultivation is a function of population density and the low mean cultivated area in Shikomoli can partly be explained by the high population density characteristic of the area.

Crops grown

The types of different crops cultivated in the villages are shown in Table 2. As shown in the table the villages grow a wide variety of food and cash crops.

Table 1. Mean cultivated area in hectares

Village Name	Afrint I	Afrint II	Afrint III
Shikomoli	.67	.49	.52
Ekero	.91	.87	1.04
Chegulo	1.77	1.91	1.54
Munyuki	1.19	1.05	1.27
Mukuyu	1.42	1.49	1.13
Gatondo/Thegenge	.88	1.10	.80
Icuga/Gathumbi	.51	.57	.69
Kiambii	.79	.79	.85
Gatagati	.76	.93	1.06
Irigithathi	.54	.67	.98

A cursory look at the three Afrint rounds of data collection indicate that as the total cultivated land increases so do the number of different crops grown; i.e. there is a consistent but marginal increase in the area cultivated and crops grown. This finding suggests that there is a relationship between crop diversification and land area. This tendency towards crop diversification can be explained by the need to manage risks and the associated vulnerability of households and in some cases the need to increase incomes from sale of a wide variety of crops. This finding corroborates the findings of other researchers such as Mukherjee (2012), De and Chattopadhyay (2010), Delgado and Siamwalla (1997), and Kimenju and Tschirley (2008). These researchers found out that for many households that produce primarily for their own consumption with small surpluses for sale, diversifying by adding other crops (especially cash crops: cotton, tea, coffee, sugarcane, fresh horticultural produce, etc.) while continuing to produce for their own consumption can lead to greater incomes. Also, heavy reliance on few crops for cash can, in an open market economy with widely fluctuating prices, lead to instability in income and threaten rural livelihoods. Diversification into salaried wage labor and remunerative non-farm business can also greatly increase (and stabilize) total household incomes. Thus, generally from the perspective of managing risk and associated vulnerability of rural households, and in some cases from a desire to increase incomes, crop diversification

makes a lot of sense as a policy goal. Apart from stabilizing and increasing incomes, farmers could be diversifying their cropping patterns to manage risks occasioned by high costs of agricultural inputs, climate variability and by crop pests and diseases. Other reasons for engaging in crop diversification include the need to respond to the market needs and to mitigate the effects of declining soil fertility.

Table 2. Main types of crops grown in the villages

Village	Crops Grown
Shikomoli	Maize, Cassava, Sorghum, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Arrowroots, Millet, Groundnuts, Vegetables, Fruits, Sugarcane, Cashew Nuts, Tea, Coffee,
Ekero	Maize, Cassava, Sorghum, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Millet, Groundnuts, Vegetables, Fruits, Arrowroots, Sugarcane
Chegulo	Maize, Cassava, Sorghum, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Millet, Groundnuts, Vegetables, Fruits, Arrowroots, Sugarcane
Munyuki	Maize, Cassava, Sorghum, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Millet, Groundnuts, Vegetables, Fruits, Arrowroots, Sugarcane, Coffee, Sisal
Mukuyu	Maize, Cassava, Sorghum, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Millet, Groundnuts, Vegetables, Fruits, Arrowroots, Sugarcane, Coffee
Gatondo/Thegenge	Maize, Cassava, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Vegetables, Fruits, Arrowroots, Tea, Coffee
Icuga/Gathumbi	Maize, Cassava, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Vegetables, Fruits, Arrowroots, Tea, Coffee
Kiambii	Maize, Cassava, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Vegetables, Fruits, Arrowroots, Coffee
Gatagati	Maize, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Groundnuts, Vegetables, Arrowroots,
Irigithathi	Maize, Bananas, Beans, Peas, Irish Potatoes, Sweet Potatoes, Groundnuts, Vegetables, Fruits, Arrowroots, Flowers

Cultivated land allocated to different crops

Cultivated area allocated to maize declined slightly from 34.56% during Afrint I to 33.87% during Afrint II. However, the area increased to 47.77% during Afrint III. Variations are observed in the areas devoted to maize in the surveyed villages, with Shikomoli, Munyuki and Mukuyu villages devoting over 50% of the total cultivated area to maize as depicted in Table 3.

Munyuki and Mukuyu villages were virtually areas where farmers were practicing monoculture growing of maize but the farmers are now diversifying to non-food cash crops such as sugarcane. Though intercropped especially with beans and irish potatoes, maize still takes the highest proportion of cropped land among households in the two counties.

The area allocated to other food crops and vegetables, which are high value crops, fell from 38% during Afrint I to 31% during Afrint II before rising to 38% during Afrint III, but the pattern is quite diverse across the surveyed villages. This could possibly mirror the declining prices of the major cash crops in the world market. However, and the above findings notwithstanding, the mean area devoted to non-food cash crops increased from .65 in Afrint I to .90 in Afrint II before declining to .73 in Afrint III. Diversification into non-food cash crops can possibly be explained by the need to earn cash from their agricultural activities. In the villages of Mukuyu and Munyuki farmers are diversifying into non-food cash crops such as sugarcane, soya beans and sunflower. These villages in Lugari Sub-county are areas where monoculture growing of maize was hitherto widely practiced up to date.

Crop diversification trends in the villages and across farm types

In this section we present results from the HI and the SI indices. Table 4 shows the results of the diversification indices in the ten Afrint Villages. The village-wise variation in values of Herfindahl and Simpson indices shows a similar pattern. The villages, which were top in terms of these indices during Afrint1, remained at the top during Afrint II also. Ekero, Chegulo and Kiambii were the top three and Gatagati, Munyuki and Mukuyu were the bottom three villages in terms of diversification of crops.

Table 3. Area allocated to different crop categories (hectares)

Crop	Village	Afrint I	Afrint II	Afrint III	Mean
Maize					
	Shikomoli	16.57	20.44	28.41	21.80
	Ekero	8.06	12.39	20.93	13.79
	Chegulo	12.21	11.29	11.89	11.80
	Munyuki	20.94	23.68	17.02	20.55
	Mukuyu	20.00	18.98	27.54	22.18
	Gatondo/Thegenge	8.30	2.69	8.33	6.44
	Icuga/Gathumbi	12.63	11.40	19.85	14.63
	Kiambii	15.86	15.70	23.28	18.28
	Gatagati	9.31	7.59	13.35	10.08
	Irigithathi	16.10	12.90	22.72	17.24
Other Food crops and vegetables					
	Shikomoli	12.95	9.17	29.56	17.22
	Ekero	20.17	8.20	15.98	14.78
	Chegulo	11.03	10.19	9.55	10.26
	Munyuki	21.13	23.89	20.09	21.70
	Mukuyu	25.06	23.78	19.41	22.75
	Gatondo/Thegenge	7.81	2.53	10.50	6.95
	Icuga/Gathumbi	10.14	9.16	7.63	8.98
	Kiambii	12.32	12.20	14.90	13.14
	Gatagati	17.01	13.87	10.24	13.71
	Irigithathi	17.32	13.87	14.93	15.37
Non-food cash crops					
	Shikomoli	28.11	16.38	15.72	20.07
	Ekero	27.85	26.22	19.62	24.56
	Chegulo	19.21	17.76	27.50	21.49
	Munyuki	10.86	12.28	10.32	11.15
	Mukuyu	2.77	2.63	20.53	8.64
	Gatondo/Thegenge	26.45	8.58	21.90	18.98
	Icuga/Gathumbi	20.23	18.27	9.43	15.98
	Kiambii	10.60	10.49	11.25	10.78
	Gatagati	31.25	25.47	2.23	19.65
	Irigithathi	7.32	5.86	.84	4.67

Table 4. Crop diversification indices in Kenyan Afrint villages

	Herfindahl Indices			Simpson Indices		
0	1	2	3	4	5	6
Village	Afrint I	Afrint II	Afrint III	Afrint I	Afrint II	Afrint III
Shikomoli	.34(9.5)	.38(5)	.43(4.5)	.66(1.5)	.62(6)	.38(8)
Ekero	.37(6)	.37(7)	.34(10)	.63(5)	.63(4)	.37(6)
Chegulo	.34(9.5)	.37(7)	.38(8)	.66(1.5)	.63(4)	.37(6)
Munyuki	.45(4)	.55(3)	.44(3)	.55(7)	.45(8)	.55(3)
Mukuyu	.50(2)	.65(1)	.43(4.5)	.50(9)	.35(10)	.65(1)
Gatondo/Thegenge	.41(5)	.57(2)	.39(7)	.59(6)	.43(9)	.57(2)
Ichuga/Gathumbi	.35(7.5)	.35(10)	.40(6)	.65(3.5)	.65(1)	.35(10)
Kiambii	.35(7.5)	.36(9)	.37(9)	.65(3.5)	.64(2)	.36(8)
Gatagati	.51(1)	.42(4)	.49(2)	.49(10)	.58(7)	.42(4)
Irigithathi	.49(3)	.37(7)	.52(1)	.51(8)	.63(4)	.37(6)
Rank Correlation	R_{12} =.52	R_{23}=.31	R_{13}=.573	R_{12}=.52	R_{23}=.31	R_{13}=.573

Note. (i) R_i is the rank correlation between i^{th} and j^{th} column.

(ii)Figures in the parenthesis represent ranking of the villages

*All correlation coefficients were found not to be significant at 1 percent,5 percent and 10 percent levels of significance by two tailed test.

Here, the rank correlations of village-wise indices between any two study periods were found to be positive, which is an indication that the villages where the levels of diversification in the early stage were high maintained the same position over the years. As HI represents the extent of concentration of crops, SI is calculated by deducting the HI from unity, we find similar correlations between any two chosen periods for both the HI and SI. Table 4 shows that most of the villages remained in the diversified phase during the three study periods. As noted earlier this scenario where most households remain diversified can be explained by the need for households to manage risks and to meet their subsistence needs Farmers could also be diversifying away from maize to other crops due to the high cost of inputs and new diseases and pests such as the lethal maize necrosis disease and the fall army worms. Diversification is also being driven by the changes in the markets where the consumers are now demanding high value foods. Farmers could also be diversifying into crops that are resistant to drought, pests and diseases. In addition to the above reasons, the farmers are diversifying into newly introduced cash crops such as tea tree, soy beans, and grain amaranth which fetch good prices in the market. In order to understand which farms engaged more in crop diversification, HI and SI indices were calculated separately for FMFs and for MMFs (Tables 5 and 6).

Table 5. Crop diversification indices in female managed farms

	Herfindahl Index			Simpson Index		
0	1	2	3	4	5	6
Village	Afrint I	Afrint II	Afrint III	Afrint I	Afrint II	Afrint III
Shikomoli	.36(8)	.44(5)	.42(6)	.64(3)	.56(6)	.58(5)
Ekero	.39(6)	.36(9)	.34(10)	.61(5)	.64(2)	.66(1)
Chegulo	.34(9.5)	.36(9)	.36(9)	.66(1.5)	.64(2)	.64(2)
Munyuki	.47(4)	.54(2.5)	.47(4)	.53(7)	.46(7.5)	.53(7)
Mukuyu	.55(2)	.72(1)	.54(2)	.45(9)	.28(10)	.46(9)
Gatondo/ Thegenge	.46(5)	.48(4)	.37(8)	.54(6)	.52(9)	.63(3)
Icuga/Gathumbi	.34(9.5)	.38(6)	.43(5)	.66(1.5)	.62(5)	.57(6)
Kiambii	.38(7)	.37(7)	.38(7)	.62(4)	.63(4)	.62(4)
Gatagati	.73(1)	.54(2.5)	.58(1)	.27(10)	.46(7.5)	.42(10)
Irigithathi	.49(3)	.36(9)	.5(3)	.51(8)	.64(2)	.5(8)
Rank Correlation	R_{12}=.513	R_{23}=.597	R_{13}=.67*	R_{12}= .513	R_{23}=.597	R_{13}=.67*

(i) R_i is the rank correlation between i^{th} and j^{th} column.
(ii)Figures in the parenthesis represent ranking of the villages
*Correlation coefficients were not significant at 0.01, 0.05 and 0.1, save for R_{13} which was significant at 0.1.

Table 6. Crop diversification indices in male managed farms

	Herfindahl Index			Simpson Index		
	1	2	3	4	5	6
Village	Afrint I	Afrint II	Afrint III	Afrint I	Afrint II	Afrint III
Shikomoli	.34(9)	.36(9)	.44(3)	.66(2)	.64(2)	.56(8)
Ekero	.37(6)	.38(6.5)	.35(10)	.63(5)	.62(4.5)	.65(1)
Chegulo	0.36(7.5)	.41(4)	.41(6)	.64(3.5)	.59(7)	.59(5)
Munyuki	.43(4)	.56(3)	.42(4)	.57(7)	.44(8)	.58(7)
Mukuyu	.49(3)	.64(1)	.41(6)	.51(8)	.36(10)	.59(5)
Gatondo/Thegenge	.40(5)	.59(2)	.41(6)	.60(6)	.41(9)	.59(5)
Icuga/ Gathumbi	.36(7.5)	.34(10)	.38(8)	.64(3.5)	.66(1)	.62(3)
Kiambii	.33(10)	.37(8)	.36(9)	.67(1)	.63(3)	.64(2)
Gatagati	.53(1)	.40(5)	.48(2)	.47(10)	.60(6)	.52(9)
Irigithathi	.51(2)	.38(6.5)	.53(1)	.49(9)	.62(4.5)	.47(10)
Rank Correlation	R_{12}=.513	R_{23}=.077	R_{13}=.55	R_{12}=.513	R_{23}=.077	R_{13}=.55

(i) R_i is the rank correlation between i^{th} and j^{th} column.
(ii) Figures in the parenthesis represent ranking of the villages
*Correlation coefficients were not significant at 0.01, 0.05 and 0.1, save for R_{13} which was significant at 0.1.

Comparing the results in Tables 5 and 6, it is discernible that even though all the farms are diversifying their cropping practices, FMFs are more diversified than MMFs. Results for the FMFs show a higher and significant degree of crop diversification. This may be explained by the fact that females who are more inclined to meeting the subsistence needs of the family grow a wide range of subsistence crops. On the other hand, males who are in most cases more commercialized tend to grow cash crops at the expense of food crops.

CONCLUSIONS AND POLICY IMPLICATIONS

In this paper, we have examined aspects of crop diversification giving them a gender dimension. The extent of crop diversification disaggregated by the gender of the farm manager was addressed. The study first concludes that households in Nyeri and Kakamega counties are diversifying rather than specializing in their cropping activities. Consequently, the regions just like the rest of the country are in their very early stages of agricultural transformation as evidenced by the highly diversified, subsistence oriented production except in a few cases where some villages and households are tending to more specialized production oriented towards the market. Secondly, FMFs were found to be more diversified than MMFs.

One policy implication is that entry barriers for disadvantaged households, especially for the FMFs to participate in higher-paying cropping activities need to be overcome. A related policy implication is that there is still significant scope for income increases through the direct promotion of cropping activities that are better paying. Given the complementarities between crop growing and livestock keeping and the fact that both sub-sectors actually face similar constraints, appropriate policy instruments can actually serve both purposes. For instance, accessible credit schemes can facilitate the establishment of livestock enterprises and promote agricultural development simultaneously. Improved opportunities in rural areas targeting women and other disadvantaged groups can help level the playing field and reduce the gender gap with their concomitant development problems.

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