LIVELIHOOD DIVERSIFICATION AND IMPACT OF OFF-FARM INCOME ON AGRICULTURAL INVESTMENT IN NYERI AND KAKAMEGA COUNTIES, KENYA

Wambugu, S.K.[1]*, Djurfeldt, A.A.[2], Karugia, J.T.[3] and Kosura, W.O.[4]
[1]Department of Arts and Humanities, Chuka University, P. O. Box 109-60400, Chuka
[2]Lund University, Sweden; [3]ReSAKSS (ILRI)
[4]Department of Agricultural Economics, University of Nairobi, P. O. Box 30197-00100, Nairobi
** Correspondence: stephen.wambugu@chuka.ac.ke, kairu.wambugu@gmail.com*

ABSTRACT
Aspects of livelihood diversification and impact of off farm income on agricultural investment and productivity have not received enough empirical research. The question whether off farm activities and the income there of enhance or impede agricultural investment and productivity is an area that requires further research. This study examined aspects of agricultural diversification and impact of off farm income on agricultural investment in Nyeri and Kakamega Counties of Kenya. The objectives of the study were to quantify the levels of diversification at crop, livestock and income levels and to assess the impact of off-farm income on agricultural investments and productivity. The study relied on a panel data set collected in 2002, 2008 and 2013 from two counties in Kenya namely Nyeri and Kakamega. The data was collected in 10 villages and 300 households sampled in the two counties. The Herfindahl index together with some descriptive statistics was used to analyze the degree of diversification. The tobit and double hurdle models were used to analyze the impact of off-farm income on input use, agricultural specialization and intensification. The key findings of this study are that households in Nyeri and Kakamega counties are diversifying (villages had Herfindahl indices of over 0.8) rather than specializing in their agricultural activities. The impact of off-farm earnings on input use, agricultural specialization and intensification was found to be minimal. The tobit and double hurdle models showed that non-farm income had negative coefficients on adoption and intensity of agricultural input use. It is recommended that policies that will encourage a shift from promoting broad agricultural diversification to facilitating specialization among households that are likely to do should be designed. A multifaceted approach to policy that considers other constraints to intensification and specialization especially with regard to technology generation returns to input use, input delivery systems and effectiveness of extension should also be used.
Key words: Livelihood diversification, Crop, Livestock, Off-farm income, Inputs, Tobit, Intensification.

INTRODUCTION
The importance of non-farm income for livelihood strategies of rural people has attracted much attention among development scholars, policy makers and donors during the past decades (Barrett and Bezuneh, 2005). Although non-farm incomes on an aggregate level are important in the rural economies of Sub Saharan Africa, the distribution of such incomes is normally much skewed in favor of the better-off. The bulk of studies on income diversification out of agriculture into the non-farm sector have therefore focused on mechanisms that can lower entry barriers and increase the participation of the poor in such income generation (Andersson, 2011; Ellis, 2005; Karugia and Wambugu, 2009; Djurfeldt and Wambugu, 2011; Wambugu and Karugia, 2015).

Much less attention has been devoted to the question of how non-farm activities affect farming even though the great majority of rural Africans still source their income from agricultural production (Wambugu and Karugia, 2015). Disregarding the household level linkages between farm and off-farm activities severely limits the scope for designing policies and interventions capable of reducing rural poverty. This study offered to fill some of these knowledge gaps through investigating the impact of non-farm income on farm investment among small holders in two counties in Kenya (Nyeri and Kakamega Counties). This study was guided by the following three main objectives, to: (i) analyze the general trends in livelihood portfolios in Nyeri and Kakamega Counties, (ii) quantify the levels of diversification at crop, livestock and income levels, and (iii) assess the impact of off-farm income on agricultural investments and productivity.

METHODOLOGY
Study Sites
This study was conducted in Nyeri and Kakamega Counties of Kenya. Five villages were selected from each county on the basis of differences in agro-ecological potential (AEP), agro-ecological zones (AEZ), market access and other pertinent factors. The characteristics of the selected villages are summarized in Table 1.

Table1: Characteristics of the selected villages

Village	Average farm size	Population Density	General soil fertility	Average annual rainfall	AEZ	AEP	Market access	Major crops Grown
Shikomoli	Small	848	Poor	2000	UM1	Medium	Medium	Coffee, tea, maize
Ekero	Medium	617	Good	1800	LM1	Good	Good	Sugarcane, maize
Chegulo	Medium	287	Medium	1600	LM2	Poor	Poor	Sugarcane, sweet potatoes
Munyuki	Very Large	436	Good	1400	UM4	Good	Good	Maize, beans, sweet potatoes
Mukuyu	Small	373	Good	1200	UM4	Good	Poor	Maize, beans, sweet potatoes
Gatondo/ Thegenge	Small	494	Good	1400	LH1	Good	Good	Tea, horticultural products
Ichuga/ Gathumbi	Small	512	Medium	1000	UM3	Medium	Good	Coffee, maize
Kiambii	Small	510	Medium	900	UM4	Medium	Medium	Maize
Gatagati	Large	128	Good	1000	LH3	Medium	Poor	Horticultural products
Irigithathi	Nyeri	126	Poor	800	LH4	Poor	Medium	maize

Source: Karugia and Wambugu, 2009.

Research Design and Sampling Procedures

Multistage purposive sampling as was done during Afrint1 in 2002 and in Afrint II in 2008 was used from the region (formerly a province) down to the household. For detailed information on Afrint research please visit the Afrint website athttp://www.keg.lu.se/en/sites/keg.lu.se.en/files/kenya_afrint. In selecting the regions, counties, sub-counties, divisions, sub locations and the villages; this study just like Afrint1 and Afrint II was guided by the following factors:

- The area having considerable variability in agro-ecological potential (from high to low);
- The area having different levels of market access;
- Population density and farm sizes;
- Significant levels of agricultural and income diversification;
- Significant levels of poverty and inequality.

Consequently, at the national level two Counties selected during Afrint1 and in Afrint II were again selected for this study. Kakamega County in western region was selected as an area with a very high population density. Nyeri County in Central region was chosen for its considerable variability in agro-ecological potential and market access. The five villages (Table 1) as identified in Afrint1 and II were selected from each county primarily on the basis of differences in agro ecological potential and market access and other pertinent factors.

This study used the sampling frame as was used in Afrint1 and II in 2002 and 2008 studies. In the 2002 Afrint1 study, the process of sampling the households (hhs) started with the selection of villages where informal discussions on the objectives of the study were held with agricultural officers, village elders and farmers. Once villages were purposefully selected, enumerators with the help of location chiefs, sub location assistant chiefs and village elders compiled sample frames consisting of households in each village. From each sample frame, which consisted of between 150 and 200 households, 30 households were randomly selected. Most categories of households were represented in the final sample which consisted of 30 households from the ten villages. Attrition is a problem in all panel studies like this one, since a portion of the original units might disappear from the population, either by passing away or by emigrating from the area. In this study the problem of attrition was dealt with in a number of ways. In cases where we had more than one descendant household, we randomly selected one descendant household to replace the original one. We also tried to trace households which had migrated from the villages by making enquiries with neighbors. This study tried to make the 2013 sample representative of the current village agrarian population by making lists of households who have settled in the village since 2008 and drew a random sample of these. Consequently the new 2013 had the following categories of households: un-partitioned households with the same head as in 2008 (which were the majority), un-partitioned households with new head, newly sampled offspring households, in migrated households (sampled from list of in-migrants) and out-migrated households. No serious problems were reported in relation to the administration of the household and the village diagnostics questionnaires. They had relatively few

questions that were considered problematic or unduly time consuming. However, some cultural factors such as disclosing the actual number of children and incomes caused some minor problems which were addressed by the researchers. Thus, the overall quality of data collected was judged to be quite good and met the objectives of the study.

Data Sources and Methods of Data Collection

The main data collection instruments were a household survey questionnaire directed at the three hundred sampled households. A village diagnostic questionnaire which captured agricultural dynamism in the villages was also administered. Key informants interviews and focus group discussions supplemented the information collected. Treating the 2002 Afrint1 and the 2008 Afrint II surveys as baselines the 300 households were resurveyed. A combination of both quantitative and qualitative household data offered an opportunity to investigate the important dynamic relationship between diversification, livelihood portfolios, technology adoption, incomes, agricultural commercialization and household welfare. More specifically, the household survey questionnaire enabled the researchers to identify the key drivers of agricultural development in terms of temporal changes in production and yields of food staples, i.e. area expansion or intensification based on available technologies or the adoption of new ones. The main respondents to the household survey were the household heads (hhhs) or the farm managers. The study drew on existing databases comprising general livelihood portfolios, cropping patterns, income and production data for 2002, 2008 and 2013 for 300 farm households in 10 villages situated in two regions. In addition to the surveys carried out in 2002 and in 2008, the households were resurveyed in 2013 in order to obtain a panel data set allowing detailed analysis of the mentioned linkages over time

Methods of Data Analysis

Analysis of general trends in livelihood portfolios

In order to analyze the general trends in livelihood portfolios in Nyeri and Kakamega Counties, descriptive statistics were used. In particular percentages, means and proportions were used to explain household income sources, crop production trends, livestock production trends and crop cum livestock contributions to household gross income.

Analysis of diversification trends

The Herfindahl index of diversification, as applied by Kurosaki (2003) and Kimenju and Tschirley (2009) was used to quantify the amount of diversification at various levels in Nyeri and Kakamega agricultural sectors. The Herfindahl index of diversification is given by the formula:

$$D_k=1-\sum^{N}_{i=1} (S_{i,k})^2$$

Where S_i refers to share and $\sum^{N}_{i=1} (S_{i,k})=1.0$.

Dk varies from a value of zero, indicating complete economic specialization in one activity or complete spatial specialization into one spatial unit ($S_i=1$ in each case), to 1.0, indicating that economic output comes from many different activities or spatial units, none with a predominant share. The interpretation of k, i, and N depends on the type of diversification being computed. For economic diversification (diversification across economic activities within an economic unit), k refers to the economic unit of interest, i refers to a specific economic activity, and N is the total number of activities being considered. For example, to compute how diversified a household (or region) is across all economic activities, k refers to the household (or region) and i refers to the N different crop, livestock, and off-farm activities in which the household is involved (or which take place in the region). Economic diversification within a sector, e.g. diversification across crops within all cropping activities, can be computed by limiting the computation to that set of activities. When calculating spatial diversification, k refers to the spatially most aggregated unit (e.g., country), i to a less aggregated unit within k (e.g., region), and N to the number of less aggregated units.

This study based the crop diversification calculations on five groups of crops: cereals, tubers and pulses, fruits and vegetables, industrial crops, and all other crops. In calculating agricultural diversification, this study added three livestock categories to the crop categories: cattle, goats and sheep (shoats), pigs and poultry. Livelihood diversification was calculated by adding four off-farm activity groups to the eight agricultural groups: salaried employment, informal businesses, remittances, and farm *kibarua* (labour).

Analysis of impact of off-farm income on agricultural investment

In order to assess the impact of off-farm income on agricultural investment and productivity, input demand functions were modeled to determine the factors that drive farmers' decisions to use inputs and to assess how engagement in off-farm work affects this decision. Separate regression models for fertilizer and hybrid seeds (the major agricultural inputs), were estimated each with aggregated and disaggregated off-farm work types. Tobit and double-hurdle models were run for fertilizer and for hybrid seed demands.

The models were disaggregated and aggregated for off-farm income. As a robustness check, the estimated parameters were compared to the corresponding standard tobit estimation. The standard tobit specification as defined by Mathenge and Tschirley, 2009 takes the form:

$$t_1^* = X_i^{'}\beta + \varepsilon_i \text{ with } \varepsilon_i \sim N(0,\sigma^2) \text{ and } i=1,\ldots..,n \quad (1)$$

$$t_i = \begin{cases} t_i^* & if\ t_i^* > 0 \\ 0 & if\ t_i^* \le 0 \end{cases}$$

Where t_i^* is a latent endogenous variable representing individual i's desired level of expenditure on fertilizer, and t_i is the corresponding actual observed expenditure on fertilizer. X_i is a set of individual characteristics that explain the use and level of expenditure on fertilizer, and β is a corresponding vector of parameters to be estimated, ε_1 is an assumed homoskedastic normally distributed error term. Equation (1) states that the observed amount spent on fertilizer become positive continuous values if only positive amount of money spent are desired, but zero when otherwise. Since there is no negative expenditure, the censoring could be placed at zero without any loss of generality.

In the double-hurdle model specification an individual has to overcome two hurdles in order to report a positive amount of money spent. The first hurdle is based on whether farmers use fertilizer in maize production and the second hurdle models the decision on how much to invest on the fertilizer. The double-hurdle model, originally formulated by Cragg (1971) by modifying the standard tobit model, assumes that two hurdles are involved in the process of investment decisions, each of which can be determined by a different set of explanatory variables. In order to observe a positive level of investment, two separate hurdles must be passed. A different latent variable is used to model each decision process:

$$y_{i1}^* = w_i^{'}\alpha + v_i \qquad \text{Investment decision}$$

$$y_{i2}^* = x_i^{'}\beta + u_i \qquad \text{Level of investment}$$

$$y_i = x_i^{'}\beta + u_i \text{ if } y_{i1}^* > 0 \text{ and } y_{i2}^* > 0$$

$$y_i = 0$$

Otherwise, we can envision simultaneity (e.g. use of fertilizer and hybrid seed) and multicollinearity (e.g. agricultural income and off farm income) of some of the variables used in the model. Off farm income could increase farm investment leading to increased agricultural income, while farmers often use hybrid seed in combination with fertilizer. Partial correlations were used to determine the relationship between both on farm and non-farm income and relationship with farm investment. Off farm income was then disaggregated into different sources in the second regression model to minimize chances of multicollinearity. Partial correlation coefficients were also used to test for multicollinearity of the variables that were used in the regression. Figure 1 shows the trend the index takes on as a function of the number of activities in which the economic unit is involved, and assuming that each activity has an equal share in overall economic activity.

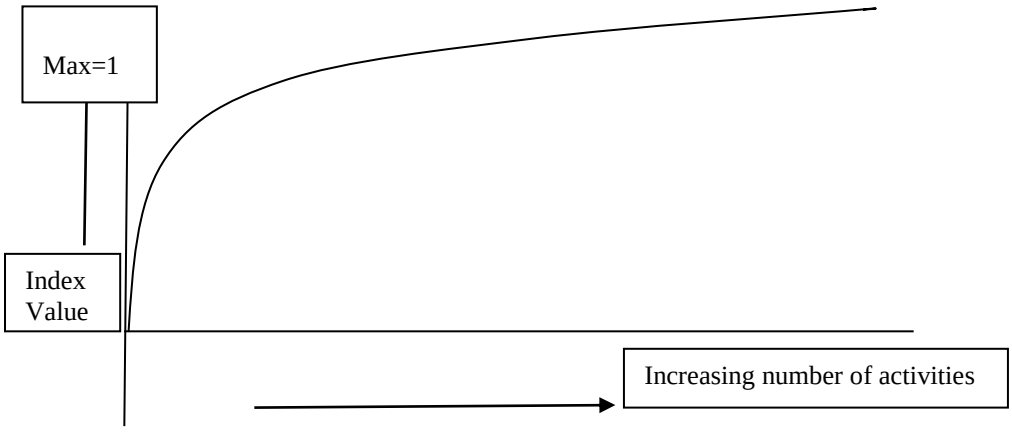

Figure 1: Values of Herfindahl Concentration index assuming equal share of each economic activity. Source: Modified from Kimenju and Tschirley, 2009.

RESULTS AND DISCUSSION

Crop and Livestock Contribution to Income

The study found out that diversified households derive their income from a number of sources with none being dominant. The decision to diversify is a conscious household decision and may be driven by factors such as price factors, new technology, government policy, or even emergence of new markets. The contribution to gross income from a certain activity is another indicator of household diversification into or out of a certain economic activity. Gross revenue is also a proxy for time and effort allocated by a household to a certain activity hence may be a better indicator of diversification than net incomes. Diversification within agriculture considers revenues from both crops and livestock. In the case of this study, the categories have been combined. As shown in Table 2, the overall contribution from the sale of food staples was lowest in 2002 at 7% while the sale of non-food crops was the highest at 19.92%.

Table 2: Agricultural contribution to gross household income as a percentage of the total

Village	Year	Sale of food staples	Sale of other food crops	Sale of non-food cash crops	Sale of animals/animal produce	Overall Mean
Shikomoli	2008	1.01	16.24	26.27	21.62	16.29
	2013	4.00	4.91	42.99	9.71	15.40
Ekero	2008	1.63	16.44	25.73	26.48	17.57
	2013	0.95	21.82	36.66	35.46	23.72
Chegulo	2008	0.64	7.37	15.89	29.47	13.34
	2013	12.15	18.16	20.96	28.29	19.89
Munyuki	2008	0.88	40.92	12.46	34.07	22.08
	2013	20.17	9.44	0.00	44.50	18.53
Mukuyu	2008	1.86	27.44	11.92	22.13	15.84
	2013	16.14	15.49	0.18	19.75	12.89
Gatondo/Thegenge	2008	14.32	29.04	6.01	0.00	12.34
	2013	5.22	2.27	14.72	3.47	6.42
Icuga/Gathumbi	2008	1.51	1.34	68.65	10.73	20.56
	2013	15.40	10.66	37.24	13.47	19.19
Kiambii	2008	33.55	17.57	2.22	6.44	14.95
	2013	13.93	5.93	4.98	21.65	11.62
Gatagati	2008	0.48	2.04	29.78	4.77	9.26
	2013	1.57	2.86	26.81	7.16	9.60
Irigithathi	2008	14.10	28.64	0.99	36.90	20.16
	2013	30.99	20.29	11.29	9.87	18.11
Overall Sample	2008	7.00	18.70	19.92	19.26	64.88
	2013	12.05	11.18	19.58	19.33	62.14

Results showed that although there were no significant variations in overall sources of agricultural incomes, there were significant variations among villages. Table 2 shows that households in Kiambii and Irigithathi villages derived their incomes from sale of food staples. In comparison, shikomoli, Munyuki, Mukuyu, Kiambii and Gatagati villages were more specialized deriving their agricultural revenue largely from two sources as opposed to the other villages which were more spread out.

Non-Farm Activities' Contribution to Household

Excluding income from agricultural activities (sale of crops, livestock and livestock products), it was observed that non-farm salaried employment was the highest contributor to household gross income. However, as shown in Table 2, the contribution of non-agricultural activities to households' gross revenue was generally on an upward trend. The overall contribution of agricultural activities to gross revenue decreased from 64.88% in 2008 to 62.14% in 2013 while that from off-farm activities increased from 35.05% in 2008 to37.85% in 2013. This could be an indicator of households slowly diversifying from on-farm to off-farm activities. However, and taking the two time periods, agricultural sources still remained as the major sources of income at 63.51%

while off-farm activities contribution stand at 36.45% (Tables 2 and 3).

Trends in Livelihood Diversification

Household economic diversification

Table 4 presents results for diversification at crop, agricultural and livelihood levels. Several results stand out; first, crop diversification (Table 5) increased over the period from 2002 through 2008 to 2013. Livestock diversification (Table 6) also increased over the period but at a slightly slower rate and actually dropped slightly from 2002 to 2008 before increasing marginally in 2013. This may imply that specialization in livestock production may have started to occur. Second, agricultural diversification may have stabilized, dipping slightly in 2008 but increasing in 2013 though the trend was not very clear. Income diversification fell slightly from 2002 to 2008 but increased in 2013.

All in all, these results suggest that households were beginning to respond to the changing policy and economic environment by slowing or even reversing their crop and broader agricultural diversification by beginning slowly to specialize in certain crops and livestock but were continuing to diversify their broader livelihoods by adding off-farm activities while maintaining most of their agricultural activities (Table 4). Thus the two counties are at quite an early stage of the agricultural transformation process.

Table 3: Non-agricultural contribution to gross household income as percentage of the total

Village	Year	Leasing out Machinery/ Equipment	Work on Others' Farms Agricultural Labour	Non-Farm Salaried Employment	Micro-Business	Large-Scale Business	Rent, Interest	Pensions	Remittances	Overall Mean
Shikomoli	2008	0.00	2.51	27.61	3.77	0.00	0.00	0.57	0.40	4.36
	2013	1.17	9.33	17.04	5.92	0.00	1.08	0.99	2.87	4.80
Ekero	2008	0.02	1.75	16.29	7.40	0.00	1.35	1.85	1.06	3.71
	2013	0.00	0.50	0.63	3.97	0.00	0.00	0.00	0.00	0.64
Chegulo	2008	0.00	0.91	42.00	0.00	0.00	0.00	1.73	1.99	5.83
	2013	0.00	0.00	0.00	0.00	9.40	0.19	5.87	4.98	2.55
Munyuki	2008	0.00	3.61	4.64	2.65	0.77	0.00	0.00	0.00	1.46
	2013	0.00	1.59	13.60	3.31	0.00	3.36	2.47	1.56	3.24
Mukuyu	2008	0.00	2.72	27.42	3.43	0.80	0.00	2.12	0.17	4.58
	2013	0.00	2.63	26.13	8.76	0.00	2.55	2.63	5.76	6.06
Gatondo/Thegen ge	2008	0.00	35.50	0.00	0.00	0.00	0.00	0.00	15.13	6.33
	2013	0.00	25.53	1.81	36.30	0.00	1.81	0.00	8.87	9.29
Icuga/Gathumbi	2008	0.00	15.63	0.00	0.00	0.00	0.00	0.00	2.14	2.22
	2013	0.00	2.67	5.17	13.46	0.00	0.34	0.00	1.58	2.90
Kiambii	2008	1.11	1.11	4.78	0.00	0.00	0.00	9.33	23.88	5.03
	2013	4.29	0.70	17.33	1.00	0.00	3.20	12.19	14.80	6.69
Gatagati	2008	0.00	35.45	26.46	0.00	0.00	0.00	0.00	1.03	7.87
	2013	0.55	0.87	34.90	9.91	0.00	4.23	7.68	3.45	7.70
Irigithathi	2008	0.00	2.74	4.22	6.04	0.00	0.00	0.00	6.36	2.42
	2013	0.00	1.56	1.14	21.86	0.00	0.00	0.00	3.00	3.44
Overall Sample	2008	0.11	10.19	15.34	2.33	0.16	0.14	1.56	5.22	
	2013	0.60	4.54	11.78	10.45	0.94	1.68	3.18	4.69	

Table 4: Diversification indices at various levels

	Type of diversification			
	Crop	Income	Livestock	Livelihood
2002	0.84	0.88	0.72	0.81
2008	0.85	0.84	0.69	0.79
2013	0.88	0.86	0.75	0.83

Table 5: Crop diversification indices

Village	2002	2008	2013
Shikomoli	0.86	0.83	0.86
Ekero	0.83	0.86	0.88
Chegulo	0.83	0.88	0.89
Munyuki	0.86	0.88	0.89
Mukuyu	0.86	0.88	0.88
Gatondo/Thegenge	0.83	0.86	0.89
Icuga/Gathumbi	0.83	0.83	0.88
Kiambii	0.83	0.83	0.86
Gatagati	0.80	0.83	0.88
Irigithathi	0.83	0.80	0.86
Overall Mean	0.84	0.85	0.88

Table 5 shows that crop specialization was yet to begin in most of the villages especially for Shikomoli and Irigithathi where specialization started in 2008 and then the farmers went back to diversification in 2013. Consequently, most of the villages remained in the diversified phase. This need for most households to remain diversified can be explained by the need for households to manage risks and to meet their subsistence needs.

Key informants interviews and FGDs revealed that farmers were diversifying away from maize to other crops due to the high cost of inputs and new diseases like lethal maize necrosis. Diversification was also being driven by the changes in the markets where the consumers are now demanding high value foods. Farmers also said that they were diversifying into crops that were drought resistant and to those that were resistant to pests and diseases. In addition to the above reasons, the farmers also said that they were diversifying into newly introduced cash crops such as tea tree, soy beans, and grain amaranth which fetched good prices in the market.

Table 6 indicates that households in Ekero, Mukuyu, Kiambii and Irigithathi villages started livestock specialization in 2008 before going back to diversification in 2013. Households in the villages of Shikomoli and Chegulo remained in the livestock diversification phase throughout the study period. However, households in the villages of Munyuki, Gatondo and Gatagati though remaining in the diversification phase in the two time periods (2002 and 2008), started to diversify in the year 2013. The higher livestock diversification can be attributed to the introduction of emerging livestock such as the dairy goats, turkeys, rabbits, guinea fowls and quails. These were being introduced due to the diminishing land sizes occasioned by land sub-divisions as sons inherit land and break away from their nuclear families to establish their own households. The 'craze' with healthy eating can also explain this observed trend of greater livestock diversification into the emerging livestock.

Table 7 depicts income diversification trends in the surveyed villages. Households in the villages of Shikomoli, Ekero, Chegulo, Mukuyu, Gatondo, Kiambii, Gatagati and Irigithathi (i.e. 80% of the households in the surveyed villages) started income specialization in 2008. However, most of them reverted to greater income diversification in 2013 save for households in Munyuki, Ichuga, Kiambii, Gatagati and Irigithathi. Households in the villages of Munyuki and Irigithathi remained in the income diversification phase with Herfindahl indices of 0.86 for the periods 2008 and 2013. However, households in the villages of Ichuga and Kiambii started to move to the phase of income specialization in 2013. The only village showing a consistent trend towards income specialization was Gatagati whose Herfindahl indices showed a consistent downward trend for the periods 2002, through 2008 to 2013 (Table 7).

The higher income diversification trend was attributed to the need for households to earn greater income by diversifying into salaried wage labour and remunerative non-farm businesses which can also greatly increase (and stabilize) total household incomes, a finding which agrees with Kimenju and Tschirley (2009). Key informants interviews, FGDs and participants/researchers' observations noted that households were diversifying into various non-farm income sources such as *boda boda* (bicycle) and motorcycle transport, brick making, sand harvesting, micro businesses (shopkeepers, posho milling, tailoring, *M-Pesa* (mobile money) shops etc, formal and informal salaried employment (in private schools and agro-processing factories) and as artisans in the *jua kali* (informal) sector.

Table 6: Livestock diversification indices

	2002	2008	2013
Shikomoli	0.67	0.67	0.67
Ekero	0.75	0.67	0.75
Chegulo	0.67	0.67	0.67
Munyuki	0.67	0.67	0.80
Mukuyu	0.8	0.67	0.75
Gatondo/Thegenge	0.75	0.75	0.80
Icuga/Gathumbi	0.67	0.75	0.80
Kiambii	0.75	0.67	0.75
Gatagati	0.67	0.67	0.75
Irigithathi	0.80	0.67	0.75
Mean Index	0.72	0.69	0.75

Table 7: Income Diversification Indices

	2002	2008	2013	Mean index
Shikomoli	0.86	0.75	0.86	0.82
Ekero	0.90	0.80	0.86	0.85
Chegulo	0.89	0.83	0.88	0.87
Munyuki	0.88	0.86	0.86	0.87
Mukuyu	0.89	0.86	0.88	0.88
Gatondo/ Thegenge	0.88	0.86	0.88	0.87
Icuga/ Gathumbi	0.86	0.88	0.86	0.87
Kiambii	0.90	0.83	0.8	0.84
Gatagati	0.88	0.86	0.83	0.86
Irigithathi	0.89	0.86	0.86	0.87
Mean Index	0.88	0.84	0.86	

Impact of Non-farm Income on Agricultural Investment

Under ideal situations nonfarm income is expected to be invested in productivity enhancing technologies and improved farming techniques. The relationship between non-farm income and farm investment is presented in table 8.

Table 8: Correlation between non-farm income and farm investment

Farm investment	Total nonfarm income
Expenditure on fertilizer	0.001
Expenditure on herbicides	0.232
Area under cash crops	0.317**
Total farm size cultivated	0.164**
Farm size rented in	0.335**
Total cattle owned	0.099
No. of graded/ cross-bred cows	0.131*
Total farm income	0.274**

The study found out that total non-farm income was positively and significantly correlated with area under cash crops, total cultivated area, amount of land rented, number of graded/cross breed cows and total farm income. Cash crops farming and keeping of graded cows is often capital intensive and farmers are likely to invest more of the non-farm income to take care of the investment and running costs. Non-farm income also enables farmers to increase total area cultivated as well as expansion of cultivated land by way of renting in, hence the significant correlation coefficient. There is however insignificant correlation between non-farm income and investment in fertilizer and herbicides in maize production. This may imply that most of non-farm income is invested away from food production possibly to buy household assets and other consumer goods.

Tables 9 and 10 present parameter estimates of the fertilizer demand model with aggregated and disaggregated off farm income respectively. The dependent variable was the total amount spent on fertilizer per hectare of maize grown. Coefficients in the first hurdle indicated how a given decision variable affects the likelihood (probability) to adopt fertilizer in maize. Those in the second hurdle indicated how decision variables influenced the amount spent on fertilizer per hectare. The results for Tobit and double hurdle were reported side by side for comparison. The results showed that fertilizer adoption decisions were driven by different mechanisms from intensity decisions. This is so for variables such as use of hybrid seed, off farm income and access to agricultural credit.

Agricultural credit services are the major sources of finance to those farmers who adopt improved agricultural technologies like fertilizer application (Mathenge and Tschirley, 2009). Although agriculture credit is mostly provided for cash crop farming, it is expected to have a spillover effect to cereals and other food crops. It is therefore expected that households that can access agricultural credit will have a higher likelihood of using fertilizer and will use it more intensely. Our analysis showed that access to agricultural credit had the expected positive and significant effect on the decision to invest in fertilizer. However, agriculture credit was not significantly influencing the level of investment in fertilizer. Amount of maize harvested the previous season positively influenced the intensity of investment in fertilizer meaning that when farmers experience increased production they tended to invest more in fertilizer in the following season.

Results showed that maize area had positive and significant influence both on the decision to invest and on the level of investment in fertilizer use in maize production. Larger farms require more capital investment and farmers are expected to use more fertilizer as land size increases. Use of hybrid maize seed was a significant factor influencing the probability of investment in fertilizer, but was not significantly influencing the level of investment. Most of the households using hybrid seed tend to also use fertilizer, thus the two inputs are likely complements. While the fertilizer adoption decision could be relatively independent of the hybrid seed adoption, decisions on hybrid seed use seem to be made jointly with those of fertilizer, but not on the level of investment in fertilizer.

Distance to the village center was included to proxy for cost of transport. Proximity of farmers to markets

is essential for timely input delivery and output disposal and results in less transport cost of inputs and outputs. The coefficient of distance was however not significant for the intensity of use of fertilizer, meaning farmers interested in using fertilizer were not deterred by cost of transport.

The farmers' age and education level had positive and significant coefficients. This indicates that probability of investment in fertilizer increases with age and as the farmers gained more experience in farming. This might suggest that older and more experienced farmers may be using off farm incomes to finance farm investment or substitute higher off farm income for farm income. This could be attributed to the experience gathered over the years in coping with the menace of soil infertility. However, sex of the household head did not significantly influence the decision to invest in fertilizer. The results also contradict common belief that male farmers often have more access to information, extension and credit services than their female counterparts, thus use more fertilizer.

Off-farm income had negative coefficients for adoption and intensity models. The negative and insignificant impact of off farm income and the small magnitude of its decision model coefficient imply that, holding other factors constant, off farm income seems not to impact both adoption and intensity of investment in fertilizer. This suggests that these households were not using some of their off-farm earnings to purchase fertilizer for maize production, but instead were investing in other activities. In this case, off-farm earnings may not be needed to relieve cash constraints for fertilizer purchase. Likewise, agricultural income was not significantly influencing the decision and intensity to invest in fertilizer in maize production. Therefore it cannot be concluded that off farm income is driving the level of farm investments.

Table 9: Probability of investing and intensity of improved fertilizer use in maize (total off-farm income)

Variables	First hurdle	Second hurdle	Tobit
Education	0.055		54.564
	(0.023)**		(66.685)
Age of the hhh	0.009		20.224
	(0.006)**		(16.677)
Hybrid seed	0.687	6270.193	1729.536
	(0.280)**	(4470.798)	(927.427)*
Sex of the hhh	0.200		646.880
	(0.210)		(603.719)
Maize area recent season	0.524	8788.056	4198.623
	(0.266)**	(1642.504)***	(690.056)***
off farm income	-1.42E-06	-0.0022	-0.004
	(7.44E-07)*	(0.0088)	(0.002)
Distance to the nearest town	0.044	-206.321	123.892
	(0.059)	(413.010)	(159.358)
Plan to sell maize		8907.295	2292.117
		(2510.339)***	(585.157)***
Access to agricultural credit	1.031	-91.479	1242.266
	(0.305)***	(1827.553)	(580.935)**
Maize production previous season		2.867	2.266
		(0.591)***	(0.284)***
agricultural income		0.006	0.001
		(0.009)	(0.003)
Constant	-1.088	-20633.660	-5009.355
	(0.503)***	(6465.075)***	(1541.048)***
Log likelihood		-2406.8	-2350.69
Wald χ^2		218.66	30.89
P-Value		0.000	0.0001

***=significance at 1%, **=significance at 5%, *=significance at 10%

Table 10: Probability of investing and the intensity of improved fertilizer use in maize (total off-farm income)

Variables	First hurdle	Second hurdle	Tobit
Education	0.053		43.4646
	(0.023)**		(65.745)
Age of the hhh	0.007		25.19892
	(0.006)		(16.932)
Hybrid seed	0.680	6295.845	1742.968
	(0.280)**	(4215.420)	(922.783)*
Sex of the hhh	0.211		603.6265
	(0.212)		(600.648)
Maize area recent season	0.493	8703.147	4363.447
	(0.267)*	(1571.385)***	(692.717)***
Distance to the nearest town		-230.782	144.0235
		(439.793)	(161.751)
Plan to sell maize		8281.015	2225.763
		(2339.345)***	(583.624)***
Access to agricultural credit	1.038	264.866	1293.454
	(0.305)***	(1738.058)	(575.932)**
Maize production previous season		2.906	2.230
		(0.612)***	(0.287)***
agricultural income		0.008	0.002
		(0.008)	(0.003)
Salary	-2.01E-06	0.003	-0.003
	(1.02E-06)**	(0.010)	(0.003)
Micro business	-4.90E-07	0.000	0.0001
	(2.31E-06)	(0.022)	(0.007)
Remittances	7.11E-06	-0.072	-0.025
	(2.10E-06)**	(0.042)*	(0.012)*
Constant	-1.004	-19718.440	-5315.03
	(0.510)**	(6020.926)***	1549.199
Log likelihood	-2348.44		-2405.7405
Wald χ^2	31.10		22.79
P-Value	0.0003		0.000

***=significance at 1%, **=significance at 5%, *=significance at 10%

Off-farm salaried employment negatively impacted adoption of fertilizer in maize but was insignificant in influencing the intensity of use of fertilizer. Income from micro-business had negative and significant impact on decision to use fertilizer but with small coefficients, implying that income from the micro businesses were important in the decision to invest in fertilizer. Remittances had positive and significant impact on the level of investment in fertilizer, suggesting that for the households using income from remittances, the level of investment increased as the income increased. Remittances from absent household members are likely to be in high amounts and on a regular basis, hence making it possible to facilitate investment into agriculture.

CONCLUSION

This article first concludes that households in Nyeri and Kakamega counties 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 towards more specialized production oriented towards the market. Secondly, it concludes that the impact of off-farm earnings on input use, agricultural specialization and intensification is minimal. Non-farm income was found to have no significant impact on adoption and intensity of agricultural input use.

RECOMMENDATIONS

A number of recommendations can be made emanating from the findings of this research:

1) Policies should be made that will encourage a shift from promoting broad agricultural diversification to facilitating specialization among households that are likely to do so. Key aspects of this policy change include:-

- More room will need to be made in the technical research portfolio for high yielding crop and livestock packages, even if they imply more risk; while not all farmers will demand such technologies, an increasing numbers of them will;
- It will be more important for farmers to have access to the right inputs at the right time. While government input programs (e.g. for fertilizer) can provide wide access to some inputs for many farmers, private systems are likely to be better at providing the range of differentiated inputs needed by the new technologies, and to provide them on a reliable basis. It is thus important that any government input programs that does exist be modest in scope, well targeted, and that they do not interfere with the growth of private input channels;
- The counties and the country at large will need more investment in supply chain efficiencies, including improved extension, market information, physical market places, and cold chains for perishable items like fresh produce, dairy, and meat. Many of these investments will need to be facilitated by government, but they must be conceived and implemented in a highly collaborative fashion with private sector;
- Increased attention will need to be paid to negative environmental externalities from agriculture; though these negative externalities might be modest now, they could grow very rapidly in the absence of an appropriate policy framework, as input use grows rapidly with increased agricultural specialization;
- Specialization will drive less efficient farmers out of agriculture. For the agricultural transformation to proceed, broader macroeconomic and investment policy must be reviewed to ensure that they encourage free investment throughout the economy so that those leaving the farm will be able to find gainful employment elsewhere;
- Finally, the government's decision to offer free primary and now secondary education appears very well timed, as greater education will be needed to drive the growth of the non-farm economy and ensure that people are not just pushed off the farm by specialization but pulled off it by attractive income earning opportunities. As access to education increases, however, attention must continue to be paid to its quality.

2) This article provides empirical evidence of the importance of certain types of off-farm work in relaxing the credit and risk constraints that typically limit agricultural intensification in Kenya. As regards policy, a multifaceted approach that considers other constraints to intensification especially in regards to technology generation, returns to input use, input delivery systems and effectiveness of extension, must be considered in drawing policy recommendations.
3) The following areas are deemed as requiring further research.
   - Given the problems encountered in collecting reliable data on incomes, this article suggests that more reliable instruments be devised. Also there is need to collect and have reliable data that will enable calculation of the various measures of diversification.
   - Further research is also needed to explore the extent to which off farm work affects farm production decisions through re-investment in farm input use and intensification.
   - Research is also necessary to ascertain the extent to which engagement in off farm work compete with farming at higher levels with households shifting their resources to other uses perhaps with higher returns than agriculture.

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