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Full Length Research Paper

Determinants of labour mobility within smallholder farms in western Kenya and implications for labour use efficiency

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Significant gains can be made if smallholder farms' households can change their livelihood strategy. This paper is concerned with how smallholder farmers allocate labour within their farms and the barriers to cropping activities with higher outcomes. Efficiency of households in labour use across the farm was evaluated by comparing labour returns across various crops while controlling the variability in bio-physical characteristics of plots. The expectation was that returns to a single factor of production would be equal, an indication that households are likely to benefit from interventions aimed at improving their livelihood. The results obtained reveal that farmers allocate comparatively, more labour to food crops than to market-oriented crops. This suggests that labour mobility within smallholder farms is constrained. Interventions which reduce the marketing costs for food and cash crops; increase participation in labour markets; and improve other rural markets like the financial will, relax the labour constraint thereby empowering smallholder farms' households to allocate labour more efficiently on their farms.

Key words: Marginal product of labour, allocative efficiency, within farm, Kenya.

INTRODUCTION

Typically, smallholder farms' households grow a range of crops, raise livestock and engage in off-farm activities. Literature offers many reasons why farm households diversify (Ellis, 1993; Barrett and Reardon, 2001; Barrett,2006). They may engage in a range of social and economic activities to balance their food and cash needs and/or to reduce risk. The chosen combination of a household's assets and activities is commonly referred to as a livelihood strategy. According to Brown et al. (2006), there are significant differences in outcomes between livelihood strategies and hence significant gains to be made by households moving from one livelihood strategy to another.

This paper is concerned with farm household choices and the barriers to activities with higher outcomes. Economic efficiency measures can be used to gauge how effectively production firms use scarce resources for the purpose of profit maximization given the technology and the level of fixed factors. In a competitive environment, resources like labour and capital move freely to where they earn their market price. Allocative efficiency studies therefore indicate whether resources are employed where they earn their market value. Factors inhibiting free movement of resources can also be identified. Most efficiency studies are at the farm level. The two assumptions made are that farmers view their farms as a single unit and there is efficient allocation within the household although the following studies suggest

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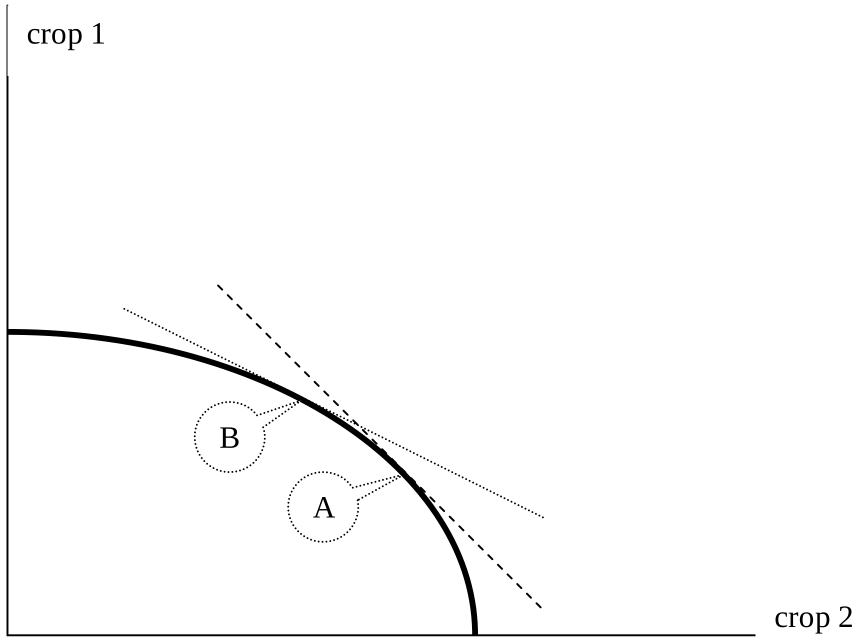

Figure 1. Within-farm allocative efficiency.

otherwise .There is great heterogeneity[I] within smallholder farms (Tropical BBiology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT 2003; Vanlauwe, 2006) and farmers normally delineate the farm using live hedges, terraces, ditches and paths or permanent crops to map out this heterogeneity. This, coupled with easy identification of distinct units suggests that they are managed individually. Agricultural production is rain-fed, which means that agricultural activities in smallholder farms are carried out simultaneously across all the units in a farm (referred to as plots). The issue of efficiency in resource allocation within smallholder farms is addressed by Udry (1996). He found differential application of labour and fertilizer in plots controlled by the household on the basis of gender. His approach focused on who is in control and the consequences for efficiency.

Our approach is different in that issue of control does not arise[II]. Under centralized control, allocation of labour over the plots is considered efficient if no gains can be made from re-allocating labour between plots within a farm. In other words, the marginal value product of labor should be the same across all plots.

[I] Usually used in reference to the variability in biophysical characteristics of a farm in terms of soil quality, position on the slope etc. Heterogeneity may also refer to the diversity in crops grown, crop combinations and their spatial distribution within a farm.

[II] In western Africa, control of plots is determined on the basis of gender (Udry, 1996), but there is no evidence of a role of gender in control of plots in western Kenya.

The research problem as it relates to Kenya agriculture should be clearly stated and specific and broad objectives properly delineated.

METHODOLOGY

Analytical Framework

It is common to find more than 5 different crops planted on a farm as farm households endeavour to meet their needs from their small[III] parcels of land. For a household growing two crops, efficient labour allocation is achieved when the marginal products of labour (MVP_L) in both plots are equalized. For given areas of land of the two plots, the household faces a production frontier as shown in Figure 1. The household can produce crops 1 and 2 and at given prices the combination at point A is optimal. The slope of the tangent line A is the ratio of the two MVPs. At these prices, a combination as in point B would be inefficient. If the household would perceive the product prices as different and have combination B as its optimal point, this would make point B the efficient allocation and point A inefficient.

Hence, the efficiency measure of the ratio of the marginal value products is an indicator of the combined effect of actual inefficiency within the household and differences in optimal allocations due to differences of price perceptions. A household that has more labour at its disposal, for example because alternative employment for the

[III] Virgin land is generally unavailable making it unfeasible for farm households to increase production by opening up fallow or fresh land. Expansion of production by hiring-in of land is out of the question since this is only possible in the minor season and is discouraged by insecurity and the fact that only the poor plots are hired-out (personal communication with farmers).

family members is lacking, may choose to grow more of both crops and particularly more of the labour intensive crop. This need not affect the ratio of MVPs however, and the measure of allocative efficiency is still relevant.

We used theory with data to establish whether farm households in western Kenya are efficient in allocation of labour within their farms and to explore possible factors which explain household deviation from profit maximizing behaviour. The concept of efficiency suggests that if markets are working well, the value of the marginal product (MVP) of a production factor will be equal to the market price of the factor. The MVP measures the incremental value of output resulting from an additional unit of a factor. The MVP of factor *m* is calculated from the marginal effects derived from crop specific production functions by taking the first derivative of the production function. The functional form of production functions used was a Cobb-Douglas. The logarithm is written as:

$$\ln q_j = a + \sum_m \beta_{jm} \ln x_{jm} + e_j$$

The coefficients (β_{jm}) are directly interpreted as elasticities (ε_{jm}). They indicate the percentage change in output of crop *j* resulting from a percentage change in an input x_m.

$$\varepsilon_{jm} = \frac{\%\Delta q_j}{\%\Delta x_{jm}} = \frac{1}{AP_{jm}} MP_{jm}$$

Where

$\%\Delta$ is the percentage change

MP_{jm} is the marginal product of the input *m* in crop *j*.

AP_{jm} is the average product of the input *m* in crop *j*.

Crop/intercrop specific marginal product for each factor of production is calculated as:

$$MP_{jm} = \varepsilon_{jm} AP_{jm}$$

And the marginal value product as:

$$MVP_{jm} = MP_{jm} p_j$$

On the basis of these measures, we compared MVPs between households and between crops grown by a household. In the perfect model all the MVPs of a single production factor should be the same. If some households are less well integrated into the labour market than other households, the MVPs of labour will be different among the households, but should be the same within the household. If, however, the households that are less well integrated in the labour market are also at a disadvantage as to the output markets, MVPs can differ within the households (and between crops therefore) and among the households.

Our interest is to test for equality of marginal products of labour and also to determine the factors influencing household behaviour in labour allocation. From the theoretical model (Kamau, 2007) the decision price of a household is influenced by the conditions in the factor and output markets and the liquidity position of a household. Imperfections in the output markets prevent free movement of factors of production within the farm because they result in: an inflated price for food[IV] such that the household decision price is an internal price which is higher than the market price; discounted prices for non-food crops so that farmers re-allocate factors of production away from such crops to food crops which have higher (internal) prices. This implies that whilst we observe the market price $\overline{p_m}$, the household decision price is $\tilde{p}_{im}$ and the marginal product of labour is equalized to this household (internal) price. The effect of poor output markets is therefore the over application of a factor on plots planted with food crops and the under application on plots planted with non-food crops.

Market failure is specific to households (De Janvry et al., 1991), so we expect the effects to vary across households. A household specific index c_i comparing MVP_L in plots planted with other crops to the MVP_L in maize plots was generated. It shows the extent of within-household inefficiency and is expected to vary with household and farm characteristics. It is calculated as:

$$c = \frac{MVP_{Lothers}}{MVP_{Lmaize}}$$

That is the ratio of the MVP_L of other crops in the household ($MVP_{Lothers}$) except maize to the MVP_L for maize (average if household has more than one plot of maize).

Where,

$$MVP_{Lothers} = \tfrac{1}{N-N_m} \sum_{j \neq maize} MVP_{Lj}$$

N_m is the number of maize plots.

The index is an indication of the extent to which a household's internal price for output may deviate from the market price.

Description of study area

The data set used in this study comprises household and plot level data collected in 2003/2004 from a random sample of farm households in sixteen villages in two districts of western Kenya namely, Kakamega, and Vihiga districts. Much of the land in these two districts falls within the high to medium potential areas where rainfall ranges between 1400 to 2000 mm (RoK 2000). The rainfall occurs in two distinct seasons which vary in the total amount of rainfall received and the length of the rainfall period. The long rains (LR) fall between March and July while the short rains (SR) fall between August and October. Tittonell (2005a) and Ojiem (2006) provide an in-depth exposition of the bio-physical characteristics of the study area.

Farms are generally small[V] with fifty percent (50%) of the households owning not more than 0.81 ha in Kakamega and 0.5 ha in Vihiga. It is common for smallholder farmers to subdivide their farms into smaller units (plots) with most households having two

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[IV] In the study site, most households are net buyers of maize which is the staple in the study area

[V] The average farm size is 0.79 ha for the overall sample to four plots. The plots range from a minimum of 0.02 to a maximum of 2.42 ha with a mean of 0.24 ha in Kakamega and 0.16 ha in Vihiga.

Specification of crop specific production functions

As indicated in the analytical framework, the MVP of factor *m* is calculated from the marginal effects derived from crop production functions. Since mono-cropping is rarely[VI] practiced in the study area, the first task was to identify predominant intercrops or practices for which production functions were estimated. The common cropping practices identified are outlined as:

Maize-based intercrop

Maize intercropped with beans is the most predominant cropping practice although a few households plant only maize during the long rain season. With declining farm sizes, households tend to include a third or fourth crop in this intercrop.

Banana-based intercrop

All plots planted with bananas are included in this group. Bananas permanently occupy the plot adjacent to the homestead. These plots have high organic matter content formed by the gradual transfer of nutrients from other parts of the farm (manure, ash, household refuse). Bananas are intercropped with other crops especially vegetables, chewing cane, maize and beans.

Bean mono-crop

This practice is not dominant and is only observed during the short rain season.

Napier mono-crop

Napier grass is a supplementary livestock feed sold by poor households while the wealthier households feed it to their own animals. It is more common to plant Napier grass along the contour lines for erosion control and to delineate plots within the farm.

Vegetable mono-crop

Vegetables grown in this system are mainly grown for the market. The very tiny patches of vegetables plots adjacent to the banana/homestead are not included.

Others

Others comprise crops like sweet potatoes, cassava, sorghum and millet which do not fall into any one of those earlier stated.

There are several challenges in the measurement of crop output in an intercropping system. The first challenge was getting reliable estimates of the proportion of plot area under each of the crops. Moreover attribution of inputs to crop output is difficult where inputs directed at one crop benefit other crops planted in the same plot. Under these circumstances it made sense to take a systems approach where all inputs applied to the plot were aggregated. The second challenge was that output is only comparable in value terms and not in physical units (weight) of output. Whereas crop value may be captured in terms of the food value (calorie or protein content), we opted for the market value whereby the output of each crop in a plot was valued at the selling price. Total crop value was computed as a sum of the value of all crops harvested from a plot in a season. Not all households participate in output markets and hence lack a market price for some or all crops grown. In such cases, a village level price was generated from households that participate in the market and where prices were absent the prices were obtained from neighbouring markets. Total crop value was computed as a sum of the value of all crops harvested from a plot in a season. The final challenge was in the definition of the "harvested" crop because in western Kenya, maize and beans are harvested in their green and dry state. Previous studies in Kenya (Hassan 1998) have ignored the green harvest because it forms but a small component of the total harvest. However, if the same is assumed for western Kenya it would return zero output observations for many households because consumption of green maize is very common. In this study we valued the total crop harvest that is the green and dry harvest.

Estimated model

The sample of households over which crop or intercrop specific production functions can be estimated is essentially truncated since production data is reported only for households who planted a crop or intercrop. If crops grown are not randomly picked, then the error in the crop choice equation and that in the production function are related in some way. Ignoring this non-random nature of the sub-samples introduces a selectivity bias in the production functions and in the inferences made (Trost and Lee, 1984). To get consistent estimates of the parameters (if there is selection bias) from production functions of specific crops/combination given that they are chosen, the disturbance term μ in the production function should be replaced by the conditional expected value obtained from the binary choice estimations. In the case of a multinomial logit, the bias correction term λ is similar to the inverse Mills ratio (IMR) and is given as:

$$\lambda_j = \frac{\phi(\Phi^{-1}(P_j))}{P_j} \quad \text{for j=1, 2, …}$$

Here, ϕ(.) and Φ(.) are the standard and normal density in the distribution functions respectively. In this study we corrected possible selection bias in selection of crops or intercrop by adopting the approach proposed by Heckman (1979) whereby the inverse Mills ratio is included in the OLS estimation. The predicted probabilities used in the construction of the selection bias correction term λ_j were obtained from the logit model.A Cobb-Douglas[VI] functional form was adopted because the number of observations for some crops is small and does not allow estimation of models with squared and interaction

[VI] a modified Cobb-Douglas with interaction terms included to capture interaction between the factors of production did not yield better results.

Table 1. Descriptive statistics of variables included in the production functions.

Variable	Maize	Bean	Vegetable	Banana	Napier	Tea	Sugarcane	Others
SR season								
N	414	72	33	122	68	5	2	52
Crop value	2649	1654	2831	2893	1936	3520	1438	1069
Plot size	0.48	0.55	0.42	0.53	0.39	0.27	0.20	0.39
Total labour	175	149	61	93	60	562	69	79
Manday /acre	56	39	29	26	25	508	54	30
Fertilizer expenditure	272	45	91	55	113	1420	0	50
Fertiliser KSh[a]/acre	492	75	417	75	117	7466	0	99
LR season								
N	619	1	25	102	78	10	2	21
Crop value	4651		2625	1908	2277	4073	1499	1857
Plot size	0.55		0.46	0.51	0.34	0.66	0.20	0.47
Total labour	176		51	44	43	319	24	111
Manday /acre	55		22	15	21	104	22	38
Fertilizer expenditure	255		42	12	5.6	1648	0	4.8
Fert KSh[a]/acre	508		153	22	22	2553	0	19

[a] the mean exchange rate in the year 2004: KSh. 75 = 1 USD. N = number of plots planted with crop; LR = long rain season; SR = short rain season

terms[VII]. Despite its limitations, it is parsimonious in parameters, easy to estimate and interpret. The estimated model is specified in the logarithmic form as follows:

$$lpcropval_{ji} = \alpha_j + \beta_{1j} ltotalL_{ji} + \beta_{2j} lplotsize_{ji} + \beta_{3j} l\exp_{ji} + D_{1j} fertile1_{ji} + D_{2j} fertile2_{ji}$$
$$+ D_{3j} fysr2002_{ji} + D_{4j} division_{ji} + D_{5j} iffert_{ji} + \lambda_j IMR_{ji} + \varepsilon_{ji}$$

Unlike farm level production functions, the aggregation level for crop or intercrop production functions is the plot (*i*). The intercrop/crop is *j*, *lpcropval* is the log of value of output, *ltotalL* is the log of total labour used, *lplotsize* is the log of plot size, *l*exp is the log of fertilizer expenditure, *fertile1* and *fertile2* are dummies for high and moderate fertility status respectively, *fysr2002* is a dummy indicating manure use in the year 2002, *division* is a dummy for Kakamega district and captures the effect of differences in amount and variability in rainfall between the districts. *iffert* is a correction term for the large number of zeros in fertilizer use, λ is the correction term for selectivity bias and ε_i is an error term which summarizes the effects of unobserved variables.

In the area of study, inorganic fertilizer is exclusively applied to maize. The variable *lexp* was therefore included in production functions for maize but was omitted in the other production functions. To circumvent the variation in the quality and measurement of organic fertilizers, we used a dummy variable that indicates use or non-use of organic fertilizers. Manure use lagged behind for one year since organic nutrients are often not immediately available to the plants and the positive effects of these inputs are observed in subsequent seasons. The lagging behind in manure use also solves potential problems in estimation where current year manure is considered endogenous.

Tables 1 and 2 provide the descriptive statistics for variables included in the production functions.

Land is one of the important inputs in production whilst plot characteristics like soil fertility status, slope and distance from the homestead influence input-output relationships. Interaction terms for fertility status with the fertilizer dummies were found not significant and hence left out of the final model. Plot characteristics without interaction and only indicators of plots fertility status were retained since others like position on slope and distance from homestead did not improve the model. In any case the effect of distance is through its influence on labour and manure use. The dummy for poor fertility was left out of comparison. Plot characteristics should be used in order to obtain consistent estimates of the fertility[VIII] differential. This was not done because we lacked a variable that is highly correlated with fertility status of the plot but uncorrelated with the unobserved variation in the plot.

RESULTS AND DISCUSSION

Crop specific production functions

Table 3 shows the results from the production function for the maize/bean intercrop system which is the most commonly found in the study area. Maize is planted by

[VII] preliminary analysis using more flexible functional forms like the translog that include squared and interaction terms did not improve the model and yielded coefficients that were not statistically significant.

[VIII] Fertility status of a plot may be considered endogenous since farmer practices contribute to the enhancement or detriment of the fertility status

Table 2. Average distance (metres) from the household of plots planted with specific crops/intercrop.

Location	Maize intercrop	Bean Mono crop	Vegetable Mono crop	Banana intercrop	Napier Mono crop	Tea Mono crop	Sugarcane Mono crop	Others
Vihiga (SR)	52	26	3	4	96	23	12	179
Vihiga (LR)	55		6	4	41	23	12	25
Kakamega (SR)	120	90	14	8	90	111	31	26
Kakamega (LR)	346		15	8	100	111	29	94

Legend: SR = short rain season; LR = Long rain season.

Table 3. Plot level production functions for maize specified by season and district.

Parameter	Vihiga Short rain Season	Kakamega Short rain Season	Vihiga Long rain Season	Kakamega Long rain Season
Dependent Variable = log of output				
Log of total labour	0.57***	0.59***	0.52***	0.51***
Log of plot size	0.01	0.06	0.19**	0.45***
Log of fertiliser expenditure	0.15	0.18*	0.16	0.13*
Dummy for fertile plots	1.04***	0.64**	0.19	0.17
Dummy for moderately fertile plots	0.82***	0.88***	0.24*	0.13
Dummy for manure application in short rain season of 2002	0.33***	0.14	0.06	0.20*
Dummy =1 if no fertiliser and 0 if fertiliser was used	0.68	0.37	0.62	0.37
constant	3.16***	3.35***	4.59***	5.31***
N	250	135	271	324
F	18.99	15.43	14	46
Adj. R^2	0.34	0.43	0.25	0.50

Legend: * P<0.1; ** P<0.05; *** P<0.01.

virtually all households making it possible to estimate separate production functions for each district. Because their production functions[IX] only by season.

Labour is a limiting factor in maize production in both Kakamega and Vihiga districts in both seasons. One percent change in hours of labour spent on maize production yields an increase of over half a percent in maize output. It is only during the long rain season that maize production increases with plot size which is consistent with the previous knowledge (source and date) that land is relatively more intensively cropped during the long rain season. This response is higher in Kakamega where a one percent increase in plot size yields an increase of 0.45% in maize output whereas in Vihiga it yields a response of 0.19%. Lower productivity of land in Vihiga may be explained by relatively tired[X] soils compared with Kakamega.

The response to fertilizer is only weakly significant at 10% in Kakamega and 15% in Vihiga. Effects of differences in soil fertility status are mainly noticeable during the short rain season where plots with high or moderate fertility have higher production compared with plots of poor fertility. This may be explained by poorer plots being relatively less intensively cropped during the short rain season. During the long rain season, all plots are intensively cropped making the differences in output, due to fertility status, insignificant. Do these findings agree or disagree with established literature?

Labour is the limiting factor in production of other crops except Napier grass during the long rain season and other food crops in the short rain season (Tables 4 and 5). Increasing plot size has a positive effect although it is not significant while it can be negative in some cases. This surprising response may be attributed to biases due to measurement error in the plot size which biases the estimates downwards towards zero. Instrumenting plot size with farm size did not improve the result which suggests that the poor response may be due to other reasons. Other possible reasons for the poor response

[IX] not expected to influence results since the production technology is largely the same in the two study areas.

[X] farm sizes in Vihiga are relatively smaller such that land is hardly ever left fallow.

Table 4. Plot level production functions for bananas and Napier grass specified by season.

Parameter	Banana Short rain Season	Napier Short rain Season	Banana Long rain Season	Napier Long Season
Dependent Variable = log of planned output				
Log of total labour	0.54***	0.37**	0.62***	0.26*
Dummy for fertile plots	0.26	2.54**	0.09	0.32
Dummy for moderately fertile plots	0.13	1.54***	0.20	-0.07
Dummy for manure application in SR 2002	0.01	0.30	0.41***	-0.76***
Division	0.48**	-0.48	-0.31	-0.54*
IMR of the crop	1.19	-3.73	-2.87	4.35
Constant	4.24***	7.13***	6.98***	3.72
N	117	45	93	61
F	8.41	4.40	13.34	2.71
Adj. R^2	0.28	0.34	0.45	0.15

* P<0.1; ** P<0.05; *** P<0.01; IMR = inverse Mills ratio.

Table 5. Plot level production functions for beans, vegetables and other crops specified by season.

Parameter	Bean Season 1	Vegetable Season 1	Others Season 2
Dependent Variable = log of planned output			
Log of total labour	0.67***	1.31***	0.33
Dummy for fertile plots	0.08	1.57*	0.91
Dummy for moderately fertile plots	-0.10	0.83	0.52
Dummy for manure application in SR 2002	0.03	-0.004	0.57
Division	0.55	-0.14	0.16
IMR of the crop	3.65	3.42	-2.05
Constant	1.05	-1.39	6.25
N	59	31	35
F	4.05	5.16	1.26
Adj. R^2	0.24	0.45	0.05

Legend * p<.1; ** p<.05; *** p<.01: IMR = inverse Mills ratio.

include; lower cropping densities in larger plots compared with smaller plots; labour may limit response to land where small plots are better managed than large ones; larger plots may be located further from the homestead and hence have a fixed traveling[XI] cost on labour which may not have been accounted for; unobserved variation in land quality in bigger plots; in small holder farms, fertilizer may be more limiting in larger than in smaller plots; and lastly field pests like rodents may also limit response to land.

Positive coefficients for dummies for soil fertility status signify higher output in more fertile plots; however they are significant only for Napier grass and vegetables. A larger coefficient for fertile soils compared with that for moderate fertility suggests that farmer's perception on fertility status can serve as an indicator for soil fertility status. The mixed effect of manure can be attributed to the difference in quality of manure and in plot characteristics. Insignificant selectivity correction terms indicate that there is no serious selection problem.

Within-farm allocative efficiency

Table 6 shows that the MVP of labour (MVP_L) varies between the various crops/intercrops and seasons for the same crop/intercrop. It is low in plots planted with food crops and highest in plots planted with vegetables and banana. MVP_L when compared with the prevailing wage rate is indicative of allocative efficiency. During the short rain season, the MVP_L in bean and maize plots was close

[XI] Although the distances may not be too prohibitive as compared with those in West Africa, the hilly terrain that characterises the study area makes visits to such fields inconvenient (Misiko, 2007).

Table 6. Marginal value product of labour applied to specific crops/intercrop.

Variable	Maize Vihiga	Maize Kakamega	Banana	Napier	Vegetables	Bean	Other
MVP of labour in SR (KSh/h)	12.74	16.90	36.17	21.23	48.70	10.81	2.80
MVP of labour in LR (KSh/h)	14.94	19.49	47.47	31.07			

SR = short rain season; LR = long rain season; The daily market wage for farm labour during the survey period was between Kenya Shillings (KSh) 50.00 - 60.00 when meals were included or KSh 100.00 - 120.00 where meals were not included. This translated to an hourly wage rate of KSh 8.00 with meals and KSh 16.00 without meals, respectively.

Table 7. ANOVA results showing the variation in MVP of labour between crops and farms.

Source of variation in MVP_L	F	Prob. >F	Std. dev. between plots within farms	Std. dev. in maize plots between farms
Variation between crops/intercrop (SR)	48.88	0.000	0.74	1.06
Variation between crops/intercrop (LR)	47.87	0.000	0.53	0.94

to the market wage rate while that of Napier, bananas and vegetables was higher. This suggests that farm households would increase their profits in the short rain season by increasing labour applied to crops/intercrops with a higher wage rate MVP_L while reducing labour applied to crops/intercrops with a MVP_L lower than market wage rate. The MVP_L for vegetables and even bananas is exceptionally high which is suggestive of constraints to increasing labour applied to these crops. During the long rain season, the MVP_L was still exceptionally high in banana and Napier plots while it was higher than market rate in maize plots in Kakamega and close to the market rate in Vihiga. Farm households would increase their profits by increasing labour to bananas, Napier and maize in Kakamega, the MVP_L was generally higher during the long rain season suggesting a larger labour constraint.

ANOVA results in Table 7 indicate significance in the variation of the MVP_L between crops/intercrops leading to rejection of the hypothesis that households in Kakamega and Vihiga allocate labour so as to equalize returns of labour applied to different crops.

Factors which determine labour use within the farm

Deviation from expected behaviour by farm households arise not from inefficiencies but from different notions of the incentives/prices facing them (Shultz, 1980). Because of markets failure for individual household (De Janvry et al., 1991), household and farm characteristics will influence the relative value given to crops and hence labour allocation within the farm. Households are known to place a relatively higher value to maize (food) where high transaction and transportation costs prevail (Omamo, 1998). Even where food is readily available in the market, there is a risk/uncertainty associated with whether households will access the maize due to seasonal fluctuation in output prices. Other than output prices, the state of other rural markets also influences labour use within the farm.

We regressed the index c (see definition of *c* in section 2.1) against several variables to test the hypothesis that *c* is determined by market and household characteristics. A *c* greater than 1 means that MVP_L in maize plots is lower than MVP_L in other crops simply because they value an extra unit of maize higher than its market price or they value an extra unit of other crops lower than the market price. A *c* less than one (1) means that MVP_L in maize plots is higher than MVP_L in other crops because they value an extra unit of maize lower than its market price. Factors that increase a household's access to the market are expected to reduce *c* whilst factors that increase a household's labour capacity are expected to increase the *c*.

Results are provided in Table 8 with a significance F-statistic indicating that collective variables included in the model do explain variation in *c*. A household's labour capacity was the strongest determinant of within-farm labour use. Increasing the number of adults in a household by one increases the labour applied on maize plots relative to labour applied to other crops thereby increasing *c* by 0.66. This means that in western Kenya, a larger labour capacity translates into deterioration in labour use efficiency as households attempt to increase its food production; an indication that food markets do not function well. It is also suggestive of barriers to alternative crop enterprises and off-farm employment. A household head in salaried employment results to a lower *c* (-1.0) maybe because they have less labour available for farming or have access to financial resources which ease the cash constraint or enable them to pursue

Table 8. Factors that influence the index c_i.

Variables in model	Coefficients for overall sample	Coefficients for Kakamega	Coefficients for Vihiga
Dependent variable = c[a]			
Distance to the tarmac road	-0.23*	-0.26	-0.03
Distance to a motorable road	0.71	-0.64	0.90
If head has salaried employment	-1.09*	-0.70	-0.17*
Non labour income ('000)	-0.08**	-0.06	-0.17**
Age of head	0.05**	0.05	0.05*
If head is male	-0.14	0.07	0.57
Family size	-0.24	-0.15	-0.28
Number of adults	0.66***	0.47*	1.07***
Farm size	-0.43	-0.58	-0.51
Constant	1.01	0.68	-0.95
N	239	112	127
F (9, 272)	3.46	1.24	2.83
Adj R^2	0.09	0.01	0.12

* P<0.1; ** P<0.05; *** P<0.01; [a] = marginal product of labour in maize relative to the marginal product of labour in other crops.

alternative crop enterprises other than maize. Access to non-labour income reduces *c* because it eases the cash constraint thereby reducing the household internal (decision) price for maize.

Increasing age of household head leads to relatively more labour applied to maize (a higher *c*) maybe because they are likely to have a larger labour capacity or are less likely to pursue alternative crop enterprises.

Increasing distance to a motorable road by 1 km increases *c* by 0.71. Although not significant, it means that households anticipating transportation problems allocate relatively more labour to food crops compared to market-oriented crops. A negative coefficient for distance to the tarmac road is unexpected. A larger farm size leads to a reduction in the *c* (not significant) probably because less labour is available as farm size increases.

In summary, characteristics important in determining labour allocation within-farm are household's labour capacity and liquidity status. Mixed signals on the effect of farm characteristics may be because the variation in distance to a motorable road is not large enough and the presence of tarmac roads has not reduced costs[XII] of transportation. The distance to tarmac may therefore be picking up a different effect.

Conclusion and recommendations

The practical meaning of these results for different households was demonstrated by simulating the expected change in *c* due to changes in the specific household characteristics (see results in Table 9).

An increase in the number of adults in a household makes maize relatively dear to other crops grown. The household responds by applying more labour to maize production leading to a fall in MVP_L in maize plots (0.66 for each additional adult) relative to that in other crops. For the same number of adults, maize was 55% more dear (relative to other crops) to households in Vihiga compared with Kakamega. Maize is a staple food so the results reflect the internal value placed on an additional mouth (adult) to feed. Moreover, because households in Vihiga are primarily net buyers of maize, a larger *c* reflects not only the inefficiencies in food markets but also the value of money.Conversely, salaried employment for household head and increasing non-labour income makes maize less dear compared with other crops grown. The impact of non-labour income is however smaller than that of salaried employment. This effect is not significant in Kakamega but is high and significant in Vihiga emphasizing the importance of cash and maybe security for these net buyers of maize.

Labour importance is a productive factor in smallholder farms. This study however revealed that in spite of its importance, the factor is not being efficiently allocated within smallholder farms. This can be attributed to immobility of labour within smallholder farms where much more labour is allocated to food crops when compared with other crops. This can be overcome through interventions which reduce the marketing costs for food and cash crops, increase participation in labour markets and improve the functioning of other rural markets like the financial market.

[XII] availability and cost of cash is high & households prefer to walk.

Table 9. Impact on the index c_i due to changes in household's labour capacity and liquidity.

Change in variable	Overall sample	Kakamega	Vihiga
Number of adults			
1	0.66	0.47	1.07
Non-labour income (KSh)			
1,000	-0.08	-	-0.16
2,000	-0.16	-	-0.33
3,000	-0.24	-	-0.50
5,000	-0.40	-	-0.84
Salaried employment			
Yes	-1.09	-	-1.75

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