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By:

Munialo S., Akundabweni L. S. M., Mburu J., and Namutebi A.

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Munialo S[1], Akundabweni L. S. M[2], Mburu J[2] and Namutebi A[3]

1. Department of Plant Science and Crop Protection, Faculty of Agriculture, PO Box 30197-00100, University of Nairobi, Kenya.

2. Department of Agricultural Economics, Faculty of Agriculture, PO Box 30197-00100, University of Nairobi

3. Department of Food Technology and Nutrition, School of Food Technology, nutrition and Bio-systems Engineering, Makerere University, PO Box 7062, Kampala, Uganda

3.1 Abstract

Strong gradients of decreasing soil fertility are found with increasing distance from the homestead within smallholder farms in Vihiga-Kenya. Nutrient use efficiency varies strongly between fields along these gradients of soil fertility. There is continuous accumulation of nutrients in areas around the homestead at the expense of nutrient depletion in further and larger fields. Unequal distribution of nutrients on the farm causes differences in yield with more yields being obtained in some areas on the farm than others. This has affected the overall crop yield and general wellbeing of the households on the smallholder farm. This study therefore undertook an evaluation of the economic benefits of the various fields belonging to smallholder farmesr. This was an effort to recommend strategies aimed at improving soil fertility levels to nutrient deficient fields. The objective of the study was to determine Economic Net Benefits across the fields on smallholder farms in Jinja and Vihiga. A division of the smallholder land into three farm portions of Near House (NH), Mid Farm (MF) and Far Farm positions with respect to distance from the homestead was done. An onion design layout was adopted to refer to these reference points. A household survey was administered to 76 households from in Vihiga. Using data on the gross margins collected from farmers, the Economic Net Benefits of various fields found on smallholder farms were calculated. Data was analysed using SPSS version 14. T test analysis showed a high significant difference of $P \leq 0.001$ in Economic Net Benefits between the (NH and MF) and (MF and FF) positions. Differences in Economic Net Benefits across the farm as a result of differences in soil fertility occasioned by unequal resource allocation might have implications in the economic as well as nutritional wellbeing of the household members. Appropriate intervention therefore need be instituted.

Key words

Smallholder, Economic Net Benefits, Gross margin, Land positions, Soil fertility, Unequal

Background

The net nutrient flow of resources is not equal for the various fields belonging to a single smallholder farm household (Smaling et al., 1996). Allocation of more resources on the already fertile soils (soils closer to the homestead) than on infertile soils (soils located at a further distance from the homestead) has resulted in continuous accumulation of nutrients in the smaller areas around the homestead, at the expense of nutrient depletion in further and larger fields. This has led to an overall negative nutrient balance at farm level (Giller et al., 1997). Studies by Tittonell et al., 2005 show strong gradients of decreasing soil fertility with increasing distance from the homestead on smallholder farming systems, which has been attributed to differences in soil properties (van Asten, 2003), agronomic practices (Mutsaers et al., 1995), farmers' resource allocation decisions (Nkonya et al., 2005), or combinations of these factors (Samake et al., 2006). These land use decisions that farmers have made have contributed to differences in soil fertility levels across the smallholder farms leading to low yield.

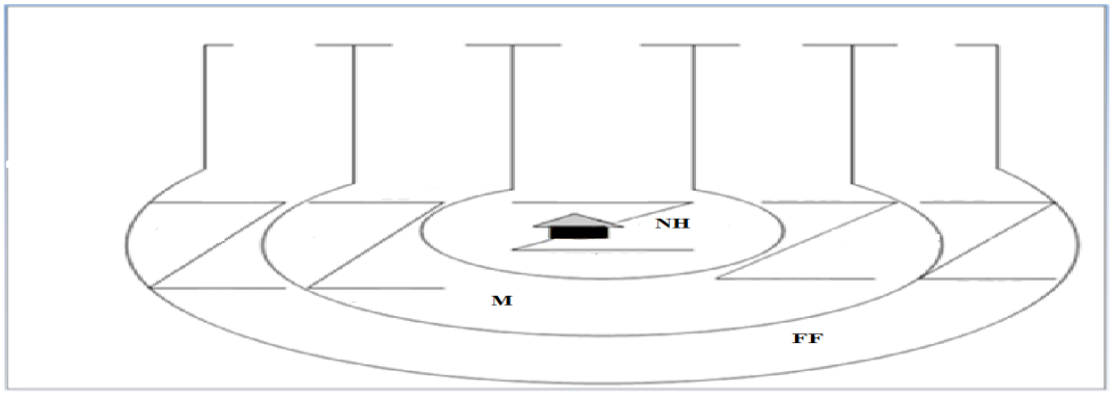
The problem of persistently low quantity of food in many households can also be attributed to differential resource allocation on smallholder farms. Farmers on smallholder farms apportion resources to more fertile fields. Over time, these resource allocation patterns feed back to positively reinforce the spatial variation in soil fertility and hence yields. This negatively affects the overall quantity of food harvested and consumed at the household. The overall crop yield of the farm is very important to the general livelihood of the households. Higher overall crop yield can only be achieved by equitable performance of all fields found on the farm. High performance of one field and low performance of another field on the farm generally lowers crop yield. Farmers are unaware of the fact that overall crop yield is important for the general well being of the households. This unawareness stems from inadequate knowledge on the benefits of different fields located on the farm. However, an economic evaluation of land to determine benefits of different fields on the farm of smallholder will help farmers know which fields have low returns and which measures to take to ensure equitable returns to all fields on the farm. This raises the questions; how should land performance be measured, so as to provide predictions that are useful to decision makers (including farmers)?

Economic land evaluation is important as it helps farmers determine the profitable enterprises to be undertaken on the farm (Rossiter 1995). Studies on economic benefits to land have focussed on the most profitable crop enterprises in Kenya. For instance, Kibet et al., 2011 analysed profitable enterprises and determined benefits to land using gross margin analysis. Studies by Onyango et al., 2009, Kibet et al., 2011, Otieno and Kipsat et al., 2001 have been done on the economic analysis of land for different agricultural enterprises using gross margins. However, in determining the profitable enterprise, the basic assumption has been that soil fertility levels across the farm are the same. However soil fertility levels on the farm vary according to distance from the homestead and topography. Differentiation of the farm into positions with respect to distance from the homestead is not considered. An apportionment of land into positions with regard to distance from the homestead is needed in carrying out an economic land evaluation in order to have a clear understanding of which

fields have higher and low benefits in terms of returns to land, and the type of measures to be taken to improve overall crop yield and consequently the quantity and quality of food consumed at the household level.

3.6 Materials and methods

The main micro-study data collection instruments was household survey questionnaire containing pre-coded questions directed to 76 randomly selected households from both Vihiga. The main respondents to the household survey were the smallholder women farmers. In circumstances where the female respondents were not available, the questions were administered to male households. Each farm was delimited on a 3-position basis as a Near-house (N) position portion, a Mid-farm (M) and a Far farm (F) according to Akundabweni et al., (2010) for phyto-diversity determination. An onion layout design was used to refer to these phto-diversity positions as shown in Figure 1.



H –Near house position, M- Mid position, FF- Far Farm position

Figure 1: An onion design of positioned phyto-diversity by Akundabweni unpublished

In each position, an inventory of crops grown and their corresponding yields from the previous cropping season was done. Additionally, approximate area occupied by these crops was also collected. Approximate annual gross margins per acre of the crops identified were then calculated as in the formula;

$$GMy = \mathbf{TRy} - \mathbf{TCy}$$

Where GM was the Gross Margin of crop y, while TR was Total returns of crop y and TC was the Total Cost involved in the production of crop y. To determine the net benefits of crop, the annual gross margins per acre of crops were first multiplied by the specific area occupied by a certain type of crop as in the following formula;

$$\mathbf{CNBy} = \mathbf{GMy} * \mathbf{Ay}$$

Where CNB was the annual Crop Net Benefit of crop y, GMy was the gross margin of crop y while Ay was the area in acres occupied by crop y in a certain land position.

The Economic Net Benefit of a given land position was computed by summing all the Crop Net Benefits on each smallholder farm as shown in equation;

$$\mathbf{ENBp1} = \sum_{k=0}^{n} \left(\mathbf{CNB} \binom{n}{k} \right)$$

Where ENBp1 was the Net Benefit of a certain farm position for example the Near House Position, CNB was the Net Benefit of various crops that were summed in a given land position, while n and k were the various types of crops like maize, beans growing on the smallholder farm. The total net benefits were then analysed using SPSS version 14 to determine the difference in the benefits across the three farm positions.

Results

There was a variation in the Economic Net Benefits across the farm positions as shown in Table 1, 2 and 3. In particular, there was high significance difference of P≤0.001between the Near House and Far Farm positions as shown in Table 1. The same difference was also observed between Mid Farm position and Far Farm position as shown in Table 2.

Table 1: Differences in Economic Net Benefits between the Near House Position and Far farm position

	Mean ENB	Standard deviation	Standard error
NH	9926.3	2115.55	242.67
FF	5933.61	5771.41	662.02

ENB-Economic Net Benefit, NH-Near House, FF-Far Farm

N=76, Test statistic t=5.501 on 75 degrees of freedom, P≤0.001

Table 2: Differences in Economic Net Benefits between the Mid House Position and Far farm position

	Mean ENB	Standard deviation	Standard error
MF	8860	2936.9	336.89
FF	5933.61	5771.41	662.02

ENB-Economic Net Benefit, MF-Mid Farm, FF-Far Farm

N=76, Test statistic t=2.369 on 75 degrees of freedom, P≤0.001

There was a significance difference between the Near House position and Mid Farm position as shown in Table 3.

Table 3: Differences in Economic Net Benefits between the Near House Position and Mid Farm position

	Mean ENB	Standard deviation	Standard error
NH	9926.3	2115.55	242.67
MF	8860	2936.9	336.89

ENB-Economic Net Benefit, NH-Near House, MF- Mid Farm

N=76, Test statistic t=3.756 on 75 degrees of freedom, $P \leq 0.001$

Discussions

Differences in Economic Net Benefits could have resulted from variability in management. Documentations by P.Tittonell et al 2005 show that farmers manage their fields according to their perceived land quality, varying the timing and intensity of management practices along soil fertility gradients. For instance, fields that are classified as poor by farmers are planted with sparser crops and have higher weed infestation levels than those classified as fertile. Moreover, farmers invest more resources on the already fertile soils (soils closer to the homestead) than on infertile soils (soils located at a further distance from the homestead) (P.Tittonell 2008). There is better management (weeding, fertilizer application, pest control, irrigation and harvesting) of crops located near the homestead compared to the crops located further from the homestead.

Conclusion

Findings from this study show that crop enterprises located near the homestead tend to have higher yields translating into high gross margins and hence high Economic Net Benefits, compared to crop enterprises located away from the fields. Distance from the homestead therefore has a direct influence on crop yield which subsequently affects the Economic Net Benefits of the various fields found on the smallholder farm.

Recommendations

- Resource allocation should therefore be on an equitable basis on all farm positions consideration being given to patterns with poorer soil quality that is the FF.
- Fields located far from the homestead (MH and FF) represent the majority of the farming area in western in Vihiga and Jinja and need to be targeted with major rehabilitation strategies like fertilizer and manure application to improve land productivity and rural livelihoods. Such rehabilitation strategies will not, however,

translate into improved crop productivity unless accompanied by improvements in agronomic practices, such as planting density and timeliness of planting and weeding.

- Farmers already apply more inputs to their most fertile fields for which only soil fertility maintenance strategies are required resulting in variation in nutrient use efficiency. As nutrient use efficiency varies strongly on the farm, such heterogeneity must be considered when designing soil management strategies, aimed at improved overall resource use efficiency at farm scale. Importantly, vegetable production should be encouraged in areas where land sizes are small, as they would act as alternative sources of income by ensuring continuous cash flow. Vegetables especially the indigenous varieties have shown to have a high ENB and short maturity period compared to cereals, cash-crops and root and tubers.

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