Livestock, banana and livelihoods: A case of sedentary pastoralism in the western shoreline of Lake Victoria, Uganda

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Abstract

Shrinking of grazing land and the expansion of banana plantations are key land use changes that threaten the sustainability of land resources in the Western shoreline of Lake Victoria. An integrated approach to land evaluation that examines the suitability of selected land utilization types and their impact on soil nutrient budget was used to evaluate the suitability of land resources for rainfed bananas and livestock grazing at low, intermediate and high input levels. Arable soils in the western shoreline are suitable for crop production; however, sustainability is threatened by the low levels of nutrient inputs. Consequently most of the low input land utilization types are associated with negative nutrient balances. Livestock is not profitable and the situation is likely to be worsened by the continued shrinkage of grazing area. As such, land degradation is on the increase due to the above optimal stocking rates. At intermediate input level of banana production, about 5 ha are needed to support a household of 6 that fully depends on farm income for survival.

Keywords: land evaluation, soil nutrient balance, grazing, household income, Lake Victoria basin, Uganda.

Introduction

Semi nomadic pastoralism in the western shoreline of L. Victoria is changing fast into agricultural land with consequent increase in sedentary pastoralism. Agricultural land increased by over 100 % at the expense of forest, thicket and savannah. The rangeland decreased by 30%; while the actual livestock population tripled and exceeds by more than 200% the optimal stocking density. While the shrinkage of grazing land may cause land degradation, the profitability of livestock enterprise is debatable.

Apparently, there is need to design land use systems that promote food secure livelihoods within a healthy Lake Victoria ecosystem through promotion of changes in land use that benefit farm households, the terrestrial ecology and the lake itself. Until this balance of sustainable use of natural resources to full economic growth can be coupled with land use decisions that ensure food security in all its dimensions, livelihood conditions can be expected to deteriorate at an accelerated rate with significant negative social and economic impacts.

Evaluating the performance of grazing enterprises is central to the management of the stock and the supporting land resources like pastures and soils to ensure minimal degradation of land resources. This study looked at the availability of grazing land, pastures and the economic performance of grazing in the western shoreline of Lake Victoria basin.

Methodology

Study site

The western part of Lake Victoria consists of a plain on the shoreline and a hilly landscape beyond it. The mean annual rainfall is 916 mm with a bimodal rainfall with the first rainy season from March up to May, and a second between September and December. The natural vegetation consists of aquatic grassland, aquatic tree savannah, savannah grassland, semi-deciduous forest and thicket and swamp
forest. Eroded gravely shallow soils on the hills and the imperfectly and poorly drained soils on the lacustrine plain are extensive with deep clayey soils located on the foot of the slopes.

Intensive mixed agriculture consisting of banana-coffee systems with maize, beans and sweetpotatoes as annual crops coupled with extensive grazing (Parsons, 1970) is practiced. Burning of rangelands is a common practice and seasonal swamps are grazed during the dry season. The Uganda Bureau of Statistics (UBOS) (2001) household survey shows that 57 % of the income comes from farming with an average monthly income of 73.5 $. Monthly household expenditure stands at 66.58. The same study shows the average human population growth rate is 3.4 % with an average household size of 5.7, 53 % of the population is aged less than 15 years, and is composed of 49 % males and 50.4 % females.

Between 1960 and 1999, livestock population in Rakai increased as follows: cattle from 35,000 to 118,726 heads; goats from 8000 to 181,463 heads; sheep from 2,471 to 26,647 heads; Ministry of Agriculture, Animal Industry and Fisheries, 1993. The average banana bunch weights recorded at three input levels was 46.7 kg (high), 30.4 kg (Intermediate) and 13.4 kg (low). The same study showed livestock output at the following three input levels: milk (Litres / ha) = 31 (intermediate), 55.2 (low), and meat (kg / ha) = 37.0 (intermediate), 61.0 = (low), and manure (kg / ha) = 1245 (intermediate), and 1861 (low).

**Estimation of available rangeland and optimum livestock population**

In this study, the available rangeland was taken to be all that land currently not utilized for crops, gazetted forest and nature reserves. By comparing available rangeland (ARL) with the optimal stocking rate, the sustainable number of grazing livestock was estimated. Optimal stocking rates used were based on results of a four year stocking rate trial conducted in South-western and Eastern Uganda (Stobbs, 1966; Thornton, 1966). The experiment in South-western Uganda, on black alluvial clays and silts, involved Ankole longhorn steers (248 kg) with three stocking rates, 1.2, 2.4, and 3.6 ha per head, under continuous and deferred grazing on Themeda triandra and Hyparrhenia filipendula pastures. Under deferred grazing, the best stocking rate (1.2 ha per head) was associated with 65.2 kg live weight gain per ha per year; continuous grazing was associated with 48 kg live weight gain per ha per year.

Although 1.2 ha per head under deferred grazing was best in South-western Ugandan, it is rarely practiced by farmers. As such, 1.2 ha per head under continuous grazing was chosen as the optimal stocking rate. These stocking rates are equivalent to optimal stocking rates of 0.83 Tropical Livestock Unit (TLU) per ha for South-western Uganda. One TLU is equivalent to an animal of 250 kg live weight. The calculations were based on the district census done in 1999. Livestock population for 1960 was obtained from the Department of Veterinary Service and Animal Industry (1961). The available rangeland area was assumed constant between 1954 and 1960.

**Economic suitability**

In ALES, economic suitability for Bananas and grazing land use types was evaluated by the net margin (all crops), net present value (bananas), and the benefit per cost ratio (Bananas and livestock). The discount rate was adjusted by subtracting the inflation rate (0.1) from the interest rate (15% for sugarcane farmers and 10% for others). For all levels of production, it was assumed that all labor costs are hired at a rate of 0.35 $ per person day. It is also assumed that all farmers rent land at a cost spread out to cover all the growth cycle.

**Economic suitability classes**

For compatibility with the FAO framework, the net present value and gross margins were expressed as currency grouped into four discrete suitability classes corresponding to FAO classes ‘s1’, ‘s2’, ‘s3’, and ‘n1’ within ALES. To allow ALES to perform this grouping, three economic suitability class limits, i.e. values of currency per unit area –year (for gross margin analysis) which divide ‘s1’ from ‘s2’, ‘s2’ from ‘s3’, and ‘s3’ from ‘n1’ were determined.

The limit between ‘s3’ and ‘n1’ was set for a gross margin below which the land user will elect not to implement the land use type. The limit between ‘s1’ and ‘s2’ and that between ‘s2’ and ‘s3’ was set to
differentiate the best land from moderately good land, and moderately good land from marginal land. Expenditures were used to give an indication of the annual financial needs of a farm household. Annual household expenditures were derived by farm sizes (average of 2.55 ha; to obtain annual financial requirements per ha; the estimated value was 346 $ per ha per year.

Suitability rating was based on the assumption that all the money spent was earned through agricultural enterprises. S2 and S3 net margins reflect a reduction of 20% and 40% of the S1 net margins (Table 1).

<table>
<thead>
<tr>
<th>Rating</th>
<th>High*</th>
<th>Intermediate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>346</td>
<td>277</td>
<td>221</td>
</tr>
<tr>
<td>S2</td>
<td>277</td>
<td>221</td>
<td>177</td>
</tr>
<tr>
<td>S3</td>
<td>138</td>
<td>111</td>
<td>88</td>
</tr>
</tbody>
</table>

* Level of production

Calculating the nutrient budget

The nutrient budget was calculated using the methodology described by Stoorvogel and Smaling (1990). The nutrient budget of a land use type was calculated as the difference between the sum of inputs (application mineral fertilizers, organic manure, Atmospheric deposition, Biological nitrogen fixation, oedimentation) and the sum of outputs (removal of harvested crop parts, removal of crop residues, leaching, denitrification, and water erosion). The NUTMON toolbox was used to calculate the balances using the determinants of inputs and outputs for bananas, maize and sugarcane.

The costs incurred to replace depleted nutrients were assessed by using the value of the depleted nutrient on the market. This gave the Nutrient Deficit Market Value (NDMV) – van der Pol (1993). The ease with which nutrients could be replaced was assessed using the Farmers Income Sustainability Quotient: FISQ = 1 – value of nutrient deficit/farmer income.

Assumptions. All crop residues are removed from the field and all organic household waste is applied to bananas. All livestock faeces are dropped in the rangeland during the day and in the kraal during the night. Pastures not grazed are returned to the soil as crop residues. Pastures are also used as source of mulching material. Food for home consumption and associated residues e.g. banana peelings are estimated based on the household food requirements. After supplying the household food requirement, the balance of the produce harvested is considered as surplus for sale.

Food requirement estimates

Food requirement estimates were calculated based on the following assumptions: There was no pregnant or lactating mother in the household; same energy and protein requirements for 0-14 (1 boy; 2 girls) year’s category, 15-64 (1 boy; 1 girl) and 65+ (1 woman) years category. Energy requirements are based on FAO (1985) and 4 kcal/gram are provided by carbohydrates. As long as the energy requirements are met, protein requirements are met too. A household size of six (Uganda Bureau of Statistics, 2001) and farm located on suitable land for growing bananas as food crop is assumed.

Results

Available rangeland and livestock population in Rakai district

Table 2 shows that between 1960 and 1999, available rangeland decreased by 30% while the actual livestock population tripled. Hence, whereas in 1960 the stocking rate was still below the optimum in 1999 it is exceeded by more than 200%.
### Table 2: Evolution of available rangeland compared to actual and optimal livestock population in Rakai district

<table>
<thead>
<tr>
<th></th>
<th>1960</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available rangeland ('000 ha)</td>
<td>153.1</td>
<td>107.5</td>
</tr>
<tr>
<td>Optimal stocking rate* (TLU/ha)</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>Actual livestock population ('000 TLU)</td>
<td>35.61</td>
<td>133.54</td>
</tr>
<tr>
<td>Optimum livestock population ('000 TLU)</td>
<td>127.07</td>
<td>89.23</td>
</tr>
</tbody>
</table>

The breeds are Ankole long horn in Rakai, Optimal stocking rates based on Stobbs (1966) and Thornton (1966); †Estimation based on 1987 data (Source: authors' calculations based on livestock data from Ministry of Agriculture, Animal Industry and Fisheries, 1993)

**Economic suitability**

In Table 3, the net margins show that bananas are marginally suitable at high and intermediate input levels and not suitable at low input levels. The benefit cost ratios are low and close to zero. The Net Present Value is high and positive. Livestock production is associated with negative Net Margins and Net Present Values with close to zero Benefit / Cost at intermediate input level. Low input livestock production is not suitable as indicated by the low Net Margin, Net Present Value and Benefit / Cost values.

### Table 3: Economic Benefit/Cost and Net Present Values for banana and livestock land use types in Rakai district

<table>
<thead>
<tr>
<th>land Use Type</th>
<th>Net Margin</th>
<th>Benefit/Cost</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bananas (High input)</td>
<td>264</td>
<td>1.2</td>
<td>606</td>
</tr>
<tr>
<td>Bananas (Intermediate input)</td>
<td>163</td>
<td>1.3</td>
<td>985</td>
</tr>
<tr>
<td>Bananas (Low input)</td>
<td>25</td>
<td>0.9</td>
<td>-79</td>
</tr>
<tr>
<td>Livestock (Intermediate input)</td>
<td>-185</td>
<td>0.6</td>
<td>-110</td>
</tr>
<tr>
<td>Livestock (Low input)</td>
<td>10</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Livestock* (Intermediate input)</td>
<td>-160</td>
<td>0.7</td>
<td>-99</td>
</tr>
<tr>
<td>Livestock* (Low input)</td>
<td>60</td>
<td>1.1</td>
<td>-39</td>
</tr>
</tbody>
</table>

* Lowland grazing;

**Nutrient balances**

Generally NPK nutrient balances calculated for bananas are more negative at low input level of production and the reverse is true for pastures (Table 4). NPK balances are positive for bananas at high, and intermediate level of production.

**Household food requirement**

Environmental threat and food security are closely intertwined, since food production is highly sensitive to environmental conditions, and conversion of natural land for agriculture is a major cause of the deterioration of earth’s support systems (Ehrlich et al., 1993). Table 5 shows the estimated nutritional supply and demand-based on banana as source of calories. As expected the energy supplied decreases with yield against a constant household demand. Energy supply estimates are well above the demand at all levels of the banana land utilization type. However, with bananas at low input level, energy supply from one hectare of land is marginal. Protein associated with the supplied energy is very high compared to the household demand at both per hectare and household levels. In monetary terms, a household of six people will require 544 $ to purchase 10,872 kg bananas required to last one year. In
terms of land resource allocation, 0.78 hectare of land is required to produce at low input level, bananas that can supply enough energy requirements for a household.

### Table 4: Comparison of sustainability characteristics for land utilization types

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Nutrient Balance</th>
<th>Fertilizer Value</th>
<th>Economic Parameters*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Kg/ha</td>
<td>P $/ha</td>
<td>K Kg/ha</td>
</tr>
<tr>
<td>Banana</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Input</td>
<td>67 23 63</td>
<td>77.3 55.4 66.8</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>35 11 29</td>
<td>40.3 26.5 30.7</td>
<td></td>
</tr>
<tr>
<td>Low Input</td>
<td>2 -2 -6</td>
<td>2.3 4.8 6.6</td>
<td>11.4 130 0.09</td>
</tr>
<tr>
<td>Pastures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>-44 -25 -4</td>
<td>50.7 60.2 4.2</td>
<td>115.0 34 3.38</td>
</tr>
<tr>
<td>Low Input</td>
<td>-28 0.9 0.8</td>
<td>32.0 1.7 0.85</td>
<td>32.0 14 2.29</td>
</tr>
</tbody>
</table>

NDMV=Nutrient Deficit Market Value; NM=Net Margin; TSP=Triple Super Phosphate; MOP=Muriate of Potash; FISQ=Farmers Income Sustainability Quotient:= 1 – NDMV/NM (van der Pol, 1993);

### Table 5: Annual energy and protein output and requirements per household

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Yield kg/ha</th>
<th>Output† per HH</th>
<th>Starch‡ kg/HH</th>
<th>Energy* Kcal/HH</th>
<th>Starch kg/ha</th>
<th>Energy Kcal/ha</th>
<th>Energyreq** Kcal/HH</th>
<th>Protreq** kg/HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>46,700</td>
<td>49,689</td>
<td>10,932</td>
<td>43,726,144</td>
<td>5,753</td>
<td>23,013,760</td>
<td>5,237,750</td>
<td>97</td>
</tr>
<tr>
<td>Low</td>
<td>14,010</td>
<td>14,907</td>
<td>3,279</td>
<td>13,117,843</td>
<td>1,726</td>
<td>6,904,128</td>
<td>5,237,750</td>
<td>97</td>
</tr>
</tbody>
</table>

†Farm area used = 1.9 ha; * FAO, 1985; ** FAO, 1985 based on UBOS 2001 household size

### Discussion

**Economic suitability**

With good prices and market accessibility, bananas are some of the most paying crop enterprises in Uganda (Karugaba and Kimaru, 1999; Nkuba, 2001; Pender, 2002; Nkonya, et al., 2004). The marginal economic performance of bananas, despite the relatively high yields realized, is due to remoteness that is usually associated with low produce prices (Ssewaya, 2003). It is demonstrated that with high input good yields can be achieved. Overall, livestock is performing poorly better.

**Nutrient balances**

Uganda has been associated with generally negative NPK balances at national level (Stoorvogel and Smaling, 1990) Balances at farm level vary depending on the level of production. Negative nutrient balances are associated with land use types at high inputs and the reverse is observed for low input farms (Walaga et al., 1999; Esilaba, 2000, de Jagera, In press). de Jagera (In press), calculated negative NPK balances for both conventional and low external input farm practices. Negative or positive NPK balances at field levels have been calculated (Walaga et al., 1999. Esilaba (2000), observed negative balances for total N, P and K for all soil fertility management classes. However, farmers classed as good soil fertility managers had higher negative nutrient balances than farmers classed as poor soil fertility managers. This is because class 1 farms extracted more nutrients from the soil when they produce and sell more.

However, calculations here indicate that low input levels of production are associated with negative balances for NPK. Table 4, shows that intensification of production is generally associated with positive
balances with the exception of K whose balances are negative for all land Use Types except for high and intermediate bananas. The negative K balances could not be offset by fertilizer and manure inputs at both high and intermediate input levels. Bananas are more ecologically balanced with negative balances experienced only at low levels. Fortunately most farmers produce bananas at intermediate level with good soil management practices.

Livestock and low input banana farmers operating with negative net margins do not have the financial ability to compensate for the nutrients lost through various pathways. These enterprises are also associated with negative Farmers Income Sustainability Quotient. Farmers Income Sustainability Quotient near or above 0.50 indicates that farmers have the capacity to replace nutrients mined through fertilizer application.

Net margins alone portray the profitability of land Use Types; additional information from nutrient balances has shown how unsustainable some land Use Types can be despite their good net margins. It is more revealing when nutritional aspects are included as discussed below.

Food requirements
Results show that one hectare of suitable land can supply enough starch or carbohydrate to meet the annual energy requirements for a household. Farms below one hectare, at least from the nutritional point of view, cannot support a household of six from land alone. This concurs with similar observations in Nepal where, an average farm size below one hectare is considered too small to support a typical farm family of six people (Ehrlich et al., 1993). In such a situation, off farm income is required to supplement the energy requirement through purchase of food items. This explains the observed importance of off farm income in supplementing farm income in sustaining rural households (Zwick and Smith, 2001; Abele, 2003; Nkonya et al, 2004). The non-farm income generating activities have increased in number with a majority of households involved in at least one non-farm income generating activity in addition to farming (Zwick and Smith, 2001; Isabirye et al., 2001). A study on strategies for sustainable land management and poverty reduction in Uganda shows that off farm income is associated with better soil management and therefore improved crop productivity (Nkonya et al., 2004).

The problem of hunger linked to a particular land use type does not exist in Rakai despite the lower net margins for bananas because the dual subsistence and commercial objective of banana crops. However, assuming that all household energy requirements are purchased, a household of six will require 544 $ annually to purchase bananas for food. Net income from bananas is estimated at 264 $, 163 $ and 25 $ for high, intermediate and low input banana crop respectively. Apparently the proceeds from one hectare of bananas at all levels of input cannot support the nutritional requirements of a household. Annual household welfare financial requirement estimates by UBOS (2001) is 798 $. At intermediate input level of banana production about five hectares are needed to support a household that fully depends on farm income for survival.

The above findings indicate that cultivation at low input levels is not sustainable for the average farm sizes. However, with good market accessibility and prices, intensive crop production has been associated with secure food supply, increased household income from 280-500 $ and annual savings of about 70 $ (Nkuba, 2001).

Agriculture is unprofitable in Uganda. Farmers will only really start enhancing soil fertility when they have the money to do so; and that only occurs when most of the population is located in towns which can pay high prices for agricultural produce, which will, in turn, pay for the fertilizers and manure. In his concluding remark, It will take a long time before real and lasting improvement to the land can be expected. Stobbs (1966) observed that it was not possible to establish a profitable livestock enterprise on small farms due to the low returns available from genetically inferior stock.

In the absence of non-farm income to supplement farm income in meeting household requirements, farmers have no option other than acquisition of extra land so as to meet these demands. As a strategy
to cope with nutritional demands and general household livelihood, able farmers rent additional land but the majority, constrained by poverty, have been forced to cultivate shallow, steep marginal land or encroach on the forest reserves in the neighborhood. Agricultural expansion, in pursuit of food security and household welfare, is the leading land use change associated with nearly all deforestation with poverty and human population dynamics as underlying driving causes (Ehrlich et al., 1993; Place and Otsuka, 1997; Geist and Lambin, 2002; NFP, 2002).

The analysis of nutritional household requirements possibly explains why, even when the net margins and Farmers Income Sustainability Quotient indicate that a farmer has the financial capacity to replace nutrients, will not actually do it. He is hungry and hungry people are in no position to consider the long-term health of the earth’s life-support systems – Ehrlich et al., 1993. In most cases scientists and policy makers will see how irrational the farmer is as seen from statements like “unfortunately farmers do not clearly visualize the problems of nutrient mining”

Conclusion

Low input levels of production are associated with negative balances for NPK. The intensification of production is generally associated with positive balances with the exception of K whose balances are negative for all land use types except for high and intermediate bananas.

Livestock and low input banana farmers operating with negative net margins do not have the financial ability to compensate for the nutrients lost through various pathways as indicated by the Farmers Income Sustainability Quotient. Net margins alone portray the profitability of land use types; additional information from nutrient balances has shown how unsustainable some land use types can be despite their good net margins. It is more revealing when nutritional aspects are included as discussed below.

Assuming that all household energy requirements are purchased, a household of 6 will require 544 $ annually to purchase bananas for food. Net income from bananas is estimated at 264 $, 163 $ and 25 $ for high, intermediate and low input banana land use types respectively. Apparently the proceeds from one hectare of bananas at all levels of input cannot support the nutritional requirements of a household.

Annual household welfare financial requirement estimates by UBOS (2001) is 798 $. At intermediate input level of banana production, typical for Rakai, about 5 ha are needed to support a household that fully depends on farm income for survival.

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