Resource use efficiency in rice based farming systems: A case of upland and paddy rice in Namasagali sub-county Kamuli District

J. Mabiriizi Julius and M. Isabirye

Faculty of Natural Res. and Environ. Sci, Busitema Univer., Tororo, Uganda
mabiriizijulius@yahoo.com

Abstract

Rice is an emerging and one of the important cereal crops grown in Uganda. Being a relatively new crop, farmers are faced with a challenge of effectively utilising resources and their combination for maximum productivity and therefore profit. Therefore the study identified the determinants of efficient rice production in Namasagali sub-county with a backdrop of ensuring food security and enhancing the sustainable use of wetlands. These were attained through the use of a logistic regression and the Cobb-Douglas production function model to find the determinants and the level of technical efficiency respectively. Results show that out of the 11 factors assessed, 7 of them were found significant at 5% level of significance. Land size devoted to rice cultivation was the most significant factor determining technical efficiency of rice cultivation in the area. Others are education level, experience, motive of the farmer, family size, labour and use of ox-plough. However, rice type, fertilizer application, gender and land ownership were found insignificant in determining technical efficiency in the area. The Cobb-Douglas results exhibit that the farmers in Namasagali sub-county are generally technically inefficient due to decreasing returns to scale of production, implying that key factors of production are over-utilized. It is therefore recommended that farmers should shift to upland rice cultivation especially NERICA 4 the high yielding one so as to divert attention and ensure limited exploitation of wetlands.

Keywords: resource use efficiency, technical efficiency, rice, wetland, upland, Uganda.

Introduction

According to (27), rice is an emerging crop with foreseen positive benefits towards the livelihoods of farm households and processors in Uganda. It is a major intervention identified in the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) development Strategy and Investment Plan (DSIP) 2009/10 -2013/2014 for food security and poverty reduction in Uganda (11). Introduced in 1942, rice is mostly grown in wetlands by smallholder farms mostly in eastern Uganda. The consumption estimate of 225,000 t is more than the produced 165,000 t. In view of the current population growth rate of 3.2%, the gap between production and demand for rice is expected to increase. Uganda adopted NERICA 1, NERICA 4 and NERICA 10 varieties in addition to the old lowland varieties. Since the introduction of upland rice in 2002, rice farming has grown from 4,000 farmers to over 35,000. From the earlier releases of three upland rice varieties in Uganda in 2002, farmers earned USD 9 million (14.9 billion) in 2005. In the process, the country has seen rice imports drop between 2005 and 2008. This saved the country about USD 30 million in foreign exchange earnings.

However, with continuous cultivation farmers are experiencing low and declining rice yields, affecting their income and food security (27). Yields as low as 0.9-1.1 t ha⁻¹ have been recorded on farmers fields (27). Production is constrained by low and declining nutrient and lack of water, pests and diseases, lack of information on the optimal use of resources, ineffective marketing and extension system and inadequate policies on agricultural inputs and finance (27; 11). These factors are exacerbated by climate change. Furthermore, the inappropriate rice cultivation practices have affected wetland biodiversity and water conservation functions of the wetlands. Upland rice varieties are promoted to reduce pressure on wetlands and thus sustain wetland ecological functions amidst rice cultivation. This study identified the economic benefits and determinants of efficient rice production in Namasagali sub-County with a backdrop of ensuring food security and enhancing the sustainable use of wetlands.
Materials and methods

The study area

Namasagali sub-county is bound on the east by Nile River in Kamuli District, and 60 km North of Jinja town in Uganda. It is endowed with land resources of which wetlands and floodplains are prime for rice cultivation. The area is characterised by a bi-modal rainfall with peaks in March-June and August-November with the March-June peak as the major one. The annual average rainfall is 1,350 mm with a mean monthly rainfall of 75-100 mm (19). There has been a trend of pronounced dry seasons in this sub county over the recent years. Temperatures in most areas of the sub-county are 9-25°C.

Maize is the staple food crop in Namasagali. Therefore, the analysis of rice as a source of food security was made in comparison to maize. Rice cultivation is a new enterprise. Rainfed upland and paddy rice varieties are grown with an increasing tendency of farmers growing upland rice in wetlands, especially during the dry seasons. Upland varieties grown include NERICA 1, NERICA 10, NERICA 4 and NARIC 1 while the paddy varieties include Kaiso and Super with Kaiso dominating. Kaiso was considered in this study.

Both qualitative and quantitative data was collected using crop yield surveys, individual interviews using a pre-tested structured questionnaire. Parameters collected and analysed included crop yield, the cost of purchasing or hiring land, cost of planting materials, labour (ploughing, weeding, bird chasing, harvesting, bush clearing), sun-drying, cost of drying material, transport costs from fields to homes and from homes to processing mills, bio data, aspects related to sustainable wetlands use and food security.

Both purposive and snowball sampling techniques were used to collect data from rice growers. Fifty households was sampled from the villages of Bwizza, Kakaanu, Nalwekomba, Kapalaga, Kisaikye, Namakoba, Malugulya, Kabbeto and Mutukula.

Field plots measuring 2 x 2 m were diagonally established in farmers’ plots during the April-August season of 2012. Quantities of grain from these plots were translated in crop yields with averages used for statistical analysis.

STATA11 and MINI TAB 15 programs were used to analyse data. Descriptive, cross tabulations, cost-benefit analysis, logistic regression model and Cobb-Douglas production function models were used to analyse the data.

Logistic regression model

A logistic regression model was used to analyse the factors that determine rice yields as well as the technical efficiency in rice production especially the socioeconomic factors that could not be analysed by the Cobb-Douglas production model. It was preferred to other models such as probit and logit because of its mathematical simplicity. The logistic regression model was chosen because its dependent variable is binary and can only take two values. It also allows for estimation of the probability of a certain event occurring. The general operational model was as follows:

\[
\text{Logit} (P_i) = \ln \left( \frac{P_i}{1-P_i} \right) = \alpha + \beta_1 X_1 + \ldots + \beta_k X_k + \nu
\]

Where The ratio \( P_i/1-P_i \) is the odds ratio, \( P_i \) - probability that a farmer is efficient, \( 1-P_i \) - probability that a farmer is not efficient, \( X_i \) - various independent variables, \( \beta_k \) - estimated parameters, \( \nu \) - stochastic term.

Therefore the model for analysis is as stipulated below

\[
\text{Yield} = \beta_0 + \beta_1 \text{VARIETY} + \beta_2 \text{Fsize} + \beta_3 \text{Landownersh} + \beta_4 \text{Rlands} + \beta_5 \text{Rex} + \beta_6 \text{Rmotive} + \beta_7 \text{Hirelab} + \beta_8 \text{oxplough} + \beta_9 \text{Fertiliser} + \beta_{10} \text{Education} + \beta_{11} \text{Gender}
\]
**Cobb-Douglas production function model**

This production function was used to analyze the factors that influence rice production especially those that are concerned with technical efficiency. The reason behind using this type of production function is that it is linear in its logarithmic form, and allows for the usage of Ordinary Least Squares (OLS) which was also applied in the above specified linear regression model. It has been also widely used for production function analysis by many researchers worldwide. In theory it is expressed as below:

\[ Y = AL^{\alpha}K^{\beta} \]

Where \( Y \) = output; \( A \) = constant; \( L \) = labour; \( K \) = capital; \( U \) = error term \( \alpha \) and \( \beta \) - elasticities of production.

For constant returns to scale, the sum of the coefficients, \( \beta \) and \( \alpha \) must be equal to one (\( K=1 \)). For increasing returns to scale, they must be greater than one (\( K>1 \)), and for decreasing returns to scale they must be less than one (\( K<1 \)).

The model was used mainly because of its mathematical simplicity. It also has limited effect on empirical efficiency measure and not exclusive to labour and capital alone but also other production inputs. Shortcomings of this function model include the inability to represent all the three stages of the Neo-classical production function thereby representing one stage at a time and lastly the elasticities in this model are constant regardless of the amount of inputs used. The specific model for this study relating to the production of \( Y \), to a given set of inputs \( X \), and other conditioning factors is presented as follows:

\[ Y = a X_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6} + v \]

Where \( Y \) = total yield of rice produced (kg), \( X_1 \) = land devoted to rice (acre), \( X_2 \) = quantity of seeds used (kg), \( X_3 \) = fertilisers used (kg), \( X_4 \) = pesticides used (in kg), \( X_5 \) = labour used (in days), \( X_6 \) = capital/ox plough, \( \beta_1 \ldots \beta_5 \) are parameters to be estimated and \( v \) = error term.

To allow for use of the Ordinary Least Squares procedure, the Cobb-Douglas production function was linearised using logarithms. Taking logarithms on both sides, the model would be:

\[ \ln(Y) = \ln(a) + \ln\beta_1 X_1 + \ln\beta_2 X_2 + \ln\beta_3 X_3 + \ln\beta_4 X_4 + \ln\beta_5 X_5 + \ln\beta_6 X_6 + v \]

**Results**

**Social characteristics**

Rice is a new introduction in this part of the country with about an equal number growing upland and low land rice type. With an average household size of 6 (Table 1) and the youthful majority of rice farmers who use an average of 1.3 acres (Table 1), the rice enterprise is sure of a reliable supply of labour mostly literate to support the rather labour intensive rice enterprise. This observation is in line with the country’s population structure that is dominated by youths (35).

<table>
<thead>
<tr>
<th>Table 1: Descriptive statistics of some social characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Family size</td>
</tr>
<tr>
<td>Experience</td>
</tr>
<tr>
<td>Seeds</td>
</tr>
<tr>
<td>Rice acreage</td>
</tr>
</tbody>
</table>

*Transforming rural livelihoods in Africa: How can land and water management contribute to enhanced food security and address climate change adaptation and mitigation?*

*Nakuru, Kenya. 20-25 October 2013*
Analysis of rice production as a source of food security

According to (17), it requires 1700 kg of maize to feed a single family of 6 people annually and 0.63 ha of land is required to produce the equivalent maize grain. Therefore, it costs USD 816 to feed a family of 6 people with maize flour for a period of one year. The net returns from rice grown on land equivalent to 0.63 ha of all the rice varieties are paddy (USD 963.46), NERICA 1 (USD 884.77), NERICA 10 (USD 884.77) and NERICA 4 (USD 1,171.93) (Table 2). It is evident that rice growing can serve to ensure food security in the area since the farmer can be in position to buy food and remain with surplus income to invest in other economic activities including saving for future investment.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Land size (ha)</th>
<th>Milled (kg)</th>
<th>Net revenue (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy</td>
<td>0.63</td>
<td>2028</td>
<td>963.46</td>
</tr>
<tr>
<td>NERICA 1</td>
<td>0.63</td>
<td>1825.2</td>
<td>884.77</td>
</tr>
<tr>
<td>NERICA 10</td>
<td>0.63</td>
<td>1825.2</td>
<td>884.77</td>
</tr>
<tr>
<td>NERICA 3</td>
<td>0.63</td>
<td>1926.6</td>
<td>956.56</td>
</tr>
<tr>
<td>NERICA 4</td>
<td>0.63</td>
<td>2230.8</td>
<td>1,171.93</td>
</tr>
</tbody>
</table>

Maize flour of 1700 kg produced from 0.63 ha cost 2040000; 1700 kg of maize flour is the quantity required to annually support a family of 6 people in the study area (17).

Costs-Benefit Analyses for the different rice varieties

The benefits of growing paddy rice are generally close to upland rice varieties with the exception of NERICA 4 that portrays superior benefits (Table 3). This therefore implies that farmers as well can start growing upland rice varieties instead of the paddy rice varieties. This will enable them to enjoy the benefits of upland rice while conserving the wetlands to ensure flood control, sinking functions, resource base, among others; this was also noted by other researchers (18).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Paddy</th>
<th>Upland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NERICA 1 &amp; 10</td>
</tr>
<tr>
<td>Net Income per acre (USD)</td>
<td>617.6</td>
<td>567.16</td>
</tr>
<tr>
<td>Benefit – cost ratio</td>
<td>1.54</td>
<td>1.50</td>
</tr>
</tbody>
</table>

1700 kg of maize flour * 0.48 (market price) = USD 816

Logistic regression model result

The seven significant variables; family size, farmer’s experience in farming, land size devoted to rice, use of ox plough, education level, cost hiring labour and the motive of growing rice. It does indicate the importance of these factors in rice cultivation (Table 4).

Farmers’ farming experience

It is positively significant at 5% level of significance (p > t = 0.043), (Table 5), with the implication that there is a positive relationship between the farmers’ experience in farming and the rice output that is likely to be harvested. The more experience a farmer has, the better the use of available resources. It is a pointer to the improvement of productivity and technical efficiency. According to (16), many rural rice farmers have low levels of education but with much experience in rice production that enables them to harvest rice yields since they are versed with the field practices.

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Table 4: Logistic regression model results

| Yield          | Coefficient | Std. err | T     | P>|t| |
|----------------|-------------|----------|-------|-----|
| Variety        |  323.6      |  328.4   |  0.99 | 0.330ns |
| Family size    |  -219.1     |  63.7    | -3.44 | 0.001** |
| Landownershi p (acre) | -117.8 | 136.9   | -0.86 | 0.394ns |
| Land size (acre) |  1482.2     |  87.3    | 16.9  | 0.000** |
| Experience (yrs.) |  84.9    |  40.8    | 2.08  | 0.043* |
| Motivation     |  68.4       | 189.7    | 3.63  | 0.001** |
| Labour (days)  |  40.0       | 408.1    | 2.06  | 0.045* |
| Ox plough      |  931.4      | 376.3    | 2.48  | 0.017* |
| Fertiliser (kg) |  301.2      | 426.5    | 0.71  | 0.484ns |
| Education level|  42.0       |  2.9     |14.37  | 0.04* |
| Gender         |  329.6      | 243.6    | 1.35  | 0.182ns |

Number of observations = 50, Prob>F = 0.0158, R-squared = 0.682, Adjusted R-squared = 0.668; * = Significant at 0.05 level, ** = highly significant at 0.01, ns = not significant at all levels

Table 5: Cobb-Douglas production function model results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of elasticity</th>
<th>Std error</th>
<th>t- ratio</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land size(acre)</td>
<td>0.310</td>
<td>70.3</td>
<td>10.23</td>
<td>0.000</td>
</tr>
<tr>
<td>Seeds (kg)</td>
<td>0.281</td>
<td>2.0</td>
<td>9.32</td>
<td>0.002</td>
</tr>
<tr>
<td>Fertiliser (kg)</td>
<td>0.250</td>
<td>40.4</td>
<td>9.32</td>
<td>0.024</td>
</tr>
<tr>
<td>Ox plough</td>
<td>-0.194</td>
<td>376.2</td>
<td>-2.48</td>
<td>0.017</td>
</tr>
<tr>
<td>Pesticides(kg)</td>
<td>0.066</td>
<td>251.5</td>
<td>1.35</td>
<td>0.182</td>
</tr>
<tr>
<td>Labour (days)</td>
<td>-0.099</td>
<td>40.0</td>
<td>-3.04</td>
<td>0.044</td>
</tr>
<tr>
<td>Constant</td>
<td>49.1</td>
<td>2.36</td>
<td>0.008</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R- squared = 0.67, Sum of b's = 0.543, Sum of obs = 50

Education level
There is a positive significant linear relationship between the efficiency in rice growing and the level of the farmer’s education. Greater schooling could enhance farm efficiency, either through acquisition of knowledge relevant to agriculture and the usage of available resources efficiently or enhanced adoption of technology

Land size devoted to rice
The variable land size devoted to rice (Table 5), is positively and highly significant at 1% level (p>|t| = 0.000), which is the most significant variables found. The implication is that there is a positive relationship between land size devoted to rice and rice yield.
Family size
Family size is highly significant at 1% level (P>t=0.001), which happens to be one of the most significant variables, but negative. Labour input replaces capital input and the majority of family labour is applied to rice, so access to family labour is an important catalyst for increasing yield. Therefore, it eases the labour constraint faced by most rice farmers in Namasagali sub-county. However, the result implies that there is negative relationship between family size and yield of rice produced implying an optimum amount must be selected for an acre because too many of them impose a negative relation and too little affects the output as well.

Use of ox plough
Using an ox plough by the farmer has a positive relation with the output of rice, and is significant at 5% level (p>t=0.017). There its use helps to improve on the efficiency other than using the traditional means of Ploughing that are time consuming and inefficient, according to one respondent, it takes 2 days to plough an acre of land using the oxen and it takes a minimum of two weeks for two energetic men to plough an acre of land. Therefore as regards efficiency in rice production use of ox plough is very paramount.

Hiring of labour
This variable has a positive relationship with rice production, and significant at 5% level (p>t=0.045). This implies that as regards rice production efficiency in this area care should be taken when determining the number of labourer’s to hire for use. This appears like that that’s slightly significant because in this area farm production is highly dependent of family labour as shown by the significance of family size towards rice production.

Motive of growing rice
This is another key variable identified as very significant in determining rice yields in Namasagali sub-county with a positive and significant relationship. This implies that the mindset and aim of a farmer determines very much their levels of action towards ensuring high yields and efficiency in production as a farmer will endeavor to allocate the resources optimally to ensure profitability.

Cobb-Douglas production function model results:
The main reason for using Cobb-Douglas production function is to determine the technical efficiency of rice growing of the farmers in Namasagali sub-county. There are a number of variables that are usually known to affect agricultural production for cereals rice in particular. As a result, it is important to use a model that relates production to those variables for a better understanding of the functional relationships. The results indicate that out of six variables used in the Cobb-Douglas, five were significant with one being negatively significant. This implies that there is an input to output relationship.

Elasticity of production
The results indicate that the estimation of the production function resulted in adjusted R- squared of 0.67, indicating that the independent variables included in the model account for about 67% of the variation in rice production in Namasagali (Table 6).

Land size devoted to rice
The result shows that the size of land devoted to rice is an important factor in rice production. With a positive and highly significant elasticity, an increase in one acre of land devoted to rice can result in 31.0% increase in the total yield of rice.

Ox plough use
Cost of hiring the ox plough was used as a proxy for capital. The elasticity coefficient of ox plough is significant but negative, which indicates that the input is paramount but farmers are over-utilising it in the production of rice.
**Seeds used per farm**
The elasticity of seeds is positive, and also one of the highly inputs significant at 5%. The results indicate a 1% change in the quantity of seeds is associated with a 28.1% change in the total rice yield ceteris paribus.

**Labour**
The elasticity of labour is significant but negative where a decrease by 1 unit of this variable results in 9% decrease in the rice yields.

**Fertiliser used**
According to the results in Table 6 a 1% increase in the quantity of fertiliser applied is associated with a 25% increase in the total yield of rice

**Pesticides**
This variable is negatively related and not significant at all as regards production of rice in this area. It should be noted that few farmers apply pesticides to their rice crops. This is based on the reason that rice is relatively a new cereal crop in this area and therefore the case of pests and diseases infestation is still low and hardly reported by many farmers in this area.

**Return to scale**
For constant return to scale, the sum of the technical coefficients β and α must be equal to one (K=1), for increasing return to scale, they must also be greater than one (K>1), and for decreasing return to scale they must be less than one (K<1). The regression results indicate that the sum of b’s is less than one (K<1), where K is the sum of the coefficients a and b, thus simply indicating decreasing return to scale. This serves to indicate that the output of rice is priced below the marginal costs of production. It also serves to imply that the factors are over utilised which result in them being technically inefficient in the cultivation of rice.

**Discussion**
The socioeconomic characteristics displayed in Table 1 favor the production of rice, a labour intensive crop. In line with the country’s population structure (35), a youthful family of 6 does present the labour to support rice production. Labour is a critical factor in rice production as observed by several studies (10 & 1). The labour scenario shows situations of disguised un-employment and therefore farmers have to be very keen when determining the number of worker for matters of productivity and profitability. Farmers contend that upland rice yields highest in wetlands and this coupled with the available labour is likely to ensure a continued production of rice in wetlands. This presents a challenge to conservationists to devise proper mechanisms of striking a balance between rice production levels and wetlands conservation.

Access to land is one of the most important variables, explaining the differentiation in output (Tables 5 and 6). This is in line with the findings of many scholars (1, 7 and 10), Land as one of the primary factors of production is very important and because of its limitedness in supply it has always accelerated a number of aspects such as migration from upland areas to low land wetlands.

Use of ox plough in this area is a common practice but many of these farmers fail to cost it and thus end up operating in phase 3 of the neoclassical production function. Therefore this serves to imply that any further increase in the use of this input yields diminishing returns of rice production.

The variable “seed” (Table 6) is sensitive to the total output of rice, meaning that there is an input to output relationship. The species of the seeds used is very important in ensuring productivity of the rice crop since various seed varieties yield differently for example NARIC 1 yields about 3.5-4 t ha⁻¹, NERICA 4 yields about 4.5 t ha⁻¹ (33). The use of good seeds in crop production is one way of increasing productivity in terms of quantity and quality (10 and 20).
The variable “fertiliser used” plays a big role in improving productivity and in the intensification of agricultural production as a whole especially where the scarcity of farm land is a big problem (1 and 10). However, the appropriate use of these fertilisers is very important in achieving farm efficiency (13). It should be noted that very few farmers have access to fertilisers and that they are not readily available at affordable prices in this area. Therefore according to the returns to scale, it indicates that the per unit cost of the inputs used in production process of an output of rice exceeds the returns from that output rice. Thus showing inefficiency as they spend more on inputs than they should in the view of the yield, given the fact that their livelihood is majorly dependent on farming. In addition to this they in many cases underestimate the inputs more especially labour, time, land especially where it’s freely accessible (12).

**Returns to scale**

This indicates that per unit cost of the input used in the production of an output of rice exceed the returns from that output of rice. Thus showing inefficiency as they spend more on inputs than they should in the view of the yield, given the fact their livelihood is majorly dependent on farming. In addition to this they in many cases underestimate the inputs more especially labour, time, land especially where its freely accessible. Similar studies in Uganda regarding matooke growing indicate the same decreasing returns to scale.

**Conclusions**

There was a significant difference between the paddy rice yields and NARIC 3 species of the upland varieties. The farmers of paddy rice had slightly higher yields than those of NARIC 3. On the other hand there were significant differences between the yields of paddy rice and NERICA 1, 10 and 4 where the yields of paddy rice were more than those of NERICA 1 and NERICA 10; however the yields of NERICA 4 were significantly greater than those of paddy rice. This implies rejection of the hypothesis that there is no significant difference between the yields of paddy and upland rice.

The following inputs were found to be key determinants of technical efficiency in rice production and rice output in general: these are land size devoted to rice growing, quantity of seeds used, use of fertilisers, labour, ox plough (cost of hiring); and ox plough and labour were over-utilised, thus if farmers are to improve on production they have to take note of these inputs. The following socio-economic factors were seen as very paramount: family size, farming experience and motive of the rice farmers. It is noteworthy that the returns to scale for the rice farmers are decreasing, suggesting that rice cultivation by farmers in Namasagali is not technically efficient.

Although upland rice is quite promising, the hindrance to its full adoption and therefore a switch out of the wetlands is the use of wetlands during the rather long dry seasons. The performance of upland rice is rather an attractive during the dry season- a reason why farmers grow both paddy and upland rice in the wetlands. Otherwise NERICA 4 is superior to all varieties and therefore a promising variety for integration into the upland crop enterprises.

To realise efficiency and avoid the technical inefficiency portrayed by decreasing returns to scale of rice production, there is need to adopt modern agricultural farming practices such as use of fertilisers, planting of recommended and good rice seeds that are high yielding in companion with improved institutional support, and human resource improvement. This will serve to form bedrock for improving the livelihood and standards of living of the many rural farmers.

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**References**

Africa Rice Centre (WARDA), (2009). The growing NERICA Boom in Uganda. WARDA publication: Catonou, Benin.


Agricultural Research Council (ARC) (2002) Food and Agricultural research council. Proceeding of the fifth annual meeting of Agricultural Scientists; Pretoria.


Alice Nakiyemba Were (March, 2013), Stakeholders’ Perspectives on the Governance of Natural Resources in Ugandan Lake Victoria Catchment: a Case of Upper River Rwizi and Iguluibi Water Catchments.


Gabriel S. Umoh (October, 2005), resource use efficiency in urban farming: an application of a stochastic frontier.


Kamuli district local government (2010), Kamuli district environmental report.


Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) (2009), agricultural production.
Transforming rural livelihoods in Africa: How can land and water management contribute to enhanced food security and address climate change adaptation and mitigation?