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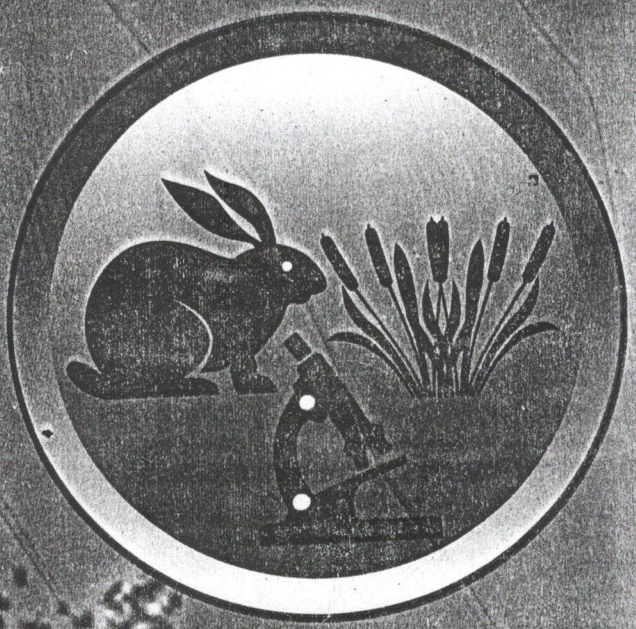

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EDITORIAL

The Editorial Board of Biological and Environmental Sciences Journal for the Tropics (BEST) is proud to present the thirty - second (32^{nd}) edition of the Journal (***Volume 10 Number 2 of June, 2013***) to the numerous scholars who will like to be informed about current issues and research findings in the areas of pure and applied aspects of biological and environmental sciences as well as biochemistry. 'BEST' is an official publication of the Department of Applied Biology, Bayero University, Kano, Nigeria and it is published four times a year (March, June, September and December). The journal presents original ideas and findings in areas of pure and applied aspects of biological and environmental sciences as well as biochemistry with the aim of:

- improving the understanding of the relationship between scientific activity and the exchange of such ideas;
- assisting scientists improve their management of research findings and dissemination of research results; and
- creating a global village whereby researchers from far and wide are brought close through this forum.

This is, no doubt, a very ambitious programme and in the past editions and subsequent issues, we will continue to strive to live up to these aims with the help of our highly qualified and experienced team of reviewers. We were surprised at the vast interest generated by the announcement of the 'BEST' journal. We, of course, take this opportunity as a challenge to further publish large numbers of high quality scientific research papers.

A. H. Kawo (PhD)
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For and on behalf of the Editor-In-Chief,
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OPTIMIZING THE USE OF LAGOS WETLAND RESOURCE IN SOUTH-WESTERN NIGERIA

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ABSTRACT
This study determined the optimum pattern of allocating wetland resource among competing agricultural uses in Southwest Nigeria. It was based on primary data collected on livelihood activities of 96 wetland users that were drawn in a multistage sampling process. The data were obtained by administration of questionnaire that was designed to elicit information on the respondents' socio-economic characteristics and livelihood activities around the wetlands. The data were analyzed by descriptive, budgetary techniques and linear programming (LP). The study revealed that most (88.5%) were males, having primary (36.5%) or secondary (38.5%) school education. Budgetary analysis showed that the Net Factor Income (NFI) per ha per year, which is the economic value of the wetland when used for crop farming, was ₦263,699 and ₦175,633 for Badagry and Epe wetlands respectively. Shadow prices obtained from the LP results shows that each hectare of wetland put into agricultural production, results in ₦272,557/ha/year increase in farm households' income at Badagry and ₦57,347/ha/year at Epe wetland. The study therefore concludes that wetlands add to the economic well-being of rural farmers as they are used as resources for continuous production of farm produce. The study thus recommends that wetland destruction should be discouraged as it leads to a considerable loss of farm income.

Keywords Wetlands, Optimizing, Linear programming, Lagos, Crop production

INTRODUCTION

Wetlands have been described both as "*the kidneys of the landscape*", because of the functions they can perform in the hydrological and chemical cycles, and as "*biological supermarkets*" because of the extensive food webs and rich biodiversity they support (Mitsch and Gosselink, 1993). International Panel on Climate Change- IPCC (1996) reported that 6% of the world's land is covered by water while in Nigeria 1,076,728 ha of land is designated as Wetland of International Importance (Moloko, 2008).

Wetland systems directly support millions of people and provide goods and services to the world outside the wetland. People use wetland soils for agriculture, they catch wetland fish to eat, and they cut wetland trees for timber and fuel wood and wetland reeds to make mats and to thatch roofs. Direct use may also take the form of recreation, such as bird watching or sailing, or scientific study (Emerton, 1998). Apart from using the wetlands directly, people benefit from wetland functions or services (Babier *et al.*, 1997): For example, as floodwater flows out over a floodplain wetland, the water is temporarily stored; this reduces the peak river level and delays the time of the peak, which can be a benefit to riparian dwellers downstream. By benefiting in this way, people are making indirect use of the wetland functions.

Direct and indirect human activity has considerably altered the rate of change of wetlands (Barbier *et al.*, 1997). To some degree, artificial wetlands have been created by building reservoirs, canals and flood storage areas. However, the loss of wetlands has far outstripped the gains (Barbier *et al.*, 1997). In Nigeria for example the Hadejia-Nguru wetlands in Jigawa and Yobe states respectively, have shrunk by as much as two-thirds (Idris, 2008) while Taiwo and Areola (2009) reported that 19% of wetlands in Lagos were lost between 1978 and 2006 at the rate of 0.6% and suggested that water loss would likely continue if the management system was not changed.

Most of the physical losses of wetlands have been due to conversion of wetlands to other land uses, for example residential and industrial (Ajibola, Oloyede and Atere, 2011). However, the benefits derived from such conversion must be sustainable, environmentally friendly and tailored towards food security in the case of agricultural purposes. Demand for wetlands, as a resource for agriculture and other developmental purposes does lead to change in land use. This change may lead to either great benefit or great losses, sometimes in economic terms, sometimes in less tangible but significant environmental change. The negative impacts of uncontrolled resource utilization on destabilizing ecosystem and the changing land use patterns makes communities vulnerable to lots of environmental and economical problems, and creating burdens on ecological resources of the world.

The uncontrolled utilization of land in developing countries has led to a considerable loss of prime agricultural land and the disruption or total destruction of fragile wetlands. Consequently, there is a need to examine the pattern of use of this wetland for crop production in order to determine the use that will be of optimum benefit. This study assessed the optimum pattern of wetland resource allocation among competing agricultural uses, and estimates the associated shadow prices as a measure of net economic losses to wetland degradation and/or conversion to non-agricultural uses.

MATERIALS AND METHODS

The study focused on wetland communities around or within Lagos Lagoon wetland in Lagos State, in the Southwest rainforest zones of Nigeria. It is located on latitude $6^0 27'$N and longitude $3^0 27'$E. Lagos Lagoon wetland stretches from Epe LGA to Badagry LGA in Lagos state. Wetlands in Lagos are fed by several rivers, the most important of which are, the Yewa, Ogun, Ona/Ibu, Oshun, Shasha and Oni.

The study was based on primary data collected by personal administration of questionnaires /interviews schedule from individuals that have their livelihood activities around the wetlands in the study area. The questionnaire included questions on various socio-economic parameters such as age, gender, educational status, occupation, farm size, land ownership, organizational participation, involvement in farm activities, participation in decision making, access and rights on wetland resources, livelihood patterns as well as production costs and returns.

The study respondents were selected by multi-stage sampling technique. The first stage was a purposive selection of wetland communities located around/along the Badagry and Epe wetlands in Lagos state. At the second stage, crop farmers found around the water bodies were selected by systematic random sampling, and interviewed. This process generated a total of 100 respondents but only 96 respondents were used for final analysis.

The study data were analysed by a combination of descriptive statistics, budgetary techniques, and linear programming techniques following the method illustrated by Woodward and Wui (2000).

Descriptive Statistics

Descriptive statistics such as mean, frequencies and percentages, crosstabs, tables were used to describe the socio-economic characteristics of the respondents (Table 1).

Budgetary Analysis

Budgetary techniques were used to estimate the costs and returns as well as the Net Wetland Income (NWI) associated with various livelihood activities found around the wetlands (Table 3). The NWI which is a measure of the economic value associated with wetland uses is defined as follows:

NWI = GFI – NWTC ..... (1)

Where,

GFI = is the Gross Farm Income, which is the total value of farm outputs including those sold, consumed at home and/or given out;

TNWC = is the Total Non-Water Cost of production, including the cost of all the variable and fixed inputs employed in production except that of the wetland water, land and associated resources.

Linear Programming

Linear programming (LP) method was used to determine the optimal pattern of wetland allocation among competing farm enterprises by an average farm household in each of the wetlands and the associated shadow prices (Tables 4 and 5). The farm objective was assumed to be maximisation of the Net Wetland Income (NWI), and the LP model was as follows:

Maximise: $$\pi = \sum_{i=1}^{k} \pi_i X_i$$

Subject to: ..... (2)

$$\sum_{i=1}^{k} b_{ij} X_i \leq c_j$$

$$X_i \geq 0$$

Where:

π is the gross Net Wetland Income (NWI) of the average wetland farm operator in the reference wetland.

π_i is the per hectare NWI (N/Ha) recorded by an average wetland farm operator in the reference wetland.

X_i is the area (Ha) of the wetland holding of the average wetland farm operator allocated to the i^{th} enterprise (crop) in the reference wetland.

b_{ij} is the quantity of the j^{th} resource – land (Ha), labour (Man-days), cost of intermediate materials like planting materials, fertilisers, etc (N) required to cultivate each hectare of land allocated to the i^{th} enterprise in the reference wetland.

C_j is the average amount of the j^{th} resource that was available to an average farm enterprise operator in the reference wetland.

RESULTS AND DISCUSSION

In this section the socio-economic characteristics of people pursuing various types of livelihood activities around the selected wetlands were discussed.

Personal Characteristics of Respondents

Table 1 summarises personal characteristics of individuals involved in crop farming around the selected wetlands. Majority (93.8%) of these individuals were married people with an average age of 47 years. In Badagry, most (54.2%) of the farmers were within the active age of 31 and 40 while none of them was above 60 years. The case was however different around Epe wetland as a substantial number (29.1%) of farmers were 51 years and above though a larger percentage of them were between the ages of 31 and 50 years. The youths (30 years or younger) constituted only 10% of the wetland users in both Badagry and Epe. This however conforms to the findings of Nonga *et. al.* (2010), who found out that the mean age of people around lake Manyara basin was 48 years and majority of them were males. The implication of this is that in the nearest future, wetlands in Badagry and Epe may become redundant as the youths who are supposed to continue to utilize the resource for agricultural production are presently not involved. The women-folk (11.5%) were out-numbered by their male counterparts (88.5%). Furthermore, respondents were predominantly primary school (36.5%) or secondary school (38.5%) leavers. Only a few (18.8%) were educated up to the tertiary school level. It has been reported by Muchapondwa (2003) that, education aids better understanding and perception of wetland services and can also enhance wetland management. Therefore, since most of the respondents have had primary or secondary education, there is a possibility that with proper guidance, they should be able to utilize the wetlands without destroying it and preventing it from performing its other functions.

Table 1: Distribution of Respondents by Personal Characteristics

Description	Location		
	Badagry	Epe	All (n=96)
Age group			
Below 30	3(6.3%)	7(14.0%)	10(10.4%)
31-40	26(54.2%)	13(27.1%)	39(40.6%)
41-50	16(33.3%)	14(29.2%)	30(31.3%)
51-60	3(6.3%)	10(20.8%)	13(13.5%)
Above 60	0(0.0%)	4(8.3%)	4(4.2%)
Mean	38	47	47
Gender			
Female	4(8.3%)	7(14.6%)	11(11.5%)
Male	44(91.7%)	41(85.4%)	85(88.5%)
Marital status			
Married	48(100.0%)	42(87.5%)	90(93.8%)
Single	0(0.0%)	3(6.3%)	3(3.1%)
Widow(er)	0(0.0%)	3(6.3%)	3(3.1%)
Education level			
None	4(8.3%)	2(4.2%)	6(6.3%)
Primary	20(41.7%)	15(31.3%)	35(36.5%)
Secondary	22(45.8%)	15(31.3%)	37(38.5%)
Tertiary	2(4.2%)	16(33.3%)	18(18.8%)
Household size			
1-3	16(33.3%)	9(18.8%)	25(26.0%)
4-6	22(45.8%)	8(16.7%)	30(31.3%)
7-9	10(20.8%)	19(39.6%)	29(30.2%)
10-12	0(0.0%)	5(10.4%)	5(5.2%)
Above 12	0(0.0%)	7(14.1%)	7(7.7%)
Mean	5	7	6

Source: Data from field survey (2010)

Resource Endowment of Wetland Based Farm Enterprises

Table 2 summarises the descriptive statistics of the resource endowment of an average farmer in Badagry and Epe wetlands respectively. As shown on Table 2, most of the farmers operated on a small scale, and were predominantly resource poor. The average land holding ranged from 0.86ha in Badagry wetland to 1.38ha in the Epe axis of the Lagos Lagoon wetland. This indicates that the farmers are subsistent in nature and may not enjoy economies of scale which in turn leads to commercialization. Access to labour (including household and hired labour) ranged from 98 Mandays per production season at Epe to 111 Mandays at Badagry, while use of intermediate materials (seeds, fertilizer, agrochemicals and transport facilities) was worth an average of ₦27,262.50 for Badagry and ₦55,250 for Epe.

Costs and Returns to Wetland Based Crop Enterprise

Wetlands serve as a source of income to crop farmers as they are used for crop production all year round. As shown on Table 3 the gross margin obtained from crop farming was ₦82, 932 and ₦270, 998 for Badagry and Epe Wetlands respectively. A key evidence from the results on Table 3 is that the RETS for Epe (₦263, 698.82 per hectare per year) was higher than what obtained in Badagry (₦75, 633.42 per hectare per year). This could be because farmers in Epe utilized more land and could have enjoyed better economics of scale and therefore increased output. This is in line with Ibekwe (2010) who opined that increase in farm size will lead to a significant increase in farm income since farmers with large farms are likely to enjoy economics of scale. Furthermore, farmers in Epe were better educated and this could have lead to their use of better practices which in turn translate into increased production.

Table 2: Descriptive Statistics of Resource Endowment of Wetland Based Farm Enterprises

Wetland	Land (Ha)	Labour (Mandays)	Intermediate Materials (₦)
Badagry	0.86 (0.15)	111.49 (26.36)	27262.50 (7083.78)
Epe	1.38 (0.47)	98.18 (31.62)	55250.00 (39503.32)
Average	1.07 (0.17)	108.74 (14.73)	34165.56 (8894.76)

Source: Data from field survey (2010)

Note: Figures in parenthesis are standard deviation of respective means

Table 3: Per Hectare Costs and Returns to Wetland Based Crop Enterprise

Description	Badagry	Epe
Value of Product(₦/Ha)	173,722.69	469,264.88
Total Variable Cost(₦/Ha)	90,7889.52	198,266.72
Gross Margin(₦/Ha)	82,932.93	270,998.16
Fixed Cost(₦/Ha/Yr)	7,299.34	7,299.34
Net Farm Income (₦/Ha)	75,633.42	263,698.82

Source: Data from field survey (2010)

Optimal Agricultural Land Use Pattern on Selected Wetlands

As shown on Table 4, the land available to a typical farmer in Badagry wetland (0.86Ha) will be optimally allocated with a gross margin of ₦275,071 if 0.094ha of land is utilized for vegetable production and 0.77ha for cassava. The contribution to the VOF was ₦3779 and ₦238263 from cassava enterprises respectively. The shadow price of land in the wetland was found to be ₦272,557/Ha, while those of labour and intermediate materials were respectively ₦111 and ₦25153. The estimate of the shadow price of land suggests a farm household income increase of ₦272, 557/Ha per annum for each hectare of land put into agricultural use. The implication is that the use of the wetland for agricultural production makes the farmer better off economically as additional hectare of land put into agricultural use will translate into increased farm household income.

The major crops identified in Epe were leafy vegetable and Rice (Table 5). The use of 1.06ha of land for the cultivation of leafy vegetable will yield a gross margin of ₦80,208 while 0.32ha of land for rice production will yield a gross margin of ₦32, 083. The shadow price of land was ₦57, 347.66 and that of labour was ₦339.88. This implies that the conversion of one hectare of wetland for other purposes other than crop production will reduce the income of the farm household by ₦57, 687.54. The table also revealed that intermediate materials cost was not a limiting factor but labour and land were limiting factors. Therefore, increase in the use of land and labour will further increase farm income. This will aid the farmers to attain the conditions that are required for an acceptable standard of life, such as adequate health, nutrition, shelter and economic productivity as Haddad and Alderman (2000).

Table 4: LP Results for Optimum Resource Use in Badagry Axis of Lagos Lagoon Wetland

Enterprise	Leafy vegetable	Rice	Cassava			
Initial Tableau						
GM/Ha	41,994.03	177,282.79	309,433.01	VOF=	0	
Allocation (Ha)	0	0	0			
Resource requirement				Used	Available	
Land	1.00	1.00	1.00	0	0.86	
Labour	399.61	143.92	99.95	0	111.49	
Intermediate Material cost	79000	41353.57	23787.50	0	27262.50	
Final Tableu						
GM/Ha	41994.03	177282.79	309433.01			
Allocation (Ha)	0.09	0.00	0.77			
Contribution to VOF	3779.46	-	238263.42	VOF=	**275, 071.26**	
Resource requirement				**Used**	**Available**	**Shadow price**
Land	1.00	1.00	1.00	0.86	0.86	272,557.03
Labour	399.61	143.92	99.95	111.49	111.49	111.49
Intermediate Material cost	79000.00	41353.57	23787.50	25153.43	27262.50	25153.43

Source: Data from field survey (2010)

Table 5: LP Results for Optimum Resource Use in Epe

Enterprise	Leafy vegetable	Rice	Cassava			
Initial Tableau						
GM/Ha	75812.50	100822.55	63218.32	VOF=	0	
Allocation (Ha)	0	0	0			
Resource requirement				Used	Available	
Land	1	1	1	0	1.38	
Labour	54.33	127.91	110.49	0	98.18	
Intermediate Material cost	13875.00	25554.90	33262.50	0	55250.00	
Final Tableau						
GM/Ha	75812.50	100822.55	63218.32			
Allocation (Ha)	1.06	0.32	0.00			
Contribution to VOF	80361.25	32595.99	-	VOF=	**11291.70**	
Resource requirement				**Used**	**Available**	**Shadow price**
Land	1	1	1	0.86	1.38	57,347.66
Labour	54.33	127.91	110.49	111.49	98.18	339.88
Intermediate Material cost	13875.00	25554.90	33262.50	22811.49	55250.00	-

Source: Data from field survey (2010)

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It is however interesting to note that the shadow price of Badagry wetland is higher than that of the Epe wetland as all resources (land, labour and intermediate material cost) were limiting and increase in the hectarage of land used for agricultural production will lead to higher increase in gross margin in Badgry than Epe.

CONCLUSION AND RECOMMENDATION

Based on the findings, the study therefore concludes that, majority of the farmers around the wetlands have had formal education while leafy vegetable, rice and cassava were the prevalent crops in the studied wetlands, however, the cultivation of leafy vegetable and cassava will optimize the use of Badagry wetland while the Epe wetland will be fully utilized when it is used for the production of leafy vegetable and rice.

The study therefore recommends that farmers should be encouraged to cultivate more land around the wetlands as this will lead to increase in farm income. Also, farmers around Badagry wetland should be encourage to commit more of their resources to the production of cassava and leafy vegetable while Epe farmers should concentrate more on the production of leafy vegetable and rice since these crops were found to optimize the use of the wetland.

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