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Evaluation of the diversity of crop and livestock enterprises among agro-biodiversity farmer field schools (ABD-FFS) and Non-ABD-FFS households in Bondo District, Kenya

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ABSTRACT

Objective: To determine the impact of agro-biodiversity interventions on crop and livestock diversity among agro-biodiversity farmer field schools (ABD-FFS) and Non ABD-FFS households in Bondo District.

Methodology and results: The study was conducted in the greater Bondo District which comprises of the current Bondo and Rarieda Districts, in Nyanza Province, Kenya within the 2009/2010 cropping seasons. Bondo District was selected because it is one of the two districts where the agro-biodiversity project activities were implemented. The district presents a wide cross section of aquatic and terrestrial biodiversity, which provides a good opportunity for farmers to adopt enterprise diversification as a strategy to enhance agro-biodiversity. Data were obtained from a random sample of 150 households using a single household survey (SHS). Shannon's index was used to determine crop and livestock diversity in the comparison groups. Multinomial Logit (MNL) and Ordinary Least Square (OLS) regression models were used to determine the impact of crop and livestock diversity on food security and income, respectively, while optimal level of farm enterprise diversification was determined using a linear programming model. The analysis showed that crop diversity is higher for ABD–FFS farmers compared to Non ABD-FFS farmers. However livestock diversity is higher for Non ABD farmers probably due to a trade-off between crop and livestock diversity. Farmers specializing in crop production are likely to keep a few livestock species. Further, the study showed that crop diversity significantly increases the probability of the smallholder farmers being food secure.

Conclusion and application of findings: Farmers under low resource endowment can attain a profitable, diverse and nutritious benefit by bringing in enterprises with low production costs and positive gross margins. Further, farmers need to adopt crop diversity and improved technology to increase productivity of their farm enterprises and assure themselves food security and income. Finally, farmers will need to improve productivity of their livestock to keep less livestock which will release land for crop production and increased crop diversity. A farm plan with few but productive livestock in the mixed farming system provides a balance in income and ensures food security.

Key words: Agro-biodiversity, farmer field schools, crop, livestock, Bondo

INTRODUCTION

Agro-biodiversity is the result of the interaction between the environment, genetic resources and management systems and practices. Thus, agro-biodiversity encompasses the variety and variability of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystem, including its structure and processes in support of food production and food security (FAO, 1999a). Agro-biodiversity requires attention for two reasons. First, it provides a wide range of direct and indirect benefits to humans in form of goods and services. Secondly, human activities have been contributing to unprecedented rates of biodiversity loss, which threatens the stability of ecosystems in terms of their provision of goods and services to humans (Nijkamp *et al.,* 2008). It has been noted that the world's food production and agricultural activities depend on increasingly fragile agro-biodiversity.

Since the 1900s, 70% of plant genetic diversity has been lost and 30% of the livestock breeds are on the verge of extinction (FAO, 1999b). Farmers worldwide have abandoned their numerous local varieties and breeds for genetically uniform, high yielding varieties and breeds that are limited in production. Today, seventy percent of the world's food is generated from twelve plants and five animals' species only (FAO, 1999b). Factors like poverty and lack of knowledge have accelerated the rate of agricultural biodiversity loss. Increased loss of agro-biodiversity reduces community's resilience to adverse environmental and social economic conditions such as drought and fluctuations of agricultural commodity prices (FAO, 2005).

Many farmers, especially in marginal areas such as Bondo where most high-yielding crop varieties and livestock breeds do not prosper, rely on a diversity of crop and livestock enterprises (Fig. 1). The farmers in the district are mainly mixed crop and livestock subsistence farmers. Their major crop and livestock enterprises are maize, beans, sorghum, cassava, cotton, local cattle, goats, sheep and poultry. A few people are involved in fishing along the lake shore and rivers. More than 80% of the households in Bondo District are food insecure at least in some part of the year in both crop and livestock products (Mungai *et a*l., 2006). To deal with food shortages, 92% of the households buy food from the market (Mungai *et al.,* 2008). Food insecurity has been aggravated by frequent crop failure as a result of over-reliance on crops that are ecologically unsuitable for the area such as maize. Farm enterprise diversification would help them maintain their livelihoods in the face of unfavorable circumstances such as disease infestation, uncertain rainfall, fluctuation in the price of farm inputs and outputs. Crops considered as minor such as cowpeas, sweet potatoes and green grams play an important role in food and livelihood security within the production systems at the local level. Plants that grow in infertile or eroded soils, and livestock that feed on scarce vegetation found on degraded land, are often crucial to household nutritional strategies (FAO, 2005). Agro-biodiversity interventions were implemented in Bondo District by FAO-Netherlands partnership programme in 2005. The programme worked with farmer field schools (FFS) to raise awareness on agro-biodiversity issues. It used learn by doing processes with a view to enhancing the conservation and sustainable use of agro-biodiversity. The agro-biodiversity interventions implemented through FFS to enhance crop and livestock diversity were bulking of cassava, sweet potatoes, arrow roots, pumpkins and local vegetables to provide planting materials for the farmer's crop diversity. Other interventions were, intercropping, beekeeping, fish farming, rearing of indigenous goats and poultry, planting of medicinal plants and seed banking.

Figure 1: Shows the various products displayed from agro-diverse activities in Bondo

A few commercial crops were introduced to the farmers such as tissue culture bananas, onions, tomatoes, chick peas and water melon (Bondo District ABD-FFS Report, 2007; Mungai *et al*., 2008). The Agro-biodiversity interventions were expected to generate increased opportunities for enterprise diversification and benefits for farmers and fisher folks in terms of income, food security and sustainable natural resource management (FNPP National Workshop Report, 2005). FFS have been implementing food security related activities in Bondo District since 2002. Ten of these FFS comprising an average of 20 farmers each were selected to implement agro-biodiversity activities. The objective of this study was to determine the impact of agro-biodiversity interventions on crop and livestock diversity among agro-biodiversity farmer field schools (ABD-FFS) and Non ABD-FFS households in the project area.

METHODOLOGY

Description of the study area: The study was conducted in the greater Bondo District which comprises of the current Bondo and Rarieda Districts in Nyanza Province, Kenya between 2009 and 2010. Bondo District was selected because it is one of the two districts where the agro-biodiversity project activities were implemented. The district presents a wide cross section of aquatic and terrestrial biodiversity, which provide a good opportunity for farmers to adopt enterprise diversification as a strategy to enhance Agro-biodiversity. The area lies between 34^{o}E - 34^{o}30'E and 0^{o} - 0^{o}30'S. The entire South-West boundary is delineated by Lake Victoria while the northern boundary is marked by River Yala. The District has a population of 275,543 (projected based on 1999 census (Bondo District development report, 2007). Bondo District covers a total of 1972 km^2 out of which 972 km^2 is dry land and 1,000 km^2 is water surface. The total arable land is 796 km^2. The District receives 800-1600mm of rainfall per annum. The soils are mainly Luvisols with low – moderate fertility except Madiany division which has black cotton soils (Vertisols) of relatively high fertility. The District is divided into four agro ecological zones namely Lower Midland Two (LM_2), LM_3, LM_4, LM_5 of which LM_3 and LM_4 covers 96 percent of the total area (Jaetzhold and Schmidt, 1982). The major farming system is mixed crop and livestock subsistence farming. The major crops are maize, sorghum, cassava, cotton and beans while livestock kept are zebu cattle, local goats, sheep and indigenous poultry. Farmers living along the lakeshore are involved in fishing and small scale vegetable production which forms a relatively important source of income to the District.

Data collection: Both primary and secondary data were used for this study. Primary data was collected from farmers in the agro-biodiversity Farmer Field Schools (ABD-FFS) and Non ABD-FFS farmers in Bondo District through a single household survey. The household survey covered farmers selected from the ABD-FFS groups in the district and Non ABD – FFS farmers. Structured questionnaires were used to collect information on farm enterprise input - output data, household characteristics, socio- economic, household consumption and technological factors. Some primary data especially on prices of inputs and outputs was collected from the local markets.

Input - output and household consumption data was constrained by the fact that most smallholder farmers did not keep records hence depended on memory recall which was not very reliable. However month to month approach and field observation were adopted to reduce the limitation of memory recall. Field estimation was conducted to establish enterprise sizes especially for perennial crops. Secondary data was collected from various reports at Divisional and District Agriculture offices. Other data sources were Livestock, Fisheries and District Development Offices.

A sample of 150 farmers was selected for the study based on comparison groups' approach of agro-biodiversity (ABD-FFS) participants and Non ABD-FFS (NABD-FFS) participants (Erbaugh *et al*., 2002; Lifeng et al., 2007; Mungai *et al.,* 2008). The total sample was then subdivided into two equal sub-samples of ABD-FFS and NABD-FFS farmers. The sub-sample of 75 ABD-FFS farmers were selected from the 10 agro-biodiversity- Farmer Field Schools (ABD-FFS) groups in Bondo District. The ten (10) ABD-FFS groups had an average of 20 farmers. The ten groups, distributed all over the district were purposively selected for the study. A list of members for the ten groups was developed. Farmers to constitute the ABD – FFS sub-sample of 75 farmers were selected from the population of ABD – FFS members by systematic random sampling method.

An equivalent sub-sample of 75 Non ABD – FFS farmers was selected from three villages in the neighbourhood of ABD-FFS farmers by proportionate stratified sampling. First the district was stratified into three zones, Lake Zone (LZ), Hinterland (HL) and Riverine (RZ) zone. Then three villages were purposively selected where one village represented each zone to capture the varied agro-biodiversity situations. Each village was separated from an ABD-FFS village by at least one Non-ABD-FFS village to reduce the effect of diffusion. The list of farmers in each village was developed and proportionate sample selected by simple random sampling from each stratum to constitute the sub-sample for Non-ABD FFS farmers. The ABD-FFS and NABD-FFS sub-samples cut across the three ABD zones namely the Lake zone (LZ) , Hinter Land (HL) and Riverine zone (RZ).

Data analyses: Descriptive and econometric analyses were one using Microsoft Excel 2003 and Statistical Package for Social Sciences (SPSS) while the linear programming model analysis was done using LINDO 11.0 for Windows computer package.

RESULTS AND DISCUSSION

Farmers in Bondo District typically have more than one crop enterprise on their farms with an almost absolute proportion of 97.3% (Table 1). It is apparent that households make deliberate decisions to diversify so as to meet needs, probably to provide a variety of foods for their families (Miyuki, 2006).

Table 1: Number of crop enterprises per household in Bondo district, Kenya.

Number of enterprises	Frequency	Percent
One crop enterprise	4	2.7
More than one crop enterprise	146	97.3
Total	150	100.0

Just like crop enterprises, many farmers in Bondo (77.3%) kept diversified livestock types such as cattle, goats, sheep, and chicken (Table 2). Such diversifications results in better utilization of farm resources such as forage and labour and encourages crop-livestock integration (Miyuki, 2006). Further, it permits complementary relationships where crop enterprises utilize livestock manure and livestock utilize crop residues. This interaction in a mixed farming system leads not only to increased yields and income but also to a stable and sustainable farming system (Waithaka *et al*., 2003).

Table 2: Number of livestock enterprises per household in Bondo district, Kenya.

Number of livestock type per Household	Frequency	Percent
No livestock enterprise	5	3.3
One Livestock enterprise	28	18.7
More than one livestock enterprise	116	77.3
Missing	1	0.06
Total	150	100.0

Agro-biodiversity analysis was done to determine the diversity of crop and livestock enterprises among ABD-FFS farmers and Non ABD – FFS farmers in Bondo district. The outcome of the analysis would show the relative difference in crop and livestock diversity hence form a basis for making inference on the impact of the FAO-Netherlands Partnership Programme-interventions on agro-biodiversity among the participating farmers (Table 3)..

Table 3: Crop and livestock diversity mean difference in Bondo district, Kenya.

Participation in ABD-FFS	Mean		N	
	Crop	Livestock	Crop	Livestock
NABD	.3948	.3576	73	70
ABD	.5113	.1359	716	68
Missing				12
Total Respondents			150	150

Table 4: Significance of mean differences of Crop and Livestock diversity between Agrobiodiversity and Non Agrobiodiversity farms.

Variable	Crop Diversity		Livestock diversity	
	Coefficients B	Std. Error	Coefficients B	Std. Error
Constant	.393**	.021	.347*	.166
Participation in ABD-FFS	.119**	.031	-.219*	.240

Results in Table 3 show that there is a mean difference in crop diversity between ABD-FFS farms and Non ABD-FFS farms. The difference in the mean values for ABD-FFS farms (0.5113) and Non ABD farms (0.3948) is 0.1165. This implies that the mean crop diversity value for ABD-FFS farms is 0.1165 or 11.65% higher than the Non ABD-FFS farms. Mean value for Livestock diversity for Non ABD-FFS (0.3576) is higher than that for ABD-FFS (0.1359) by 0.2217 or 22.17% (Table 3). This is probably due to the trade –off in diversity between livestock and crops in a mixed farming system. Miyuki (2006) found similar results, that farmers specializing in crop production were less likely to keep more livestock. Livestock require 0.6 Ha/ livestock unit of unimproved grazing pasture (Jaetzold and Schmidt, 1982) which is the common source of livestock feeds in Bondo district.

The results (Table 3) show that the mean difference of crop diversity between the ABD–FFS and Non ABD-FFS farmers is statistically significant ($p<0.05$). This implies that project participants had higher crop diversity than none project participants. Given the short length of time that the project has been in the district, it can be concluded that the desired impact is beginning to appear and the project interventions increased crop diversity. The agro-biodiversity interventions were expected to generate increased opportunities for enterprise diversification and benefits for farmers and fisher folks in terms of income, food security and sustainable natural resource management (FNPP National Workshop Report, 2005). The mean difference

in livestock diversity between ABD-FFS farms and Non ABD-FFS farms is not statistically significant (Table 4). This is probably due to the fact that diversifying livestock is more involving in terms of capital and management skills hence farmers without little capital are less likely to promptly adopt different types of livestock and their production systems (Miyuki, 2006). Extension projects and policy interventions should promote easier-to-adopt crop-livestock technologies for smallholder farmers to enable agro-biodiversity to be an effective food security improvement strategy.

CONCLUSION

The results of the study indicated that there was a significant difference in agro-biodiversity between the ABD-FFS and Non ABD - FFS farmers. The ABD- FFS farmers had higher level of crop diversity compared to Non ABD-FFS farmers implying the project interventions had a positive impact on agro-biodiversity. However the Non ABD-FFS farmers had higher level of livestock diversity compared to ABD-FFS farmers. This difference was associated with the tradeoff between livestock and crop diversity due to ABD-FFS farmers specializing in crop production. This is plausible especially where land is limited and use of pasture improvement practices and alternative feeds is minimal. However determining the significance of the trade off on food security and income requires further research. The study further found out that increase in agro-biodiversity increases the probability of a household being food secure. This finding implies that smallholder communities in Bondo District need to enhance agro-biodiversity on their farms to ensure food security.

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