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Full Length Research Paper

Role of agricultural biodiversity on dietary intake and nutrition status of preschool children in Matungu Division, Western Kenya

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In order to determine the role of agricultural biodiversity on dietary intake and nutrition status of preschool children in western Kenya, a sample of 144 households with preschool children was systematically drawn from Matungu division. Structured questionnaires and anthropometric tools were used for data collection. Agricultural biodiversity was measured by variety of food crops grown, animals domesticated for food and food items from natural habitats. Dietary intake was measured in terms of dietary diversity and nutrient intake. Epi-Info software was used to compute nutrition indices and Pearson's correlation coefficient used to test for statistical associations between variables. Findings showed that households grew three types of food crops, kept two varieties of animals and obtained two food items from natural habitats. Preschool children were not meeting energy, fat, zinc, vitamin A, and calcium requirements, only 3% had consumed highly diversified diets and 35% of the preschool children were stunted. It was found that 48.5% of changes in dietary intake could be attributed to changes in agricultural biodiversity. In addition, 7, 3.6 and 8.1% of changes in underweight, stunting and wasting respectively, could be attributed to changes in dietary intake. Therefore, increased agricultural biodiversity enhances dietary intake thus improved nutrition status.

Key words: agricultural biodiversity, dietary diversity, nutrient intake.

INTRODUCTION

Loss of agricultural biodiversity through the extinction of species, degradation of natural habitats and intensive modern agriculture based on a few breeds of animals and plants is occurring throughout the world at unprecedented rates (Jamalludin, 2004). Today 75% of the world's food is generated from 12 plants and five animal species. Currently only 250,000 to 300,000 plant species are known Of these, only 4% (10,000) are edible and man only eats 1.5 - 2% (150 to 200) of these plants (Cromwell, 1999). The decreased agricultural biodiversity has led to simplification and decrease in diversity of diets of a large number of people to a limited number of energy foods that do not confer nutrients in the required amounts. Many traditional foods like millet, sorghum, sweet potatoes, indigenous vegetables, mushrooms and wild fruits are now associated with poverty and backwardness.

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These indigenous sources are also notably disregarded in the agricultural development agenda even though they show significant potential in enhancing nutrient security. If harnessed, these sources can cheaply improve food security and nutrition status among poor families in developing countries (Gari, 2004). Besides providing essential nutrients, diversifying local diets and helping nourish children, these foods are rich in a variety of micronutrients like vitamin A, vitamin C, iron, zinc and calcium. These micronutrients enhance the immune system thus fighting diseases and infections like diarrhea, Acute Respiratory Infections, malaria and tuberculosis that are major causes of child mortality in developing countries (ACC/SCN, 2004).

The decreased agricultural biodiversity has led to decrease in variety of animals reared and food plants grown by households (Pillay, 2003). It has also led to simplification and decrease in diversity of diets of a large number of people to a limited number of energy foods that do not confer nutrients in the required amounts. An

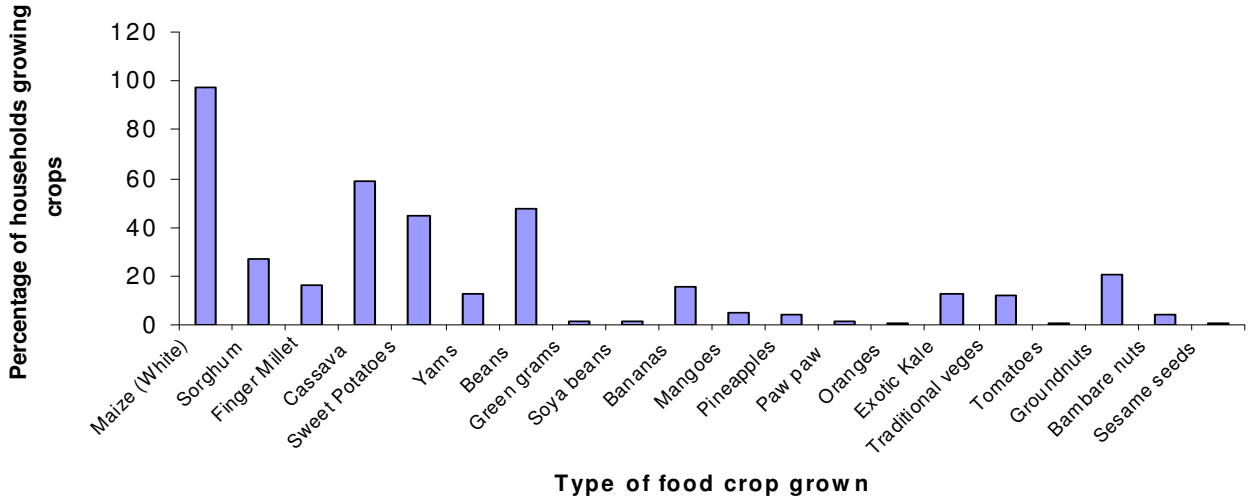

Figure 1. Percentage of households cultivating selected food crops. N = 144.

accompanying decline is in the variety of vegetables and fruit species consumed (John, 2001).

Despite the links between agricultural biodiversity, and dietary diversity and the fact that a diversity of food items mutually reinforce each other's nutrition benefits by enhancing the body's ability to absorb essential nutrients (Emile, 2004). There are major gaps in knowledge on the importance of agricultural biodiversity conservation in relation to diversity and nutrient content of diets consumed and relatively few studies have investigated the relationship between overall agricultural biodiversity and dietary quality (Jamalludin, 2004; John, 2001). The objective of this study was to find out the relationship between agricultural biodiversity and dietary diversity of meals consumed by preschool children in Matungu Division, Western Kenya.

METHODOLOGY

This was a cross-sectional survey that incorporated both quantitative and qualitative methods of analysis. The study was carried out in Matungu Division, Western Kenya. The main cash crop produced in the region is sugarcane (68% of arable land), and main food crops produced in order of importance are: maize, beans, sweet potatoes, cassava, sorghum, finger millet, and groundnuts. The Division has been facing a rising trend in poverty, 60% of the people are absolutely poor and this is due to over-reliance on one cash crop (sugarcane) (Government of Kenya, 2002-2008). A sample of 144 households with preschool children was arrived at Fisher's formula. Multistage sampling was used to obtain samples from the location level up to household level. Villages were sampled randomly, households with preschool children were listed and systematic sampling was used to select the 144 households. Structured questionnaires, food frequency questionnaires, and observation checklists were used for data collection.

Agricultural Biodiversity was measured by the variety of food plants grown, animal reared for food and food items obtained from natural habitats. Dietary diversity was measured using a metho-dology employed by Ogle, Hung, and Tuyet (2001) where dietary consumption of more than 23 food varieties was considered as high diversity, consumption of between 18-22 was moderate dietary diversity, 13-17 was low dietary diversity while <13 was very low dietary diversity (FANTA, 2004). The reference period used was seven days. Nutrition status was measured by levels of wasting stunting and underweight using the WHO/NCHS cut off points classify the nutrition status in Z-scores (WHO, BASIC, UNICEF, 1999).

Data were summarized using tabled charts and graphs, using the Statistical Package of Social Sciences (SPSS), version 11.0. This is manufactured by SPSS Inc. Head quaters, 2335. Walker Drive. 11th Floor, Chicago, Illinois 60606. Pearson's correlation quantified the relationship between agricultural biodiversity and dietary diversity.

RESULTS

Agricultural biodiversity

To determine the state of agricultural biodiversity information on variety of food crops grown, animals reared for food and food items obtained from natural habitats was obtained. Food crops grown by households are shown in Figure 1 and they include a variety of food groups ranging from cereals, vegetables and fruits.

According to Figure 1 white maize was grown by majority of the households (97.2%). Although other findings have indicated that beans are the second most popular food crop in the region, findings from this study showed that cassava was still popular among most households (59%). Kenyan traditional pre-colonial staples like sorghum, finger millet were grown by less than 30% of the population and no household grew brown/colored maize. Beans came third followed closely by sweet potatoes, groundnuts, bananas, kale, Yams, and lastly indigenous vegetables which were being grown by only 11.8% of the households (see Figure 2).

There were only five varieties of indigenous vegetables being grown by the households; cowpea leaves (*Vigna unguilata*) were the most popular, followed by slender *leaf (Crotalaria brevidens), jute mallow (Corchorus olitorius,*

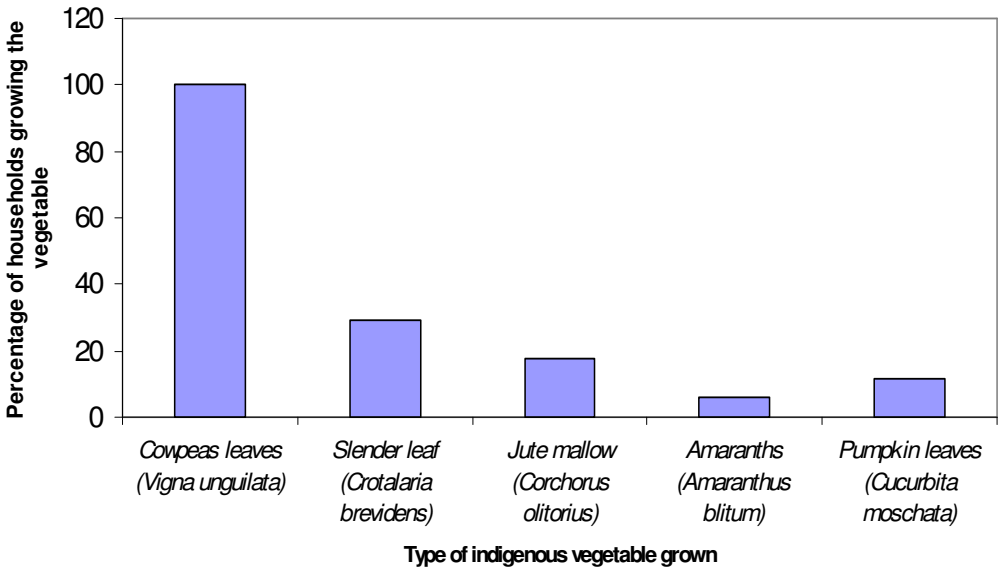

Figure 2. Indigenous vegetables grown by households in Matungu division N = 17.

Table 1. Distribution of animals reared for food among households. N= 144.

Type of Animals	Households rearing the Animals (%)
Chicken	70.1
Cattle	49.3
Sheep	18.1
Ducks	9.7
Goats	7.6
Pigs	7.6
Turkey	6.3
Birds	5.6
Fish	0.7

pumpkin leaves *(Cucurbita moschata)* and amaranths *(Amaranthus blitum*).

Domesticated animals are major sources of proteins for households and they can also be used for commercial purposes. The findings of these study showed that households in Matungu Division were keeping a total of nine varieties of animals (livestock, fish and poultry) that could be used as food. Chicken was being reared by majority of the households (70.1%). Cattle were being reared by 49.3% (indigenous cattle 48.3%, hybrid cattle 7.6%) and fish was being reared by only 0.7% of the households (see Table I).

A number of households were obtaining food items from natural habitats through gathering and trapping (Figure 3).

Ninety-seven point one percent of the households had gathered guavas, this could be because guava trees are very common in the region and they were in season. Mushrooms were gathered by 43.1% of the households, while 30.1 and 11.1% of the households trapped termites and wild birds, respectively. About 6.3% of the households gathered wild fruits. Although caterpillars, mole and giant rats were initially trapped and used as food, the findings of this study showed that only grasshoppers (1.4%) and white ants (30.1%) were trapped for food (see Figure 4). Households obtained on average 2 varieties of food items from natural habitats.

The summary in Table 2, shows reduced agricultural biodiversity. The variety of food crops grown, animals reared and food items obtained from natural sources was so limited. On average it was found that households grew three food crops, kept two animals for food and obtained two varieties of food items from natural habitats.

Dietary diversity

The findings on dietary diversity of meals consumed by preschool children are presented in Figure 4. These findings were based on the number of different food items consumed within a period of one week.

Although dietary diversity is widely recognized as a key element of high quality diets (Were, S.G., 1989, Jamalludin, S. 2004), only 3% of the preschool children had consumed highly diversified diets and 45% of the preschool children had very low dietary diversity.

Diversity of food variety in each group

Eight food groups were considered in the study. These were Bread and cereals, roots and tubers, pulses and nuts, vegetables, fruits, meat and meat products (included fish), milk and milk products and fats and oils. It was noted that 50.7% of the children had consumed between

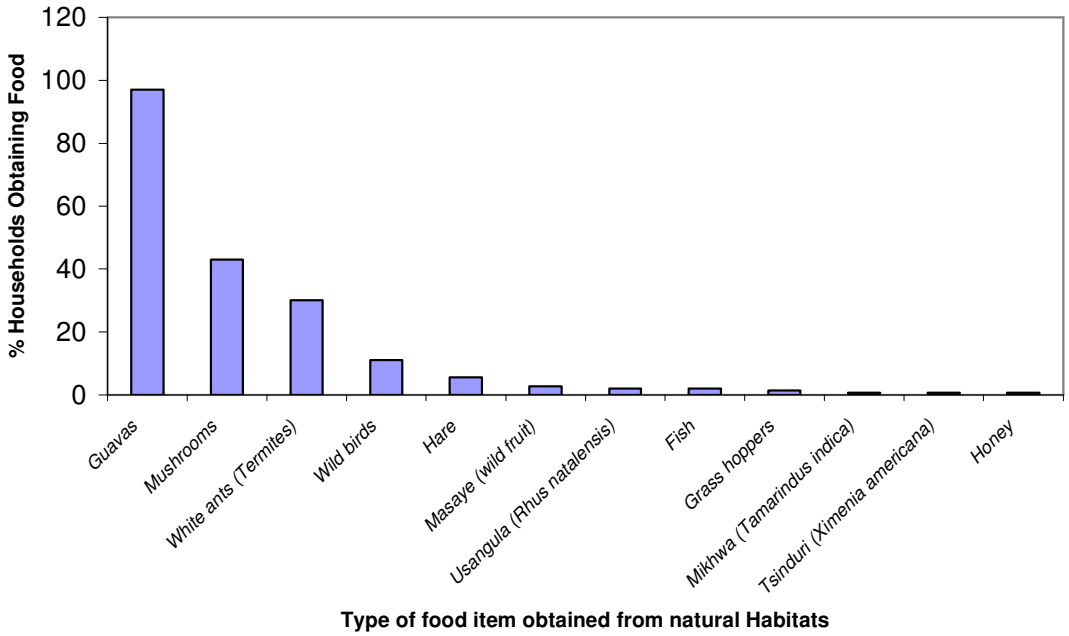

Figure 3. Food items obtained from natural sources by households in Matungu division N=144.

Table 2. Agricultural biodiversity of Matungu division, N= 144.

No/variety	Households growing food crops (%)	Households rearing the animals (%)	Households obtaining foods from Natural Sources (%)
>8	0.7	0	0
6-8	16.7	1.4	1.4
3-5	73.6	27.8	10.4
<2	8.3	65.2	58.3
0	0.7	5.6	29.9
Total	100	100	100

1 and 2 varieties of foods from the breads and cereals group in the one-week period. The findings also indicated that 21.5% of the preschool children had not consumed any pulses and nuts, 9% had not eaten and roots and tubers, 11.8% had not consumed any meat or meat product, 1.4% had not consumed any fruits, 6.3 had not consumed any food prepared using fats or oils and 30.6% had not taken any milk for the one-week period. Although all the preschool children had consumed vegetables, they were not consuming a variety of foods rich in or cooked with fats and oils (see Table 3), this indicated that most of the vegetables they ate had been boiled.

Nutrition status of the preschool children

Nutrition status refers to the nutritional status of the body as expressed according to scientifically tested parameters such as weight, height, age or a combination of these (FAO, 1998). Nutrition status assessment of the preschool children was carried out and the indicators used were stunting, underweight and wasting. Thirty five percent of the children fell below the –2 SD cut of point meaning they were stunted and 12% of them were severely stunted. Twenty one point five percent of the children were underweight and 8.3% were severely wasted (see Table 4).

Relationship between agricultural biodiversity, dietary diversity and nutrition status

By use of linear regression, dietary diversity (the number of different food items consumed in one week) was correlated with agricultural biodiversity (variety of animals kept for food, plants grown for food and food items obtained from natural habitats). There was a positive relationship between the two variables showing that agricultural biodiversity of a household positively influences the diversity of the diets given to preschool children. A standardized coefficient of R=0.697 and R^2 of 0.485 was obtained. This shows that agricultural biodi-

Table 3. Preschool children in relation to consumption of foods from the eight food groups (%).

	Food variety consumption among preschool children in one week (%)							
Food Variety	**Bread and Cereals**	**Roots and Tubers**	**Pulses and nuts**	**Vegetables**	**Fruits**	**Meat and Meat products**	**Milk and milk products**	**Fats and oils**
>5	3.5	0	0	0.7	0	0	0	0
4	12.5	0.7	0	11.1	1.4	0	0	0
3	33.3	5.6	8.3	48.6	25.0	6.9	0	0
2	45.1	38.9	25.0	33.3	44.4	43.1	6.3	4.2
1	5.6	45.8	45.1	6.3	27.8	38.2	63.3	89.6
0	0	9.0	21.5	0	1.4	11.8	30.6	6.3

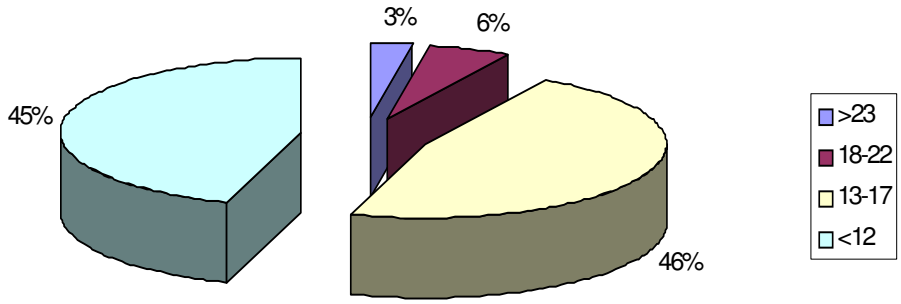

Figure 4. Dietary diversity of preschool children based on food items consumed in one week N = 144.

versity contributes 48.5% to dietary diversity. A positive relationship was also observed between dietary diversity and nutrition status: 7, 3.6 and 8.1% of the changed in underweight, stunting and wasting respectively could be attributed to changes in dietary diversity.

DISCUSSION

Agricultural biodiversity

Considering the type of food crops that were being grown by the households, maize was the most popular, these results are similar with those of the District's development plan which indicated that the total area under food crops in the district was 29,556 hectares of which maize occupied the highest area of 15,650 ha (Government of Kenya, 2002-2008). This could be because maize is the staple food of the community (Were, 1989). Although other studies in the area showed that beans was the second popular occupying 10,775 ha. In this study cassava was second in popularity. This shows that despite cases of food poisoning due to intake of cassava sited in the region (unpublished report), this food crop is still popular. Before the cassava is used, it undergoes processing that destroys the cyanide; it is then mixed with maize, ground and used in making 'ugali' a local food. The findings of this study also showed that indigenous vegetables were not so popular. There were only five varieties of indigenous vegetables being grown and cowpea leaves (*V. unguilata*) were the most popular. According to the community this is because cowpea can withstand harsh conditions and its yield is always higher than the other indigenous vegetables. In addition both its leaves and seeds are used as food. Although indigenous vegetables like African nightshades (*Solanum scabrum*), spider plant (C*leome gynandra*) and African kale (*Brassica carinata*) were used as food (Abukutsa-Onyango, 2003), and were popular among the luhya community (Were, 1989), no household was growing them. This could be due to agricultural commercialization, changing attitudes and changing dietary patterns.

Apart from enhancing diversity in diet, indigenous vegetables are rich and cheap source of micronutrients for households especially those in poor economic settings. They contain high levels of minerals especially calcium, phosphorus, iron, vitamins A, vitamin C and proteins that have a great role in boosting the immune system. In most cases, the vitamins and minerals are more than those found in exotic vegetables. A hundred grams of these vegetables provide 100% of vitamins and minerals and 40% of proteins recommended daily (Abukutsa-Onyango, 2003).

There were only nine varieties of animals (livestock, poultry and fish) being reared by the 144 households. The most popular animals were chicken and cattle. The popularity of chicken could be because it is a major deli-

Table 4. Prevalence of malnutrition among preschool children N = 144.

Classification	Stunting (HAZ)		Underweight (WAZ)		Wasting (WHZ)	
	Freq	%	Freq	%	Freq	%
>1.00sd	7	4.9	6	4.2	22	15.3
0.99 to –0.99sd	39	27.1	68	47.2	95	66.0
-1.00 to –1.99sd	48	33.3	39	27.1	15	10.4
<-2.00	50	34.8	31	21.5	12	8.3
Total	144	100	144	100	144	100

cacy in the luhya community and it is used as a gift (Were, 1989). According to the community members, the popularity of cattle could be its use in marriage as dowry, economic gain, and as food especially during weddings, funerals and any major functions.

In Matungu Division (Butere/Mumias District), hunting and trapping of animals like hare, giant rats, and mole rats was highly practiced. Wild fruits were gathered and mainly eaten on the spot by anybody. Insects like locusts and termites were trapped and used as food. These indigenous varied sources of food provided essential nutrients to the people and also acted as safety nets before harvest or in times of famine (Were, 1989). Despite this, only 12 varieties of food items were being obtained from natural habitats. According to the community members the decline in hunting, trapping and gathering is because these activities are now associated with backwardness and poverty. In addition, the introduction of sugarcane and intensive modern agriculture that involves chemicals and fertilizers has destroyed natural habitats.

Dietary diversity

Since studies have shown that dietary diversity is significantly associated with nutritional status indicators among children below five years (Ruel, 2002), the low dietary diversity observed in terms of number in food items and variety of food items from each food group means that a majority of the children in the region are not receiving adequate and essential nutrients. They are consuming inadequate and monotonous diets mainly composed of carbohydrates and very few sources of proteins, if any. The consumption of vegetables cooked by boiling and low consumption of fats and oils leads to loss of micronutrients and also reduces the bioavailability of fat-soluble nutrients such as Vitamin A. Diversity in diet has clear beneficial effects on the development of young children. Moderate to severe malnutrition and especially micronutrient malnutrition results in a variable impairment of several aspects of immunocompetence. Most notably is cell-mediated immunity, phagocyte bactericidal activity, complement system, opsonization, and mucosal immunity (Chandra, 1989). This makes individuals more susceptible to infections (Jamalludin, 2004). Therefore one possible strategy for improving the health of the poor people and especially children in developing countries is to promote dietary diversity.

Nutrition status

In Kenya the lives and livelihoods of over 2.3 million children are at risk, and malnutrition rates are reaching alarming levels, endangering the physical and intellectual development of these children (United Nations, 2004). Stunting levels observed in this study are higher than the national level of 31% and even higher than that of Western province which was 16.4% with 11.6% severely stunted, levels of under weight observed are almost similar to national levels of 20% (KDHS, 2003). The 8.3% prevalence of severe wasting observed is higher than the statistically expected prevalence of between 2-3% and a little lower than the overall global prevalence of 9.45% (ACC/SCN, 2000). Although the levels of malnutrition observed in this study were a little higher that those reported in the KDHS (2003), the similarity is that stunting was the most prevalent form of malnutrition in both surveys.

Conclusion

On average, households in Matungu Division are growing 3 types of food crops, keeping 2 varieties of animals for food and obtaining 2 varieties of food items from natural habitats. The diversity of meals given to preschool children in this region is low. On average, they are consuming 13 varieties of foods in a week and stunting is the most prevalent form of malnutrition among preschool children in Matungu Division.

There is a positive and strong relationship between agricultural biodiversity and dietary diversity. A change in agricultural biodiversity influences 50% of the diversity of diets given to preschool children. The positive but low correlation observed between dietary diversity and nutrition status indicates that although, dietary diversity affects nutrition status, there are other factors that is, morbidity that plays a major role in determining nutrition status of children.

Recommendations

Therefore to promote dietary intake in quality and quanti-

ty among preschool children, and also to reduce levels of malnutrition, the concerned bodies/ministries should initiate programs that will encourage agricultural biodiversity and utilization of indigenous food species among rural households who depend on agricultural biodiversity as their major source of food. Extension services should be intensified and directed specifically to women because they are the major family caretakers.

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