Linking farm production to household diets: Evidence from two low potential areas in Kenya

Emmaculate Kiptoo1*, Lydia Marth Waswa2 and Oscar Inagasia Ayuya1

Abstract: Despite the role played by small-scale farmers in agricultural production, majority of these farmers’ households in developing countries consume diets that are of low quality. This consumption of poor quality diets is a major factor contributing to the high burden of malnutrition. Farm enterprise diversification as one of nutrition-sensitive agriculture interventions, improve nutritional status by supporting consumption of nutritious foods. This study aimed at examining the role of farm enterprise diversity on household diet quality among small-scale farmers in two low potential areas in Kenya. The cross-sectional study targeted 320 randomly selected small-scale farmers’ households in Makueni and Nyando Sub-Counties and semi-structured questionnaires were used to collect data. From the results, livestock count had a positive significant effect on household diet quality at 5% significance level. This finding indicates that household dietary diversity (HDD) can also be achieved through the income pathway since people can purchase a variety of other foods from the market using the income they earn. Thus, there is a need to sensitize small-scale farmers on the importance of producing a variety of crops and animal species for household consumption and sale for improved HDD.

Subjects: Agriculture; Agricultural Economics; Agriculture and Food; Nutrition

About the Author

Emmaculate Kiptoo The study contributes to the existing body of knowledge on the role of farm enterprise diversity on household diet quality based on data from Integrated Modelling Platform for Mixed Animal Crop Systems (IMPACT) lite project. The study was part of the larger project by International Livestock Research Institute (ILRI). The aim of the project was to modify impact to be able to collect household level data detailed enough to capture within site variability on key performance and livelihood indicators that could be used for a range of analysis. The first author is a graduate student in Agricultural Economics in Egerton University and was a Research Assistant in the project. The second author is a lecturer of Nutrition at Egerton University, Department of Human Nutrition. The third author is a lecturer of Agricultural Economics at Egerton University, Department of Agricultural Economics and Agribusiness Management.

Public Interest Statement

Small-scale farmers play a very crucial role in the agricultural sector. Therefore, it is important to understand how these small-scale farmers’ households can benefit from agricultural production through the diets they consume. This study investigated the role of farm enterprise diversity on household diet quality among small-scale farmers in two low potential areas in Kenya. The results indicated that a simple count of livestock species, education of the household head, land size and number of social groups had a positive effect on household diet quality. On the other hand, age of the household head and difference in the study site location had a negative effect on household diet quality. There is a need for stakeholders to emphasize on interventions that focus on improving the quality of household diets among small-scale farmers in low potential areas.
Keywords: farm enterprise diversity; household; dietary diversity; diet quality; low potential; small-scale farmers

1. Introduction
Agriculture has been identified as a key sector in the achievement of Sustainable Development Goal 2 adopted by United Nations (UN) whose aim is to end hunger, achieve food security and better nutrition and promote sustainable agriculture (United Nations, 2016). However, developing countries have struggled in achieving this with non-uniform achievement levels. This is because small-scale farmers play a very vital role in the agricultural sector. Kamara et al. (2019) posited that the level of development in agriculture largely depends on agricultural productivity of small-scale farmers. Despite this, the majority of the small-scale farmer’s households in developing countries consume diets that are low in diversity contributing to the burden of malnutrition (Sibhatu et al., 2015). Many rural households in low-income countries rely on what they produce to meet their nutritional needs. This is due to several reason including poverty, lack of access to market where they can buy other foods, very high cost of transport and remoteness of the areas they live in (Pellegrini & Tasciotti, 2014). New approaches are thus needed to promote the production of a variety of foods rich in essential nutrients while using land efficiently (DeFries et al., 2015).

Natural calamities coupled with unreliable weather conditions are the main threats to the agricultural sector in Kenya enhancing vulnerability of the farming community (Kotikot et al., 2020; Tripathi & Mishra, 2017). As a result, climate change and variability have a direct impact on food security and agricultural production since most of Kenyan population lives in rural areas and depend on agriculture for their livelihoods (Ochieng et al., 2016). How well people can adapt to climate change depends on factors such as access to timely information, availability of money and behavioural barriers among others which often hinder the adoption of agricultural technologies and management strategies (Silvestri et al., 2015). For this reason, the government and development partners are collaborating to encourage farmers to intensify agricultural production by using improved food production technologies. Some of the strategies that have been promoted include the United States Agency for International Development (USAID) funded Climate Change, Agriculture and Food Security Research Program (CCAFS) in Kenya among other countries in Africa. The aim of the project was to improve farmers’ access to climate information so that they use it in their production decisions with the hope that it will impact on their food and nutrition security.

Climate Change, Agriculture and Food Security (CCAFS) project promoted a number of technologies that were supposed to be integrated into the production systems one of them being crop and livestock diversification, which is a nutrition sensitive agriculture intervention. Since small-scale farmers consume a large proportion of what they produce, farm enterprise diversification has the potential of supporting consumption of nutritious foods (Fiorella et al., 2016; Sibhatu et al., 2015). Fiorella et al. (2016) suggested that increasing the availability of micronutrient-rich and animal source foods may serve nutritional goals when households can access these products. Further, markets help in income generation since one can sell their produce at the market and use the money obtained to buy other varieties of foods that could contribute to diversity of diets consumed by rural households (Zanello et al., 2019).

Several studies have been done to try explain the link between farm enterprise diversity and dietary diversity (DD) at household and individual levels. In a study conducted by Sibhatu et al. (2015) among smallholder farm households in Kenya, Ethiopia and Malawi, farm production diversity was found to be associated with HDD in some but not all situations. Further, in this same study, an increase in market access had a greater effect on HDD than increased farm production diversity. In another study by Ecker (2018), farm production diversity alongside household income were found to be important determinants for HDD in rural Ghana.
Most of the evaluation reports that have been done in the CCAFS project sites have ended up looking at the gender aspects of the project and how the use of the climate information on farm level decisions have impacted income and food security leaving out the nutrition aspect. This study focused on two low potential areas in Kenya, where farmers face production risks which may have an impact on the quality of diets consumed by the small-scale farmers’ households. Based on the foregoing, this study seeks to address the gap on the role played by farm enterprise diversity in contributing to the quality of household diets in low potential areas in Kenya. In addition, knowledge on farm enterprise diversity can help inform policy on how to improve quality of household diets among small-scale farmers in low potential areas. Diet quality as used in this study is synonymous with DD, and it was assessed at household level.

2. Theoretical framework and empirical model

2.1. Theoretical framework

Nonseparable farm household model underpins this study by examining the connection between farm enterprise diversity and diet quality. This model tries to explain the causal effect between the output that is; what is coming from the farm and consumption in terms of diet quality besides other exogenous variables which may influence the decision. In an inseparable farm household model, production and consumption decisions are jointly determined (Benjamin, 1992). The determination of the direction of causality, is possibly confounded by cross-sectional correlation (Dillon et al., 2015). A dynamic nonseparable household model which addresses the challenge of omitted production variables on diet quality regression equation was developed which uses planting and harvest season data to improve the determination of production-consumption elasticity estimates. This model differentiates between the timing of seasonal production decisions to understand the effect of planting period production decisions on post-harvest diet quality within a full agricultural season, t (Vijayalaxmi et al., 2020). Following the dynamic agricultural household model as presented by Dillon et al. (2015), households maximize expected utility given the production function \( Q_t \), time endowment \( \left( E^t \right) \) and intertemporal budget constraint (Equation 4). The household’s problem is to choose produced agricultural goods \( x_{at} \), purchased market goods \( x_{mt} \), agricultural inputs \( V_t \) and leisure \( l_t \) to maximize utility given observed \( \mu_t \) and unobserved household characteristics \( \varepsilon_t \) such that;

\[
\text{Max} \left[ \sum_{t=0}^{\infty} \mu_t (x_{at} x_{mt}; l_t; \varepsilon_t) \right] \\
\text{Subject to the constraints:}
\]

\[ Q_t = Q_t \left( l_t, V_t, A_t; \theta \right) \]  
\[ E^t = l_t + L^t + L^Q_t \]  
\[ W_{t+1} = \left( 1 + r_{t+1} \right) \left[ W_t + W_t \left( E^t - l_t \right) + \pi - p_{at} X_{at} - p_{mt} X_{mt} \right] \]  

Where,

\[ \pi_t = p_{at} Q_t \left( l_t, V_t, A_t; \theta \right) - W_t L_t - p_{at} V_t - p_{at} A_t \] is the profit function over season t. Equation 2 is the production function which depends on vectors of farm labour \( L_t \), variable inputs \( V_t \), fixed assets \( A_t \) like land and capital and seasonal climate variability \( \theta \). The household’s time endowment represented by equation 3 is divided between leisure, on farm \( L^t \) and off-farm labour \( L^Q_t \). Equation 4 represents a standard dynamic household budget constraint.

In an inseparable household model, production factors like input prices influence the household’s consumption choices such that;

\[ x_{ct} = x_{ct} \left( P_{mv}, P_{ov}, W_v, r_{t+1}, \pi_t \left( P_{mv}, P_{ov}, P_v, P_{vb}, \theta \right), \rho_{mv}, P_{ov}, P_v, P_{vb}, Y_V, \lambda_v; \mu_t, \varepsilon_t \right) \]
Input prices affect household consumption when markets are complete and it cannot be assumed that it is only income that affects household consumption demand. Therefore, the consumption demand equation includes variables that affect both household income and production decisions (Dillon et al., 2015).

### 2.2. Empirical model

Household dietary diversity score HDD$y_i$ is a count data and is obtained from a Poisson distribution with factor $\lambda_i$, related to independent variables $x_i$ (Greene, 2007). Independent variables in the equation are; crop and livestock count variables and other variables posited to affect the relationship between farm enterprise diversity and household diet quality. Following Gido et al. (2015), the Poisson equation will thus be:

$$\text{Prob}(Y_i = y_i | x_i) = e^{-\lambda_i} \frac{\lambda_i^y}{y!}$$

(6)

Log-linear form of $\lambda_i$, which is mostly used, is presented as:

$$\ln \lambda_i = x_i \beta$$

(7)

Expected household diet quality is written as:

$$E[y_i|x_i] = Var[y_i|x_i] = \lambda_i = e^{x_i \beta}$$

$$\partial E[y_i|x_i] \partial x_i = \lambda_i \beta$$

(8)

Poisson which is a non-linear model is easier to approximate using maximum likelihood (Greene, 2007). The equations are written as:

$$\partial \ln L / \partial \beta = \sum_{i=1}^{n} (y_i - \lambda_i) x_i = 0$$

(9)

$$\ln L = \sum_{i=1}^{n} [\lambda_i \beta - y_i x_i \beta + \ln \lambda_i]$$

(10)

Coefficient estimates in Poisson distribution show by what percentage diet quality changes when independent variables change by a unit (Sibhatu et al., 2015). In Poisson model, it is assumed that mean and variance of DD are equal (Koppmair et al., 2016). Durbin-Wu-Hausman test for endogeneity was conducted and the results revealed that it was not a problem since the value of the added residual was 0.162 and it was not statistically significant.

### 3. Methodology

#### 3.1. The study area

Cross-sectional survey was used to collect data from 320 randomly selected small-scale farmers’ households in Makueni and Nyando Sub-Counties in the months of October, November and December, 2016. The study was part of the larger project by International Livestock Research Institute (ILRI) in collaboration with CCAFS entitled IMPACT lite. The aim of IMPACT lite project was to modify impact to be able to collect household level data detailed enough to capture within site variability on key performance and livelihood indicators that could be used for a range of analysis (Rufino et al., 2013). Makueni and Nyando are CCAFS project sites whose aim was to improve farmers’ access to climate information so that they use it in their production decisions with the hope that it will impact on their food and nutrition security.

The largest part of Makueni Sub-County is mostly arid and semi-arid and prone to frequent droughts, with the terrain low-lying and rising up to 600 m above the sea level. While some parts of Makueni Sub-County receive very little rainfall ranging from 250 to 400 mm, other parts receive annual rainfall ranging from 800 mm to 900 mm (Government of Kenya, 2018a). Nyando Sub-County on the other hand receives low annual rainfall between 1000 mm and 1800 mm during the long rains and between 450 and 600 mm during the short rains. The elevation in the Sub-County is
between 1,144 m above the sea level towards the plains and 1,525 m above the sea level towards Lower Nyokach Sub-County (Government of Kenya, 2018b).

3.2. Sampling and data collection
In this study, simple random sampling was applied. A 10 km by 10 km research grid was picked on each site and the study was done through resampling small-scale farmers that were previously surveyed by CCAFS in 2012. The study sites were purposively selected using susceptibility to climate change, levels of poverty, agro-ecological conditions and agricultural production systems (Silvestri et al., 2015). Data were collected using the Rural Household Multi-Indicator Survey (RHoMIS) tool which was designed to depict standardized indicators related to HDD, farm and household characteristics (Hammond et al., 2017). The RHoMIS tool was divided into several parts; the first part included questions to collect information on the study population's socioeconomic and institutional characteristics. The second part included questions on farm enterprise diversity, while the third part included questions on household diet quality.

3.3. Measurement of farm enterprise diversity
Crop and livestock count variables were used to measure farm enterprise diversity and was adopted from (Jones et al., 2014; Sekabira & Nalungu, 2020). First, crop and livestock count variables were created which is a simple count of all the crops and livestock species kept by a household in the last main season. Thereafter, both crop and livestock count variables together with socioeconomic and institutional variables were used as independent variables to model the relationship between farm enterprise diversity and household diet quality.

3.4. Assessment of household dietary diversity
Household dietary diversity is commonly used as a proxy for household diet quality and refers to the number of different food groups consumed by a household during the last 24 hours preceding the survey (Jones et al., 2014; Sibhatu & Qaim, 2016). Data from 24-h dietary recalls was used to generate the household dietary diversity score (HDDS) calculated based on the following 12 food groups recommended by FAO: cereals, white tubers and roots, vegetables, fruits, meat, eggs, fish and other sea food, legumes, nuts and seeds, milk and milk products, oils and fats, sweets, spices, condiments and beverages (FAO, 2011). If any member of the household consumed any food from these food groups a score of 1 was given, while a score of 0 if no food from the food group was consumed.

The number of food groups consumed by each household were then aggregated resulting in a score ranging from 0 to 12 with a high score reflecting high dietary diversity (FANTA, 2006). The small-scale farmers’ households were further categorized into three groups in order to define the different levels of their HDD as follows: those who had low dietary diversity (having consumed foods from 3 or less food groups); medium dietary diversity (having consumed foods from 4 to 5 food groups); and those having high dietary diversity (having consumed foods from 6 or more food groups), out of the recommended 12 food groups (Ochieng et al., 2017). Household dietary diversity score was then used as the dependent variable to model the relationship between farm enterprise diversity and household diet quality.

4. Results and discussions

4.1. General information about the study population

4.1.1. Descriptive statistics of household characteristics
The age of the household heads from the sampled small-scale farmers’ households ranged from 22 to 103 years with an average age of 55.3 years, Table 1. Overall, household size ranged from 1 to 23 persons with an average of 6 members. Land size of the sampled small-scale farmers was significantly different at 1% significance level with the average land size in Makueni (4.1) higher compared with Nyando (2.3). Walking distance to the market in kilometers was shorter in Makueni
(2.7) in comparison with Nyando (3.7) and the results were significantly different at 1% significance level. The average number of trainings attended by the small-scale farmers in the past year on crop commercialization and risk mitigation was higher in Makueni (0.9) compared with Nyando (0.5) and the results were significantly different at 1% significance level. The average number of social groups household members were engaged in was significantly different at 1% significance level with 2.7 in Makueni and 1.6 in Nyando.

The number of crops grown by the small-scale farmers ranged from 0 to 17 with an average of 6 and the number of livestock species kept ranged from 0 to 6 with an average of 4. When households diversify what they produce on their farms, they can consume from these plants or livestock species or sell these produce to access income to purchase foods from markets (Sekabira & Nalunga, 2020). The number of food groups consumed by the small-scale farmers’ households ranged from 0 to 11 with an average HDDS of 7.0 with no significant difference between households in Makueni (6.9) and Nyando (7.1). This implies that on average, the households from both Makueni and Nyando consumed foods from 7 out of the recommended 12 food groups.

4.1.2. Crop types

Results in Table 2 show that more households in Makueni planted legumes as compared to those in Nyando. On the other hand, more households in Nyando planted cereals as compared to those in Makueni. Moreover, more households in Nyando as compared to Makueni planted/harvested fruits in the last main season.

| Variable description | Total  | Makueni | Nyando | t-test value |
|-----------------------|--------|---------|--------|--------------|
| Age of the household head(years) | 55.3   | 56.1    | 54.6   | −0.87        |
| Household size (individuals who dwell in the household for 3 or more months in a year) | 5.8    | 5.7     | 5.9     | 0.77         |
| Land size (acres)     | 3.2    | 4.1     | 2.3     | −6.20***     |
| Distance to the market (km) | 3.2   | 2.7     | 3.7     | 2.89***      |
| Number of trainings attended | 0.7    | 0.9     | 0.5     | −2.65***     |
| Number of groups household members are engaged in (group membership) | 2.2    | 2.7     | 1.6     | −5.12***     |
| Crop count            | 5.7    | 5.7     | 5.8     | 0.50         |
| Livestock count       | 3.2    | 3.2     | 3.2     | −0.09        |
| HDDS                  | 7.0    | 6.9     | 7.1     | 1.08         |

Note: *** indicates significance at 1% level
4.1.3. Livestock species

The different livestock types kept by the small-scale farmers are shown in Table 3. More households in Nyando kept cattle and chicken as compared to those in Makueni. On the other hand, more households in Makueni (93) kept goats as compared to those in Nyando (85).

4.2. Household diet quality

Figure 1 presents findings on the proportion of households consuming foods from different food groups.

| Crop types          | Makueni | Frequency | Nyando | Frequency |
|---------------------|---------|-----------|--------|-----------|
| Beans               | 61      | 96        |
| Cowpea              | 89      | 54        |
| Green grams         | 77      | 37        |
| Maize               | 153     | 157       |
| Mangoes             | 13      | 11        |
| Millet              | 8       | 30        |
| Oranges             | 9       | 3         |
| Pigeon pea          | 84      | 0         |
| Sarghum             | 32      | 108       |
| Tomatoes            | 1       | 12        |
| Sweet potatoes      | 1       | 12        |
| Cotton              | 2       | 0         |
| Tomako fruit        | 1       | 0         |
| Local fruit         | 0       | 1         |
| Arrow root          | 0       | 1         |
| Avocado             | 0       | 10        |
| Banana              | 0       | 23        |
| Butternut           | 0       | 1         |
| Cabbage             | 0       | 1         |
| Cassava             | 0       | 10        |
| Coffee              | 0       | 1         |
| Groundnut           | 0       | 23        |
| Guavas              | 0       | 2         |
| Kales               | 0       | 19        |
| Lemons              | 0       | 21        |
| Local vegetables    | 0       | 16        |
| Onions              | 0       | 13        |
| Pawpaw              | 0       | 10        |
| Potatoes            | 0       | 6         |
| Pumpkin             | 0       | 1         |
| Soya beans          | 0       | 3         |
| Sugarcane           | 0       | 26        |
| Tea                 | 0       | 1         |
| Watermelon          | 0       | 1         |
| Total               | 531     | 691       |

Table 2. Important crop types planted/harvested by the households in the last main season
Overall, a high proportion of the small-scale farmers’ households consumed cereals (99.4%), spices, condiments and beverages (95.9%), oils and fats (95.9%) and vegetables (95.3%), with the same phenomenon reported in both Makueni and Nyando. While more than half of the all the study households (53.9%) consumed legumes, nuts and seeds, the consumption was higher among households in Makueni (80.6%) compared with those in Nyando (27.0%), with the findings being significant at 1% significance level. This is because more households in Makueni planted and harvested legumes in the last main season as compared to those in Nyando as shown in Table 2. Less than half of the households surveyed (38.8%) consumed fruits, however, a higher proportion of households in Nyando compared with Makueni consumed fruits (53.3% vs. 24.4%) with the results showing a significant relationship at 1% significance level.

Except for milk and milk products which were consumed by 83.1% of households, overall consumption of other animal source foods including meats (12.5%), eggs (6.9%) and fish (11.0%) was notably low among the surveyed small-scale farmers’ households. However, a higher percentage of households in Nyando compared with Makueni consumed fish (21.4% vs. 0.6%) with the findings indicating a significant relationship at 1% significance level. In addition, the consumption of eggs was higher among households in Nyando (9.4%) compared with those in Makueni (4.4%). This is because more households in Nyando kept chicken compared to those in Makueni, Table 3 and the relationship was significant at 10% level of significance. On the other hand, a slightly higher percentage of households in Makueni consumed meat (13.8%) compared to their counterparts in Nyando (11.3%).

The higher consumption of fish among small-scale farmers’ households in Nyando could be attributed to the study site being located near Lake Victoria which is a major source of fish in Kenya. Findings from a report by Nasongo and Okeyo-Owuor (2017) conducted in selected parts in Kisumu County, showed that 76% of the respondents consumed omena which is a type of fish since it is less costly. They also argued that ethnic and cultural background influence food choices and that since a majority of the respondents were from the Luo community, hence their preference for fish. On the other hand, githeri which is a mixture of maize and beans is a staple food among households in Makueni, a fact that could explain the higher consumption of legumes, nuts
Table 3. Livestock types

| Livestock types          | Makueni Frequency | Nyando Frequency |
|--------------------------|-------------------|------------------|
| Bees                     | 7                 | 6                |
| Cattle                   | 115               | 143              |
| Chicken                  | 90                | 133              |
| Donkeys, mules or similar| 23                | 33               |
| Goats                    | 93                | 85               |
| Other birds              | 2                 | 0                |
| Sheep                    | 12                | 49               |
| Pigs                     | 0                 | 2                |
| Rabbits                  | 0                 | 1                |
| Total                    | 342               | 452              |

and seeds among households in this study location compared to those in Nyando (Action Against Hunger-United States of America, 2012).

Moreover, the overall low consumption of nutrient dense foods including meat, fish, eggs and fruits among the households could be attributed to difference in cultural backgrounds where certain foods are consumed more by one community and less by the other. Further, lack of nutrition knowledge on the importance of utilizing these nutrient-dense foods for good health could also explain the low consumption of meats, fish, eggs and fruits. Some crops like fruits and vegetables are also seasonal and have a short shelf-life and therefore not available for consumption all year-round. In most developing countries, dietary patterns are comprised mainly of starchy foods which are low in energy, few animal source-foods, fruits and vegetables (Leyna et al., 2010). In a study by Keding et al. (2012) and Gitagia et al. (2019), consumption of fruits and animal-source foods by women was showed to be low, and was linked to seasonality of fruits and lack of nutrition knowledge on the utilization of available crops and livestock species to improve diets. In addition, certain starchy roots were not consumed by every woman owing to certain dietary habits and customs. In yet another study by Ochieng et al. (2017), the consumption of eggs among the households was found to be low since many households could not purchase animal products which were rarely eaten at home but were frequently sold at the markets. However, since data on food consumption was based on data collected using the 24-h dietary recall method, what the households consumed in the past 24 hours may not have represented what they consumed on a typical day.

Overall, 89.0% of the small-scale farmers’ households had high dietary diversity (consumed foods from 6 or more food groups in the past 24 hours) compared with 0.9% who had low dietary diversity (consumed foods from ≤3 food groups), Table 4. Results comparing the two study sites

Table 4. Distribution of HDDS categories by study site

| Study site | Low (≤3 food groups) % | Medium (4-5 food groups) % | High (≥ 6 food groups) % | \( \chi^2 \) value |
|------------|------------------------|-----------------------------|--------------------------|-------------------|
| Overall    | 0.9                    | 10.0                        | 89.0                     | 0.8443            |
| Makueni    | 0.6                    | 11.3                        | 88.1                     |                   |
| Nyando     | 1.3                    | 8.8                         | 89.9                     |                   |
also show that there were no significant differences in the proportion of small-scale farmer households that had high DD in both Nyando (89.9%) and Makueni (88.1%). However, the proportion of small-scale farmer households that had low DD was slightly higher in Nyando (1.3%) compared to Makueni (0.5%). This could be due to crop failure caused by drought that was experienced in Nyando in the last main season. Therefore, most families in Nyando had less harvest prompting majority of them to depend on the market and aid/gifts for their dietary needs.

This finding where no significant relationship was found between the proportion of households with different categories of HDDS and study site imply that while there was no difference in number of food groups consumed among the small-scale farmer households in the two study sites, the individual food groups consumed differed. For instance, more households in Nyando consumed fish, eggs and fruits compared with households in Makueni and more households in Makueni consumed legumes, nuts and seeds compared with their counterparts in Nyando. These findings point to the need for small-scale farmers to be encouraged to utilize the foods they produce and sell surplus at the market in order to purchase a variety of other foods not produced on the farm. In addition, the small-scale farmers need to be taught on the importance of the different foods they produce in contribution to good nutrition and health for all household members.

4.3. Poisson model results on the relationship between farm enterprise diversity and household diet quality

Poisson model was used to model the relationship between farm enterprise diversity and household diet quality. Household dietary diversity score was used as the dependent variable in the model and all other variables including farm enterprise diversity assessed using crop and livestock count as independent variables. Test for over dispersion revealed that Poisson was the best model to be used to test the relationship between farm enterprise diversity and household diet quality compared with Negative Binomial model since the value of chi-square was small in the goodness of fit that is, 63.50 and an insignificant test statistic. In addition, the likelihood ratio test at the bottom of negative binomial analysis is a test of over dispersion parameter alpha and in this case, alpha was insignificant revealing that Poisson was the best model to use.

From the results in Table 5, livestock count had a positive significant effect on household diet quality at 5% significance level. The results suggested that households kept different livestock species to provide food in order to meet their dietary needs. The households could also have sold some of their own produce and used the income to purchase a variety of other foods not produced on the farm, consequently increasing their HDD. The findings corroborate with those from studies conducted by Snapp and Fisher (2015) and Zanello et al. (2019) who also found out that crop and livestock diversity had a positive effect on dietary quality since households could consume some of the produce from their farms. This finding indicate that apart from subsistence pathway, HDD can also be achieved through the income pathway since people can purchase a variety of other foods from the market using the income they earn. Thus, there is need for the small-scale farmers’ households to cultivate different crop and animal species for own consumption and sell surplus at the market to purchase a variety of other foods not produced on the farms using the income earned.

Age of the household head had a negative but significant effect on household diet quality at 1% significance level. Households with older household heads were associated with low diet quality. The findings are in line with those of Jones et al. (2014), Dillon et al. (2015), and Romeo et al. (2016) who found out that households with older household heads had less diverse diets. This could be explained by the fact that older household heads could be lacking a steady source of income to enable them purchase a variety of other foods for their households from other sources like market to substitute foods from their own farms. Older household heads may also not be in a position to work for long hours in the farms to produce different varieties of other foods for consumption due to low energy levels compared with those with younger household heads. In
Table 5. Role of farm enterprise diversity on household diet quality

| HDDS                        | Makueni and Nyando | Makueni | Nyando |
|-----------------------------|--------------------|---------|--------|
| Socioeconomic factors       |                    |         |        |
| Crop count                  | 0.005              | 0.031   | 0.006  |
| Livestock count             | 0.020***           | 0.140   | 0.031**|
| Gender                      | −0.017             | −0.120  | −0.005 |
| Age of the household head (years) | −0.002*** | −0.013  | −0.001 |
| Education of the household head | 0.02**    | 0.163   | 0.020  |
| Household size              | −0.009**           | −0.065  | 0.012**|
| Off-farm income             | 0.044              | 0.309   | 0.035  |
| Land size (acres)           | 0.007**            | 0.060   | 0.006  |
| Institutional characteristics|                    |         |        |
| Aid                         | 0.028              | 0.193   | 0.002  |
| Gifts                       | −0.019             | −0.130  | 0.041  |
| Distance to the nearest market (km) | 0.003   | 0.019   | 0.001  |
| Number of groups            | 0.015**            | 0.106   | 0.021***|
| Study site dummy            | −0.061***          | −0.421  |        |
| Constant                    | 1.872***           | 1.751***| 1.857***|

Notes: Number of observations = 320; Wald chi² (14) = 65.56; Prob> chi² = 0.0000; Pseudo R² = 0.0088; Log pseudolikelihood = −641.78285; *, **, *** indicate significance level at 10%, 5% and 1% respectively; Study site dummy = 1 if Makueni Sub-County and 0 if Nyando Sub-County.
addition, older household heads may not have the opportunity to access and use more technologies to help them diversify their farm enterprises compared to younger household heads who may have access to more technologies.

The number of social groups household members belonged to was also found to have a significant positive effect on household diet quality at 1% significance level. Through group memberships, household members are in a better position to access money through merry-go-round, table banking and savings and credit which could be partly used to buy a variety of foods not produced on the farm for their households. In addition, they can access nutritional information which can allow them procure food that they could not produce at farm level. These social groups may also be sources of food during times of deficit by one relying on people who are in their network that is the kinship and nonkinship ties thereby helping one access better diets. These results corroborate the findings by Kang et al. (2018) who established that engagement in a group improved access of the mothers to physical materials and health information. Therefore, the mothers gained knowledge on the importance of feeding on diverse foods through their larger network.

Differences in the study site location had a negative but significant effect on household diet quality at 5% significance level. The results imply that households in Makueni had better quality diets compared to households in Nyando. The differences in diet quality in the two regions could be attributed to cultural and lifestyle differences since some foods are consumed in large quantities in one region and in small quantities or not at all in the other. This was the case with the high consumption of legumes, nuts and seeds among households in Makueni while a higher proportion of households in Nyando consumed fish and fruits. In addition, some crops are seasonal and are consumed more when they are available and less or not at all when they are unavailable. For instance, mangoes in Makueni ripen between December and March and this is the time when they are available for consumption by the households in plenty. Market days also differ and some foods may be consumed by households more, a day or two after the market day.

5. Conclusion and recommendations
Farm enterprise diversity had a positive significant effect on household diet quality. Moreover, a high percentage of the small-scale farmers’ households had high dietary diversity that is, they had consumed foods from 6 or more food groups in the past 24 hours. This finding indicates that HDD can also be achieved through the income pathway since people can purchase a variety of other foods from the market using the income they earn. Except for milk and milk products, consumption of other animal source foods including meats, eggs and fish and fruits was notably low among the households. However, more households in Nyando consumed fish, eggs and fruits compared with their counterparts in Makueni. On the other hand, more households in Makueni consumed meat and legumes, nuts and seeds compared with households in Nyando. Since farmers face production risks, there is a need to train and encourage them to use more production technologies to grow crop and livestock species for subsistence use and sell surplus. They can in turn use part of the income earned to purchase a variety of other foods not produced on the farm. In addition, programs and policies geared towards making market prices for farmers’ produce better is key in achieving household diet quality.

6. Limitation of the study
This study used 24-h diet recall which may not adequately portray the usual dietary patterns of the households. Therefore, there is a need for future research to use panel data to assess the role of farm enterprise diversity on household diet quality so as to capture the seasonality aspect of production and variation in dietary patterns.

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