ASPROWORDA

Working Paper 17/2023

Understanding the link between gendered access to agricultural land and household nutrition outcomes in the Democratic Republic of Congo (DRC)

Janvier Mwisha-Kasiwa,
Cédrick Kalemasi-Mosengo
&
Oasis Kodila-Tedika

WWW.ASPROWORDA.ORG

Understanding the link between gendered access to agricultural land and household nutrition outcomes in the Democratic Republic of Congo (DRC)[1]

Janvier Mwisha-Kasiwa
Departement of Economics, University of Goma
E-mail: kasiwa@unigom.ac.cd

Cédrick Kalemasi-Mosengo
Departement of Economics, University of Kinshasa
E-mail: Cedrick.kalemasi@unikin.ac.cd

Oasis Kodila-Tedika
Departement of Economics, University of Kinshasa
E-mail: oasiskodila@yahoo.fr

Abstract

Using data from the DRC Demographic and Health Survey, this study examines the empirical linkages between access to agricultural land and nutritional outcomes by examining gender differences. Results suggest significant effects of access to agricultural land on nutritional outcomes in the full sample, in the male and female-headed households' subsamples as well. However, gender differences are reported. Access to agricultural land appears to be a significant determinant of improved children dietary diversity among female-headed households (FHH), it is also associated with a significant increase in the children height-for-age z-score in the male-headed households (MHH). Moreover, access to agricultural land positively affects the women's likelihood of having a normal body mass index the male-headed households; and finally, the study finds that accesses to agricultural land is linked with a significant decrease in the risk of women anaemia among the female-headed households. Since then, we argue that access to agricultural land by MHHs may be beneficial for long-term nutrition indicators while it is more beneficial for short-term nutrition measures among FHHs.

Keywords**:** Access to agricultural land, dietary diversity, nutrition status, gender, DRC.
JEL Classification **:** C35, D13, I12, J16, Q12, Q15.

---

1 The views expressed in this working paper are those of the authors and do not necessarily represent those of the ASPROWORDA, its Executive Board, or its management.

1. **Background**

Investment in agriculture is widely considered as being critically an important opportunity for reducing malnutrition (Herforth *et al.,* 2012; Ruel *et al.,* 2013; Webb, 2013; Remans *et al.,* 2014). Moreover, agriculture is closely linked to food security; which provides food, constitutes a source of income and influences food prices (Arimond *et al.,* 2011). It is for these reasons that, since the mid-2000s, national and international actors have made agriculture a strategic priority by allocating an increasing share of their budgets to the agricultural sector. However, the assessment of progress in this area has led international donors and national governments to recognize that agricultural interventions are most effective when specific gender aspects are taken into account in design and implementation (World Bank, 2008; World Bank *et al*., 2008; Fortmann, 2009).

In developing countries, women play a crucial and potentially transformative role in agricultural production, processing and marketing. They produce and process food commodities, they prepare a large part of the available food and are the guarantors of the food security of their families and communities. Putting women skills to service of the food system is essential for improving household nutrition outcomes and achieving the goal of "zero hunger" contained in the Sustainable Development Goals (SDGs). According to the UN Food and Agriculture Organization (FAO) (2017), in developing countries, women represent 45% of the agricultural labour force, ranging from 20% in Latin America to over 60.0% in some Africa and Asia regions. In addition, the 2011 FAO report estimates that reducing gender inequalities in access to productive resources such as agricultural land could lead to an increase in agricultural yields among women by 20-30%; which could increase agricultural production in developing countries by 2.5% to 4% and reduce the number of people suffering from hunger in the world by 12-17%.

In DR Congo, agriculture as a key sector is the source of food and nutrition security at the household level and a promising sub-sector of economic growth (Ragasa *et al*., 2012). Agriculture sector accounts for about 43% of Gross Domestic Product (GDP), employs 62% of men and 84% of women, and it's still the most promising base for establishing nutrition security and sustainable economic development (USAID, 2018). These figures suggest a fairly high participation of women in agriculture. Therefore, reducing inequalities between men and women in access to productive resources and decision-making could be beneficial for household food and nutrition security (FAO, 2017).

Unfortunately, women still face persistent barriers and economic constraints that limit their inclusion in agriculture (IFPRI, 2012; Alkire *et al.,* 2013). Empirical studies have increasingly shown that high levels of gender inequality in access to productive resources are associated with high levels of nutrition insecurity (Quisumbing & McClafferty, 2006; Ragasa *et al*., 2012). This relationship appears to hold in the DR Congo; the country ranks poorly on the Gender Inequality Index (149th out of 188 countries ranked in 2014). In parallel, in the year 2000, following the deterioration of the nutritional situation, the DRC has adopted a National Nutrition Policy which provides the general guidelines for combating malnutrition in all its forms. In 2001, in accordance with this policy, the National Nutrition Program (PRONANUT) developed a five-year Master Plan (2001-2005) for the development of nutrition in the country. In 2006, a Triennial Nutrition Plan was also drawn up. From these plans, actions have been implemented to improve the nutritional situation of the population. The 2001-2005 Master Plan and the 2006-2008 triennial plan had identified priority areas for urgent actions expected to contribute to reducing the extent of malnutrition in the country. However, these efforts failed to bring tangible change in terms of improvement of nutrition situation of populations, especially among vulnerable groups. In 2016 an estimated 5.9 million people were experiencing acute food insecurity. This number however, rose to 7.7 million as of the end of 2017 (USAID, 2017). Nearly 2 million children are suffering from severe acute malnutrition (SAM) which accounts for 12.0% of SAM cases in the world. Although the proportion of children under 5 who are stunted has decreased in recent years, 43.0% remain stunted, which is very high. The DRC is among the developing countries experiencing the double burden of malnutrition, with high prevalence of both under nutrition and overweight/obesity. According to the recent Demographic and Health Survey (DHS), the rate of overweight/obesity among women has increased by 5 points of % between 2007 and 2014 (Ministère du Plan *et al*., 2014).

It is therefore necessary to examine the relationship between gendered access to productive resources in agriculture, especially access to agricultural land, and nutrition outcomes of Congolese households. Considering the specific needs of women and men clarify which in the design and implementation of agricultural programmes could contribute to improving productivity and achieving households' nutrition security. In addition, although access to land for agriculture is high enough among households, it does not seem to influence food and nutrition security and food consumption of the Congolese populations. While 72.0% of households with adequate diets have access to agricultural land, 70.0% of households with poor diets also have access to agriculture land. Clearly, access to agriculture land does not mean much in itself, what matters is how it is access, the amount of cultivated land accessed, the availability of inputs, the source of workforce, and the level of participation to market that influence farmer wealth and its level of food and nutrition security. Therefore, the research question of this study is: *How does access to agricultural land influence the nutritional outcomes at the household level in the Democratic Republic of Congo?* The main objective of the study is to investigate the relationship between access to agricultural land and nutrition outcomes by examining gender differences. Specifically, the study seeks to: (i) examine the extent of gender inequalities in access and control of agricultural land and (ii) estimate the effect of access to agricultural land by men and women on households' level nutritional outcomes.

The rest of the paper is therefore organized as follows: section 2 presents an overview of agriculture and nutrition policies in the DRC while section 3 presents the literature review. Sections 4 and 5 discuss the methodology and results respectively, while section 6 concludes and presents some implications for policy.

2. **Agriculture, access to land and nutrition policy in the DRC**

The DRC is the second largest country in terms of territory, the fourth most populous in Africa and potentially one of the world's richest in natural resources (World Population Review, 2018). The DRC has enormous potential for the development of sustainable agriculture with 80 million hectares of arable land (of which only 10% is currently cultivated), a variety of climates and soils, an important hydrographic network, a huge fishing potential and stock farming (Herderschee *et al*., 2012). Agriculture including fisheries generates income to 97% of households in rural DRC (WFP, 2014), while food crop farming is the most common among agricultural activities (69%), followed by livestock production (9%), fishing and forestry resources (7% respectively) and cash crops production (5%).

However, despite these advantages in terms of natural resources, agricultural productivity remains low and access to agricultural land by the population remains limited. For example, although 72.0% of rural households have access to land to cultivate during the agricultural seasons, 52.0% of them use less than 2 hectares and only 19.0% cultivate on more than 2 hectares. While the country has 25 million hectares of arable land and 66.0% of the population is rural (FAO, 2013), the average size of agricultural land per household is estimated at 2.5 hectares (WFP, 2014). Among the rural households that cultivate land during the cropping seasons, 86.0% own their own land, 11.0% rent land and the rest (3.0%) have access to agricultural land through sharecropping According to the WFP (2016), the disruption of the land tenure system, the strong ethnic polarizations which do not favor the expansion on still available and unexploited spaces and, the strong demographic pressure in certain parts of the country explains the continuous fragmentation of the cultivated surface. The state and customary land dispute resolution systems in the DRC face significant challenges to their effectiveness, particularly in protecting the rights of people living in forest and agricultural areas and populations displaced by conflict and ongoing violence (USAID, 2010). Persistent insecurity in some areas has led farmers to miss planting seasons and lead to the depletion of livestock. As a result, the situation of food and nutrition security remains unsatisfactory. Would the situation change if gender disparity in access to land was addressed?

To cope with the poor performances of nutritional indicators, the DRC Government was committed to improving nutrition by implementing some programmes aligned with the new National Nutrition Policy 2013. These include: (i) Multi-sectoral Nutrition Strategic Plan (PNSMN) 2016–2020 ; (ii) National Health Development Plan (PNDS) 2016–2020; (iii) National Policy on Food Security and Nutrition (2017); (iv) Health Investment Framework (2017)

The PRONANUT (National Nutrition Programme) within the Ministry of Health, leads the nutrition coordination and national nutrition policy formulation and development. The Government is also in the process of developing a multi-sectoral nutrition operational plan.

The new National Nutrition Policy considers all the determinants of malnutrition so well known in all sectors that are nutritionally sensitive both in government structures and in other structures such as civil society and Congolese employers. It also takes into account strategic axes that are expressed by direct interventions. It aims to promote, support and protect best practices of exclusive breastfeeding of children 0-6 months, promoting home fortification of complementary foods for children between ages of 6-23 months; by using nutritional supplements, promoting interventions to improve the nutrition of pregnant and lactating women, the fight against micronutrient deficiencies (vitamin A, iron, iodine and zinc); as well as the early detection and management of childhood illnesses, including acute malnutrition.

Through this policy, the DRC aims: (i) to halve the prevalence of chronic malnutrition among children 0-23 months in all the provinces; (ii) to reduce the prevalence of global acute malnutrition below the alert threshold (10.0%) in all the provinces; (iii) to reduce by one third the prevalence of overweight among women due to over-nutrition; (iv) to reduce the prevalence of non-insulin-dependent diabetes by one-third and; (v) to reduce the prevalence of anemia by one-third among children aged 0-23 months, adolescents and women of child-bearing age.

In addition, The DRC has made the following global and regional commitments to nutrition and agriculture: (i) Declaration of the World Summit on Food Security in 2009; (ii) Comprehensive Africa Agriculture Development Programme (CAADP) Compact in 2011; (iii) Ending Preventable Child and Maternal Deaths: A Promise Renewed in 2012; (iv) Scaling Up Nutrition (SUN) Movement and Nutrition for Growth in 2013; (v) Malabo Declaration in 2014 and (vi) Sub-regional Repositioning Workshop on Nutrition, Brazzaville in 2016.

3. **Literature review**

Access to farmland may influence nutritional status. To have a better understanding of these issues, we focused on two aspects in our review of literature. The first is related to gender in agriculture and the second establishes the relationship between agriculture and human nutrition.

3.1. **Gender in agriculture**

Improving women's social and economic status in their homes and communities has a direct impact on food diversity and nutritional status (Fortmann, 2009; IFPRI, 2012; Alkire *et al.*, 2013; Sraboni *et al.,* 2014; FAO, 2017). Therefore, the underlying rationale for examining gender inequalities in agriculture is based on a body of empirical works that suggest the ways through which women are essential to the improving of agricultural productivity, household food security and nutrition (Sraboni *et al.*, 2014).

Several studies in developing countries focusing on these inequalities, notably mention the inequalities in access to productive resources and services. In terms of resources, the literature focuses on gender differences in access to and control over land, participation in agricultural activities, access to agricultural inputs, access to credit, access to education, training and popularization, access to decision-making, access to research and appropriate techniques. Indeed, some research on land ownership and access points to the existence of significant gender disparities in the amount of land available and the degree of tenure security (Nyamu-Musembi, 2002; Deere & León, 2003; Benfica *et al.*, 2010, Ragasa *et al.*, 2012). In the case of sub-Saharan Africa, Mukasa and Salami (2016), opined that women at different stages of the production process face more constraints than men, and this may explain in part the differences in productivity levels. On the other hand, women's agricultural productivity in Burkina Faso may be 20-40% lower compared to men, but these differences are mainly due to lower use of productive inputs, because social norms are gender-based. This is the case of Burkina Faso

(Udry, 1996). Also, Tiruneh *et al*. (2001), reported similar results for Ethiopia, where the productivity gap was attributed to low levels of input use and limited access to extension services. The study conducted by Ali et al. (2014), on the short-term impact of a land regulation programme on the environment and gender in Rwanda, noted that gender inequalities exist, however, the programme improved land access for legally married women.

In the case of the DRC, Ragasa *et al*. (2012) note that women generally have limited access to productive resources. Vlassenroot and Huggins (2004), show that although equally valid for men, armed conflict in eastern DRC accentuates gender inequalities in access to land and other resources needed for agricultural productivity.

In an attempt to analyse how these gender inequalities in agriculture could disappear, studies have shown that the redistribution of inputs between men and women in the household has a high potential to increase productivity (Udry, 1996). Indeed, greater control by women over resources has positive effects on a number of important development outcomes, including household food and nutritional security. In this sense Udry and Duflo (2004), and Haddad *et al*. (1999), in the case of Côte d'Ivoire, have noted that the increase of the share of women's income in the household income significantly increase the share of the household budget allocated to food. Also, Doss (2006), show that in Ghana, the share of women's assets, especially farmland, significantly increases the budget allocated to food and children needs.

3.2. **Connection between agriculture and nutrition?**

The agricultural sector plays an important role in the availability of diverse and nutrition-dense foods (Balagamwala & Gazdar, 2013). For agricultural households, the connection between agriculture and nutrition goes a step further with agriculture being a source of income that directly affects nutrition through food consumption and absorption. The link between agriculture and nutrition runs both ways as good nutrition, and health, have an impact on the ability to carry out agricultural labour. However, time spent on agricultural labour by a woman, impacts nutrition as it reduces time for childcare, one of the underlying determinants of a child's nutritional status, and affects the nutritional requirements of a woman (Herforth *et al*., 2012; Hoddinot, 2012).

The literature notes several pathways through which agriculture and nutrition could be connected (Carletto *et al*., 2015; Pinstrup-Andersen, 2013). Although authors may differ in the definition of specific pathways, four key areas are recurrent in several empirical studies (Ruel *et al.*, 2013; Gillespie *et al.*, 2012; Hoddinott, 2012; Gillespie & Kadiyala, 2012). These areas are: (i) agriculture as source of food, (ii) agriculture as source of income, (iii) supply and demand factors in agriculture that impact household food security, (v) role of gender through female employment in agriculture and its impact on intra-household allocations, care practices.

From the above, the literature suggests that growth in agricultural production is positively associated with nutritional improvement. For example, Shively and Sununtnasuk (2015), in Asia established that there exists a positive link between production diversity and children's nutritional status measured by anthropometric indicators, a similar finding was observed in

Nepal by Malapit et al. (2015). Jones *et al*. (2014), using data from Malawi also indicated that diversity in agricultural production and nutritional diversity are positively related. A study conducted in Uganda using panel data by Carletto *et al*. (2015), examined the linkages between livestock ownership and consumption of animal related products. Their study indicates that livestock ownership especially poultry has a large positive impact on consumption of livestock-related products especially chicken consumption. Dillon *et al*. (2015), and *Kumar et al*. (2015), focus on the relationship between engagement in agriculture and crop production diversity on dietary diversity and anthropometric outcomes in Nigeria and Zambia, respectively. Both studies find positive associations between crop and diet diversity, and the Zambia study also shows a positive association between crop diversity and height-for-age z-scores in children 24 months and older. The Nigeria empirical study also examines an impact of agricultural revenues on dietary diversity. However, Koppmair et al. (2017), using data from Malawi concluded that the effects of farm production diversity on diet diversity were small but positive, and that, farm production diversity might not be an effective strategy for enhancing household's dietary diversity score.

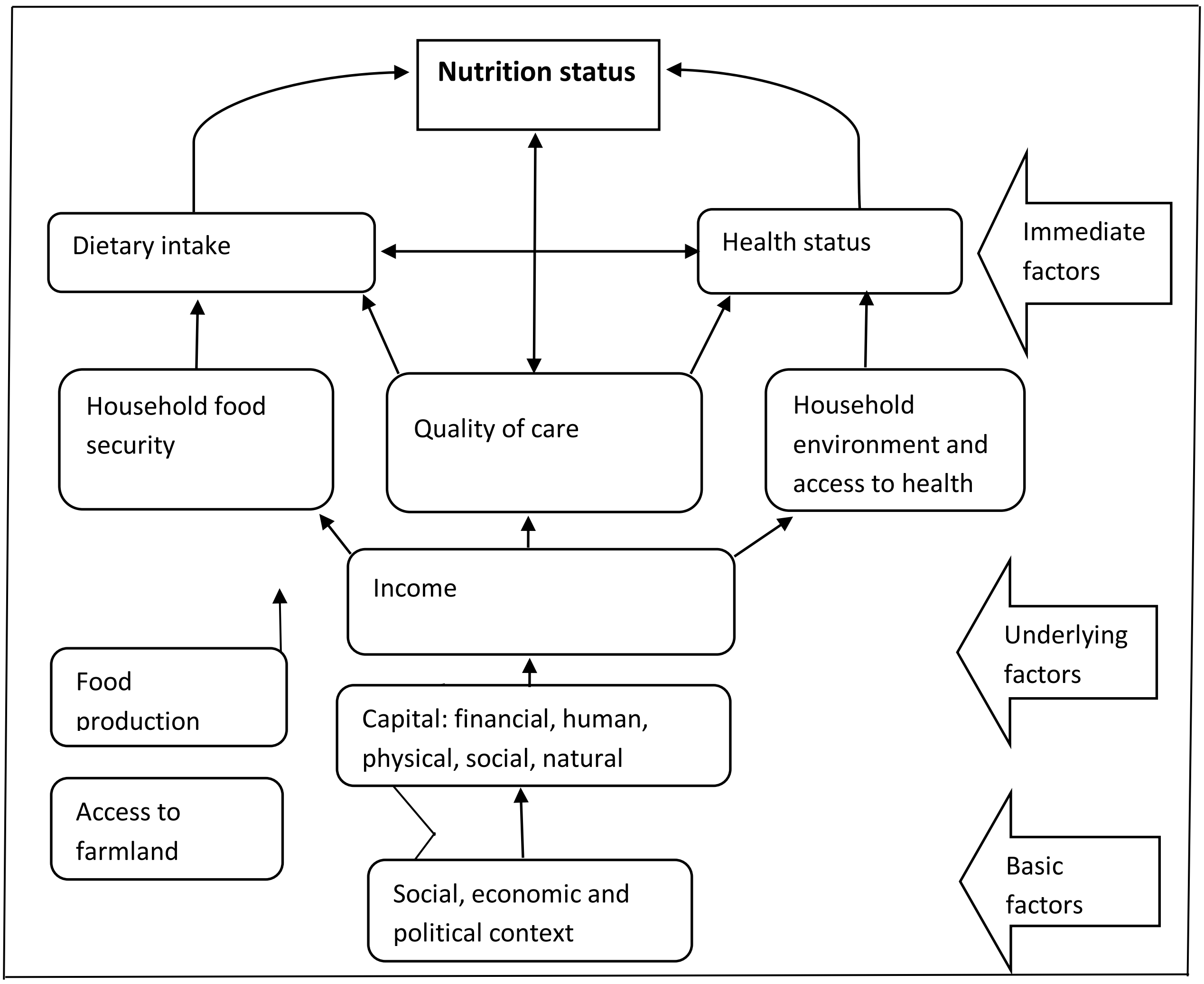
Finally, focusing on the intermediate level of nutrition outcome indicator namely dietary diversity, calorie intake and micronutrient intake, Balagamwala and Gazdar (2013) in their study in Pakistan suggest that the level of calorie intake can be explained by access to agricultural land because agricultural households have a higher calorie intake than those who rely on non-agricultural occupations. In the same line, Jones *et al*. (2014), utilizing Malawi household-level cross-sectional data concluded that farm production diversity had the potential to increase household dietary diversity. Herforth (2010), demonstrated a positive association between the number of crops grown and the farm households' dietary variety measured by the number of different foods, in the diet in the East African countries of Kenya and Tanzania. Sibhatu et al. (2015), using household cross-sectional data from Indonesia, Kenya, Ethiopia and Malawi highlighted the positive association between on-farm production diversity and household dietary diversity.

4. **Methodology**

4.1 **Conceptual framework**

An individual's nutritional status is the result of a complex set of inter-related factors that act synergistically and are dependent on the environment in which people live and the intra-household processes they are exposed to (Webb, 2013; World Bank, 2008). On the basis of these factors, UNICEF in 1990 developed a widely used conceptual framework that identifies three main underlying determinants of nutritional status: availability and access to the right amount and combination of foods of adequate nutritional quality, feeding and care-giving practices, and access to health care services (Herforth *et al.*, 2012; World Bank, 2008). Figure 1 shows the causal pathways by which nutrition status can be attain by household in the DRC.

Figure 1: Conceptualizing causal pathways from agriculture to nutrition



Source: Adapted from Webb (2013)

From the figure, it is clear that food production is a key element in the production process of an individual's nutritional status. However, it's well known that producing more food does not ensure food security or improved nutrition (World Bank, 2008); so that, agriculture interventions do not always contribute to positive nutritional outcomes (FAO, 2012; Herforth *et al.*, 2012). Thus, the proposed framework highlights the direct pathways through which agricultural production can contribute to improved human nutrition. In this framework, access to agriculture land affects nutritional outcomes through food produced in the farm and other individual, household and community characteristics. However, the nutritional outcome, especially for children, may also be affected by the household hygienic environment, the ease of access and the quality of health care and maternal care practices. We finally note that factors affecting access to food may also affect an individual's dietary intake, which is an important input in the nutrition production process.

The conceptual framework could be modified slightly to capture explicitly the gender perspective and to trace how gendered access to resources (agriculture and other socioeconomic factors) eventually leads to household nutrition or nutrition outcomes.

4.2. **Estimation strategy**

The main challenge is to estimate the effects of access to farmland on nutritional outcomes. We therefore consider the following nutritional outcome indicators: (i) the dietary diversity (DD) of children 6-23 months, (ii) the nutrition status of children 6-59 months measured by the height-for-age z-score (HAZ) and, (iii) the nutrition status of women of 15-49 years measured by the anaemia and the body mass index status; so that anaemia status=1 if the woman is anaemic and the body mass index (BMI) =1 if woman's BMI is in the normal range (18.5 to 25).

In light of the framework presented above and knowing the nature of our dependent variables, we expressed the nutritional outcome indicator as a function of access to agriculture and other socioeconomic factors. Assuming a linear function, one can write the nutrition outcome equation as:

$$N_{ih} = \alpha + \beta L_h + \delta X_{ih} + \varepsilon_{ih} \qquad (1)$$

Where, N_{ih} is the nutrition outcome indicator for the individual i in the household h, L_h is the access to farmland of the household h, X is a vector of control variables (individual and household characteristics), ε_{ih} is an error term and α, β and δ are parameters to be estimated. The access to farmland variable (L_h) is measured as follow: Looks like the study has used both the individual and the household as the unit of analysis. It is normally either but not both.

$$\text{Access to farmland} = \begin{cases} 1 \text{ if the household has access to land for cultuvation}, \\ 0 \text{ otherwise} \end{cases}$$

The vector of control variables comprises a set of child characteristics (age, gender, birth size, birth weight, and twin birth), maternal characteristics (age, educational attainment, employment status), household characteristics (household size, place of residence, household wealth index) and community and environmental characteristics (proportion of household with improved and unshared toilet, proportion of household with piped water). The household wealth index has been calculated by the DHS using the principal Component analysis method. The mother's educational level could serve as a proxy for the maternal child care practices. Use of antenatal care is used as a proxy for the use of preventive health care while the availability of family latrines, water sources, housing and number of individuals in the household provide information on the environmental conditions of the household.

As the determinants of malnutrition may differ according to the age of the child, as suggested by other previous studies (WHO, 2008; Sahn & Alderman, 1997); we separate the sample into two subsamples of observations on children under 24 months and those aged 24-59 months and we present specific models. However, we specify that the analysis concerning the children dietary diversity is done for children of 6-24 months only according to the WHO's Infant and Young Child Feeding (IYCF) recommendations.

By estimating the above general equation, we finally analyze the factors affecting the dietary diversity, the height-for-age of children under five and we determine the likelihood of anaemia and normal body mass index among women aged 15-49 years while highlighting the influence of access to farmland. With the presumption of absence of correlation between the error term and the independent variable of interest, OLS is effective as estimator. However, a logit model is used to estimate the likelihood of anaemia and normal body mass index.

With respect to the OLS, a linear functional form is adopted to represent the relationship between the dependent variable and regressors. This functional form is best suited to the structure of our data since we know that our continuous dependent variables (dietary diversity index and HAZ) are in their quantitative form. Therefore, the interpretation of coefficient β estimated by OLS from the above equation is that, it represents the change in nutrition outcome indicator (N_{ih}), in unit of the indicator, that occurs as the regressor L_h (access to farmland) changes one unit. However, as the access to agriculture land is measured as a binary variable, the interpretation is in terms of discreet change (explain a bit more). For the logit estimation, the interpretation is in terms of probability.

4.3. **Measures and definition of variables**

From the above and in light of the conceptual framework, we present some variables of interest and control variables that are the subject of the univariate, bivariate and multivariate analyses.

i. ***Dietary diversity score***

To meet the basic nutritional needs, the World Health Organization (WHO) recommends a consumption of at least a minimum of four out of seven different food groups per day for children 6-23 months of age, measured as minimum dietary diversity (MDD) (WHO, 2010). Therefore, we constructed the dietary diversity score based on the following food groups: (i) grains, roots, and tubers; (ii) legumes and nuts; (iii) dairy products (milk, yogurt, cheese); (iv) flesh foods (meats, fish, poultry and liver/organ meat); (v) eggs; (vi) vitamin A rich fruits and vegetables; (vii) other fruits and vegetables.

If a child consumed at least one food item from a food group, the group was assigned a value of one for that child. The group scores are then summed to obtain the dietary diversity score, which ranges from zero to seven, where zero represents non-consumption of the food items and seven represents the highest level of diet diversification.

ii. ***Nutritional status***

As noted above, nutritional status is measured by three variables: Height-for-age z-score for children under five (continuous variable), anaemia status for women aged 15-49 years (dichotomous variable=1 if the woman is anaemic) and the BMI status of women aged 15-49 years (dichotomous variable=1 if woman's BMI is in the normal range).

iii. ***Access to agricultural land***

The first challenge in measuring farmland access is conceptual rather than empirical (Doss *et al.,* 2015). Farmland access and control issues may differ depending on the objectives pursued by surveys, research and programmes. In this study, as defined in the estimation strategy, access to agricultural land is a dichotomous variable that takes the value one if household has access to cultivable farmland and zero otherwise.

4.5. Data

This study uses data from the 2014 DRC's Demographic and Health Survey (DHS-DRC II) conducted by the National Ministries of Planning and Public Health in partnership with Monitoring and Evaluation to Assess and Use Results (MEASURE) DHS, and other UN and International donors. The DHS are national household surveys administered by host country governments with technical assistance from the Inner City Fund known as ICF International and other Monitoring and Evaluation to Assess and Use Results (MEASURE) DHS agencies. They are an essential source of statistics on population, health and nutrition in developing countries. The information on land and farm properties collected by the 2014 DHS-DRC concerns both households and individuals.

Household questionnaires include questions such as do members of this household own farmland, how many hectares of arable land members of the household own, what type of land does respondent work in, etc. At the individual level, the information on the farmland is collected for each eligible woman (15-49 years) and each eligible man (15-59) in the household sample. Therefore, all the DHS-DRC land statistics are nationally representative for households and for women and men in the relevant age groups. In addition, the 2014 DHS-DRC collected data that enabled the calculation of maternal health indicators and nutritional status of children under five and women aged 15-49. It appears that the data was collected at household level. If this is correct, the unit of analysis should be household.

The results of calculations of health and nutritional indicators are provided in the DHS dataset: anthropometric indicators of children under 5 years (weight-for-age z-score, height-for-age z-score, and weight-for-height z-score), anaemic status of women aged 15-49, body mass index (BMI) of women and men, etc.

5. Results and discussion

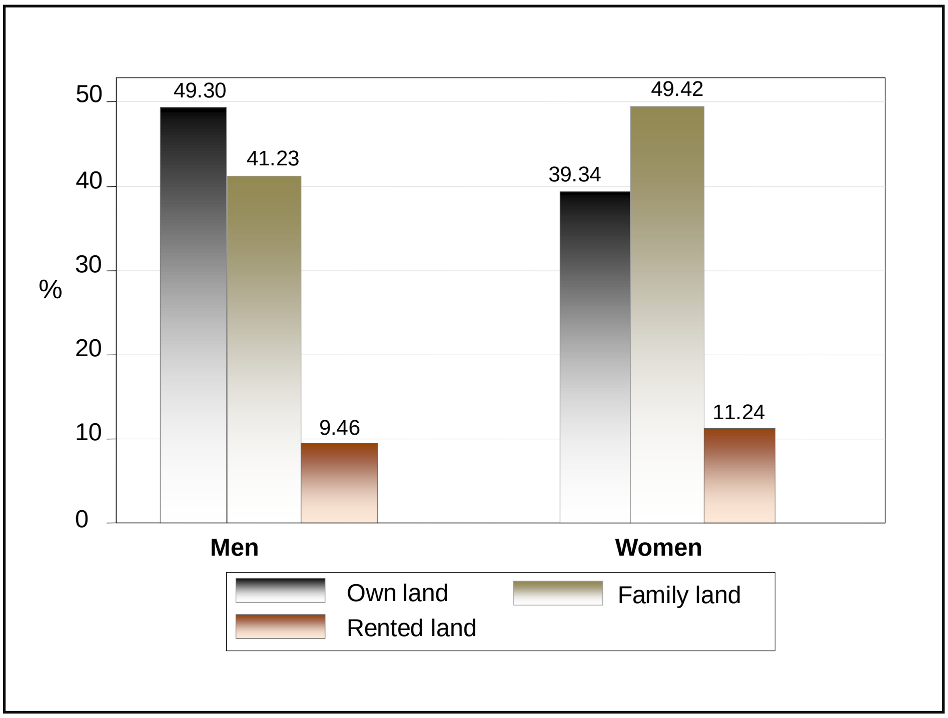
5.1. Descriptive analyses

5.1.1. Access to agricultural land: a gender disparities description

As shown in Figure 2, the percentage of women who own farmland is 39% compared to 49% for men. In rural areas, these percentages are 42% and 50% for women and men respectively, whereas they are 23% and 43% in urban areas. Family land use remains the most common method of access to land for women, for which 49% have access against 41% for men. In rural areas, about 48.0% of women have access to agricultural land through family relations and in urban areas this percentage is about 61% while for men the proportion is 39%. Furthermore, 11% of women access land through renting, compared to about 10% of men, while in rural areas these proportions are 10% and 7% for women and men respectively.

These statistical evidences suggest an idea about gender disparities in access to and control of land and highlight the fact that some women face serious difficulties in accessing and controlling farmland. The degree of difficulty is related to marital status as married women may have more access to land through their husbands without owning it (Phuna, 2008). Although the right to property is recognized by the Congolese family code through the matrimonial regime, married women and particularly those of the rural area, cannot claim to be owners of family land, just like their husbands. Ownership of family lands is inherited, so women are often excluded (Garrett & Ruel, 1999).

Figure 2: Access to farmland by sex of household head in DRC

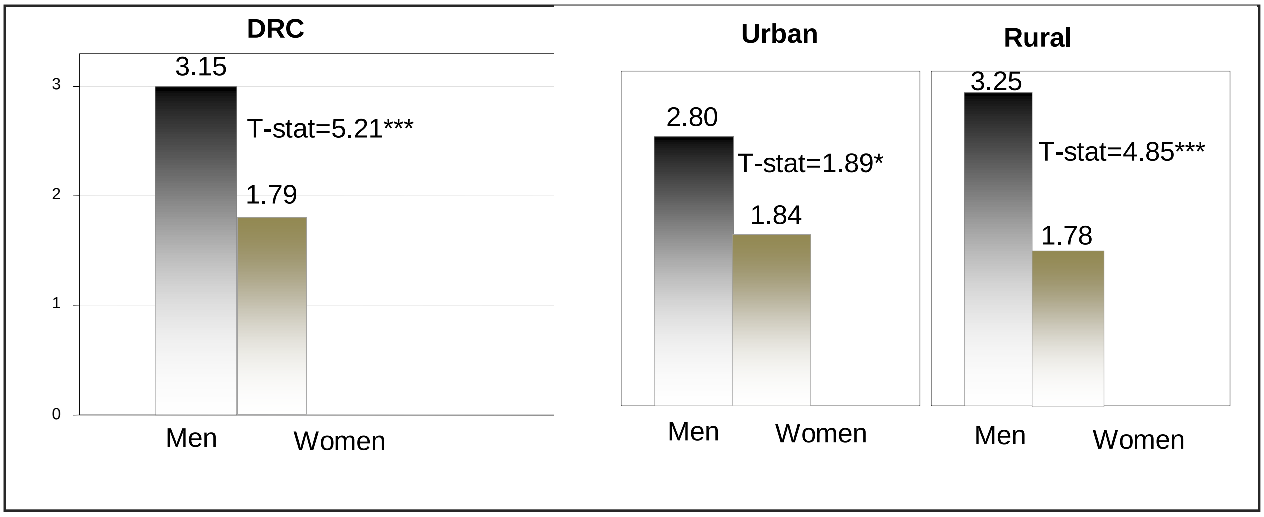


Source: Computation from DHS-2014 dataset

In the full sample, the average farmland size per household is 2.9 hectares. This average value is very close to that found by the WFP (2.5 hectares) within the 2014 Comprehensive Food Security and Vulnerability Analysis survey (Akakpo *et al*., 2015). Concerning the amount of land, there are large disparities in the distribution of farmland held by men and women. Figure 3 suggests that, on average, women own about 1.8 hectares of arable land compared to about 3.2 hectares for men. There are also disparities by place of residence as the average farmland per household is about 1.8 hectares for women and about 3.3 for men in rural areas and about 1.8 hectares and 2.8 hectares respectively for women and men in urban areas.

Results of mean-comparison tests presented in Figure 3, indicate that the observed differences in land ownership by sex are statistically significant, which confirms that the amount of agricultural land held by women is lower than that held by men.

Figure 3: Distribution of agricultural land in hectares by sex



Source: Computation from DHS-2014 dataset. **Note :** Ha: diff != 0 ; T-stat (Pr(|T| > |t|)) ; * p<.1; *** p<.01.

These statistical results are similar to those found in the CFSVA survey, which states that 52.0% of households who cultivated land during the reference farming season, used less than 2 hectares and only 19.0% of households cultivated on more than 2 hectares. The same survey found that in the provinces of Bandundu, Equateur, Katanga, and Kasai Oriental, more than 80.0% of all households cultivated on less than 2 hectares of land.

5.1.2. **Dietary diversity of children aged 6-24 months**

In accordance with the WHO (2008), Infant and Young Child Feeding (IYCF) practices include the gradual introduction of solid and semi-solid foods from the age of 6 months. This entail not only increasing the amount and the variety of foods, but also the frequency of feeding as the child gets older.

During the 2014 DRC's DHS, information on feeding practices was obtained for young children under five who live with their mothers and are adequately fed in the last 24 hours preceding the survey. Therefore, to analyze children's dietary intake, we examine trends in complementary food consumption for children aged 6-24 months before calculating the dietary diversity score.

5.1.2.1. **Trends in food consumption**

Table 1 presents descriptive statistics of food consumption for children aged 6-24 months. Foods are classified into 7 groups according to the WHO recommendation. Therefore, foods from group of grain, roots and tubers and foods from group of vitamin A rich fruits and vegetables are the most consumed by children within households. The table shows that about 47.8% of children consumed at least one of the food group of grain, roots and tubers during the last 24 hours preceding the survey and about 48.1% consumed foods from the group of vitamin A rich fruits and vegetables. The table also indicates that the consumption of all foods is less than 50.0% among households. These statistics confirm the deficiency of dietary intake of children under 5 in the DRC, a country where, according to the recent statistics, nearly 2 million children are suffering from severe acute malnutrition which accounts for 12.0% of severe acute malnutrition cases in the world. As a result, the dietary diversity score for children is very low, with an average value of 1.68 in the household sampled and the standard deviation is 1.53, while for the urban household the average value is 1.94 as against 1.57 in the rural area. There are no large disparities by gender of the household heads and by the gender of the children.

Table 1: Food Consumption by Children (Girls and Boys); 6-24 Months during the previous 24 Hours

Food groups and food items	DRC	Urban	Rural	Male hh	Female hh	Boys	Girls
Food group 1: Grains, roots, and tubers	47.78	55.41	44.66	47.33	49.79	47.11	48.44
Bread, noodles, other made from grains	35.86	44.91	32.16	35.43	37.77	35.69	36.03
Gave child potatoes, cassava or other tubers	22.31	18.85	23.74	22.37	22.08	21.90	22.72
Gave child fortified baby food (cerelac, etc)	3.38	8.83	1.14	3.40	3.26	3.25	3.50
Food group 2: Legumes and nuts	8.29	9.53	7.78	8.01	9.52	8.07	8.51
Gave child food made from beans, peas, lentils, nuts	8.29	9.53	7.78	8.01	9.52	8.07	8.51
Food group 3: Dairy products	5.60	12.91	2.61	5.58	5.67	5.71	5.49
Gave child tinned, powdered or fresh milk	4.49	10.79	1.91	4.47	4.61	4.59	4.40
Gave child cheese, yogurt, other milk products	0.90	1.96	0.47	0.90	0.93	1.04	0.77
Gave child yogurt	1.11	2.26	0.64	1.08	1.23	1.12	1.10
Food group 4: Flesh foods	34.19	37.32	32.92	33.86	35.66	33.98	34.41
Gave child meat (beef, pork, lamb, chicken, etc)	10.52	12.03	9.91	10.48	10.70	10.61	10.43
Gave child liver, heart, other organs	2.97	3.60	2.72	3.00	2.83	3.13	2.82
Gave child fish or shellfish	27.03	29.07	26.19	26.59	28.98	26.62	27.43
Food group 5: Eggs	6.54	9.18	5.46	6.49	6.77	6.60	6.49
Gave child eggs	6.54	9.18	5.46	6.49	6.77	6.60	6.49
Food group 6: Vitamin A rich fruits and vegetables	48.07	47.65	48.24	47.92	48.73	48.51	47.64
Gave pumpkin, carrots, squash (yellow or orange inside)	5.95	5.69	6.06	5.84	6.43	5.96	5.94
Gave child any dark green leafy vegetables	43.55	43.19	43.70	43.28	44.75	44.36	42.76
Gave child mangoes, papayas, other vitamin A fruits	12.15	16.00	10.58	12.37	11.17	12.15	12.15
Food group 7: Other fruits and vegetables	17.48	21.74	15.73	17.35	18.06	17.28	17.68
Gave child any other fruits	17.48	21.74	15.73	17.35	18.06	17.28	17.68

Note: Male hh=Male headed household and Female hh=Female headed household.

5.1.2.2. **Dietary diversity score**

To calculate the Dietary Diversity Score (DDS), we follow the recommendation of the WHO relative to the Infant and Young Child Feeding (IYCF). Table 2 presents the descriptive statistics of the DDS. Across the whole sample, about 31.9% of children in the households did not eat any of the seven food groups, while it was 29.9% in urban places, 32.7% in rural, 32.8% for male headed households and 27.6% for female headed households.

We note that the WHO recommendation in terms of minimum dietary diversity (MDD) is not observed. As a reminder, to meet basic nutritional needs, WHO recommends a consumption of at least a minimum of four out of the seven food groups per day for children 6-23 months of age.

Table 2: Dietary Diversity Score of Children 6-24 Months

Dietary diversity score (DDS)	DRC	Urban	Rural	Male hh	Female hh	Boys	Girls
None (zero)	31.87	29.88	32.68	32.84	27.58	31.97	31.78
1 group	16.35	14.28	17.19	15.78	18.87	16.70	16.00
2 groups	22.10	18.23	23.69	21.81	23.39	22.26	21.95
3 groups	17.17	18.23	16.73	17.07	17.60	16.23	18.09
4 groups	8.30	11.84	6.85	8.22	8.63	8.62	7.99
5 groups	2.96	5.02	2.11	2.97	2.88	2.94	2.97
6 groups	0.87	1.80	0.48	0.94	0.55	0.85	0.88
7 groups	0.39	0.72	0.25	0.36	0.51	0.44	0.34

Note: Male hh=Male headed households; Female hh=Female headed households.

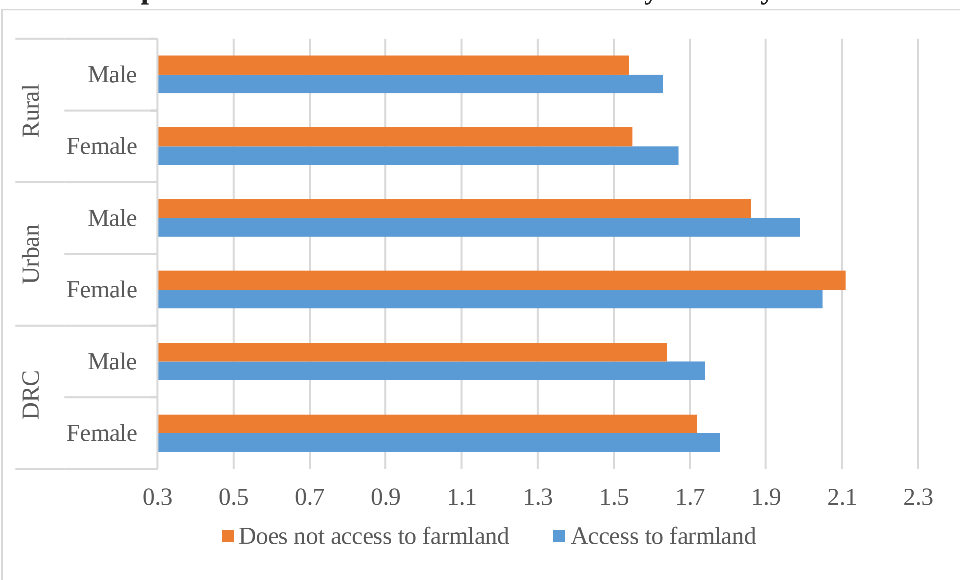
According to the figure in Table 2, only 8.3% of children across the households ate at least four different food items of different food groups. Similarly, by place of residence disparity was observed with 11.8% in urban areas compared to 6.9% in rural areas, which may suggest that children of urban areas are more nourished than those of rural areas.

5.1.3. **Assessment of relationship between access to farmland and dietary diversity score**

Figure 5 presents the distribution of the dietary diversity score (DDS) of children aged 6-24 months in relation with the access to agricultural land. For instance, in the full sample, the dietary diversification score of children does not vary substantially in the sub-sample of men, but it is higher among the children from women who have access to agricultural land.

The analyses suggest that, regardless of rural or urban residence, dietary diversity is more important for children when women access farmland. For instance, when we consider the sub-sample of women in the rural areas, the children DDS is about 1.67 for female headed household with access to farmland compared to 1.55 among those who do not have access to agricultural land. In all the cases, the children DDS is high when households have access to farmland for cultivation even in urban areas.

Figure 5: Relationship between access to farmland and dietary diversity



Source: Computations from DHS-2014 dataset

5.1.4. **Descriptive statistics of variables short-listed for regression analysis**

Table 3 provides summary statistics describing the analytic sample of the study. About 74.0% of women had normal body mass index (BMI), this means that they have a BMI ranged in the interval from 18.5 to 25. However, 40.0% of women in the sample were anemic. Furthermore, children nutritional outcomes seem to be poor.

Though the average value of the height-for-age z-score is -1.66, which is above the weight poverty line of -2 z-scores, we however, note large disparities as indicated by the standard deviation of 1.78, higher than the mean value. The average value for the DDS is 1.68 while the WHO recommends a consumption of at least a minimum of four out of seven different food groups per day (minimum dietary diversity).

About 80% of sampled households are headed by men with only about 20% by women, while about 29% of households are urban. On the average, children captured in the sample are aged about 28 months and slightly over 50% of them are girls, while about 76% of women are employed. Among the community and environmental characteristics, only 30.1% of households have improved and unshared toilets and about 37.8% have access to piped water. The size of households is about 7 members, which is higher than the African average of 5-6 members (Size, 2018).

Table 3: Descriptive Statistics of Variables used in the Regression Analysis

Variable	Observation	Mean/prop.	Std. Dev.	Min	Max
Outcome variables					
Child height-for-age z-score (HAZ)	8552	-1.66	1.78	-5.99	5.96
Child dietary diversity score (DDS)	8552	1.68	1.53	0	7
Women BMI=1 if normal	12821	74.01	-----	0	1
Women anaemia status=1 if anaemic	12821	40.06	-----	0	1
Access to farmland=1 if household has access	12821	75.42	-----	0	1
Household and community characteristics					
Household size	12821	6.78	2.86	1	24
Type of place of residence=1 if urban	12821	29.41	-----	0	1
Household wealth index	12821	0.18	0.17	0	1
Household has improved and unshared toilet	12821	30.13	-----	0	1
Household has access to piped water	12821	37.75	-----	0	1
Household head=1 if male	12821	80.28	-----	0	1
Child characteristics					
Child's age in months	8552	27.98	17.43	0	59
Child's age squared/100	8552	10.87	10.42	0	34.81
Child sex=1 if male	8552	49.70	-----	0	1
Child’s birth size=1 if small than average	8552	14.19	-----	0	1
Child birth weight<2.5Kg (low)	8552	4.85	-----	0	1
Child is twin	8552	3.68	-----	0	1
Maternal characteristics					
Woman’s age	12821	29.09	6.95	15	49
Woman’s age squared/100	12821	8.94	4.27	2.25	24.01
Woman’s year of educational attainment	12821	4.97	3.84	0	18
Woman’s employment=1 if employed	12821	76.05	-----	0	1
Woman’s place of delivery=1 if hospital	12821	79.22	-----	0	1

Source: The variables mix individual and household characteristics bringing to question the unit of analysis

5.2. **Econometric analyses**

We first report estimates of the full sample for the 6-24 months children dietary diversity. Next, we present results for under five children and women of 15-49 years nutritional status and finally, we present results by gender.

5.2.1. **Effect of access to agricultural land on children dietary diversity**

Table 4 presents econometric results of the relationship between access to agricultural land and dietary diversity of children 6-24 months for the full sample and for male and female headed households. The models are estimated using OLS with the linear functional form. Thus, the estimated coefficients are considered as change in nutrition outcome as the access to farmland changes.

Table 4: Parameter estimates of access to farmland and other factors on children dietary diversity

Variable	All	Male	Female
Access to agricultural land	0.149***	0.097	0.343***
	(0.057)	(0.066)	(0.110)
Household size	0.002	-0.008	0.038*
	(0.009)	(0.011)	(0.020)
Type of place of residence	0.188**	0.179 **	0.209
	(0.078)	(0.088)	(0.160)
Household wealth index	0.815***	0.857 ***	0.656
	(0.264)	(0.305)	(0.477)
Household has improved and unshared toilet	0.204***	0.188 ***	0.282**
	(0.056)	(0.063)	(0.121)
Household has access to piped water	-0.073	-0.119	0.036
	(0.062)	(0.071)	(0.125)
Child age	0.087***	0.087 ***	0.083***
	(0.005)	(0.006)	(0.011)
Child age squared	-0.139***	-0.139 ***	-0.136***
	(0.009)	(0.011)	(0.019)
Child sex	0.003	0.005	-0.042
	(0.048)	(0.056)	(0.095)
Child birth size	-0.066	-0.059	-0.118
	(0.073)	(0.085)	(0.139)
Child birth weight (low birth)	0.184	0.291 *	-0.218
	(0.127)	(0.151)	(0.221)
Child is twin	-0.033	0.052	-0.352**
	(0.132)	(0.162)	(0.161)
Mother’s age	0.006	-0.008	0.084
	(0.028)	(0.032)	(0.059)
Mother’s age squared/100	-0.001	0.029	-0.154
	(0.047)	(0.053)	(0.099)
Mother’s year of educational attainment	0.018***	0.013	0.035**
	(0.008)	(0.009)	(0.014)
Mother is employed	0.106*	0.140 **	-0.083
	(0.060)	(0.070)	(0.114)
Mother delivered in hospital	0.106*	0.128 **	0.034
	(0.055)	(0.064)	(0.106)
Constant	0.115	0.302	-0.803
	(0.407)	(0.470)	(0.821)
Observations	8552	6842	1710
F-stat [Prob > F]	22.12 [0.0000]	17.39 [0.0000]	8.09 [0.0000]
R-squared [Adj R-squared]	0.9549 [0.9524]	0.9543 [0.9511]	0.9799 [0.9733]

Legend: ** p<.1; ** p<.05; *** p<.01 and (...) robust standard errors.*

The econometric results for the full sample indicate that access to farmland is a positive significant determinant of children dietary diversity (CDD), thus suggesting that any additional access to farm land by household would result in about a 0.15 increase in CDD so that, the discrete change from non-access to access to farmland is associated with 0.15 significant variation in the dietary diversity score in the full sample.

Results by gender indicate that, compared to those who do not have access to farmland for cultivation, access to farmland influences positively and significantly the children dietary diversity score in female headed households and the associated effect is 0.34 while there is no significant effect in male headed households. The implication of this result is that access to land for cultivation by women is very beneficial for children dietary diversity in the context of DRC. This result is consistent with Kismul et al. (2018), who consider that shortage of land and landlessness in DRC are problems closely related to food insecurity and chronic malnutrition. Hirvonen and Hoddinott (2017) also in a study on agricultural production and children's diets in rural Ethiopia, suggest that household access to land is associated with an improvement of child dietary diversity as measured by the number of food groups consumed. However, result from a study on the effect of the dietary diversity on child malnutrition in Ghana conducted by Frempong and Annim (2017), suggest a negative and significant coefficient of owning agricultural land in the relationship with children dietary diversity.

From the above result, it is clear that the role of two partners in food search and utilization within households in the context of African countries and especially for households engaged in agriculture as a subsistence activity must be highlighted. Indeed, the effect of access to agricultural land in the female subsample does not include any contribution of men because the effect is not the result of synergistic work between men and women (see also Mwisha-Kasiwa, 2018).

Among the control variables, we note that the household assets (wealth index constructed by the DHS) influences positively the CDD score at 1% level of significance both in the full sample and the male sub-sample. Similarly, access to improved and unshared toilet affects positively and significantly the CDD score in the full sample and in the male and female sub-samples. Furthermore, the educational attainment of mothers significantly influences the CDD of children positively in the full and female sub samples. The same was the case for mother's employment in the full and male sub samples.

5.2.2. **Effect of access to agricultural land on children nutritional status**

We estimate the effect of access to farmland on children nutritional status using OLS estimator of the structural parameters of the child nutrition (HAZ) function. The variable of interest access to farmland was significant only for the male headed household subsample, thus indicating that additional male access to farmland would go to increase the child nutrition by 0.15 standard scores while controlling for other covariates. For the female-headed households subsample, the results though negative was not statically significant at any level. To the extent that women's income is land-based, women's lack of access to and effective control over land may therefore threaten the well-being of children (see also Mearns, 1999). This finding is consistent with the hypothesis that household's land access benefit children's nutrition. As discussed in the conceptual framework, a major pathway for the impact of household's access to farmland on child nutrition may be through food production. In fact, access to agricultural land has a positive association with household food production, and as a result, a significant portion of farm production can be sold in market and thus improve household income.

It is possible that the positive association between access to farmland in the households headed by men and child nutrition may come through the greater income that households who have access to farmland gain from food production after being sold. If household wealth (proxy of household income) is a significant pathway, the inclusion of household wealth in the child nutrition model should increase the effect of access to farmland, making its coefficient in the regression more important. The results presented in Table 5 include the household wealth index. When the household wealth index is omitted from the child nutrition model, the coefficient for access to farmland becomes insignificant in all the models. This is an indication that household wealth is a major pathway from household access to farmland to better child nutrition.

Our findings are therefore similar to Valverde *et al.* (1977) who have found that having malnutrition for children under five was 2.3 times greater among farming families with access to less than two 1.4 hectares of land than in those with a total access to more than 3.5 hectares using data from Guatemala. Our results are also consistent not evident with Allendorf (2007), who conducted research on women's land rights and child health in Nepal and results have suggested that the risk of child is underweight (malnutrition) is reduced by half if mother owns land. Since Guatemala and Nepal are both developing countries with context similar to that of DRC, these results are comparable to those we found for the DRC.

Concerning the effects of socioeconomic and demographic variables, the results in Table 5 indicate that the child age has a negative effect on the HAZ in the full sample and in the sub-sample of male and female headed households, but the child age squared has a positive effect. This result is consistent with the theoretical argument because the child is expected to get height as his/her age rises with the time. In line with the observation in Table 5, male children tend to have lower HAZ than their female counterparts.

Table 5: Parameter estimates of access to farmland on children nutritional status

Variable	All	Male	Female
Access to agricultural land	0.100	0.152**	-0.113
	(0.063)	(0.072)	(0.137)
Household size	-0.003	0.000	-0.017
	(0.011)	(0.012)	(0.026)
Type of place of residence	0.067	0.006	0.275
	(0.083)	(0.091)	(0.200)
Household wealth index	1.302***	1.231***	1.655**
	(0.271)	(0.299)	(0.649)
Household has improved and unshared toilet	0.049	0.044	0.073
	(0.063)	(0.070)	(0.150)
Household has access to piped water	-0.072	-0.076	-0.041
	(0.068)	(0.077)	(0.155)
Child age	-0.082***	-0.082***	-0.085***
	(0.006)	(0.007)	(0.014)
Child age squared	0.077***	0.078***	0.077***
	(0.011)	(0.012)	(0.025)
Child sex	-0.231***	-0.272***	-0.077
	(0.056)	(0.063)	(0.124)
Child birth size	-0.172**	-0.189*	-0.082
	(0.086)	(0.098)	(0.183)
Child birth weight (low birth)	-0.265*	-0.201	-0.489
	(0.137)	(0.154)	(0.306)
Child is twin	-0.606***	-0.826***	0.252
	(0.181)	(0.204)	(0.399)
Mother’s age	0.067 **	0.056	0.065
	(0.034)	(0.038))	(0.073)
Mother’s age squared/100	-0.099 *	-0.083	-0.084
	(0.056)	(0.064)	(0.124)
Mother’s year of educational attainment	0.030 ***	0.035***	0.011
	(0.009)	(0.010)	(0.019)
Mother is employed	-0.151 **	-0.168**	-0.080
	(0.067)	(0.075)	(0.152)
Mother delivered in hospital	0.003	-0.005)	0.077
	(0.069)	(0.078)	(0.156)
Constant	-1.381 ***	-1.259***	-1.482
	(0.488)	(0.554)	(1.045)
Number of observations	8552	6842	1710
F-stat [Prob > F]	44.14 [0.0000]	37.19 [0.0000]	10.61 [0.0000]
R-squared [Adj R-squared]	0.7748 [0.7738]	0.7819 [0.7808]	0.7605 [0.7557]

Legend: ** p<.1; ** p<.05; *** p<.01 and (...) robust standard errors.*

Tables 4, 5 and 6 suffer from same problem of mixing units of analysis. Their results are suspect.

5.2.3. **Effect of access to agricultural land on nutritional status of women aged 15-49**

Table 6 show estimates of the relationship between access to agricultural land and nutritional status of women aged 15-49 years. We recall that nutritional status of women is measured by two dummy variables namely, the body mass index coded 1 if the woman BMI is normal and 0 otherwise; and the anaemia status coded 1 if the woman is anaemic and 0 otherwise. Please note that the BMI is an individual’s weight relative to his or her height squared (BMI = weight / height^2) and its normal value for adults is between 18.5 and 25. The logit model was used to estimate not only the likelihood of a woman to have a BMI ranged in the normal range but also the risk (probability) of a woman to be anaemic conditional to the access to farmland and other covariates.

Table 6: Parameter Estimates on Effect of Access to Farmland on Nutritional Status of Women Aged 15-49 years – Logit estimation

Variable	BMI =1 if normal						Anemia =1 if anaemic					
	All		Male household		Female household		All		Male household		Female household	
	Coeff.	M.E	Coeff.	M.E	Coeff.	M.E	Coeff.	M.E	Coeff.	M.E	Coeff.	M.E
Access to farmland	0.201***(0.071)	0.038	0.277***(0.080)	0.052	-0.107 (0.158)	-0.020	0.013 (0.065)	0.003	0.031 (0.073)	0.007	-0.078*** (0.043)	-0.018
Household size	-0.025** (0.011)	-0.005	-0.029** (0.012)	-0.005	-0.004 (0.027)	-0.001	0.016 (0.010)	0.004	0.018 (0.011)	0.004	-0.008 (0.026)	-0.002
Place of residence	0.089 (0.088)	0.017	0.073 (0.099)	0.014	0.209 (0.205)	0.039	0.155** (0.079)	0.036	0.053 (0.088)	0.012	0.634*** (0.184)	0.143
Household wealth index	1.266***(0.233)	0.220	1.012***(0.259)	0.174	2.492*** (0.562)	0.421	0.030 (0.224)	0.007	0.094 (0.248)	0.022	0.173 (0.533)	0.039
Access to improved toilet	0.029 (0.064)	0.006	0.002 (0.071)	0.001	0.152 (0.146)	0.031	-0.020 (0.057)	-0.005	-0.089 (0.063)	-0.021	-0.495*** (0.133)	-0.112
Access to piped water	0.178** (0.071)	0.033	0.121 (0.080)	0.023	0.395 ** (0.159)	0.074	-0.139 ** (0.065)	-0.033	-0.063 (0.072)	-0.015	-0.492*** (0.150)	-0.111
Mother year of education	0.063***(0.071)	0.005	0.005 (0.011)	0.001	0.004 (0.021)	0.001	-0.026 *** (0.009)	-0.006	-0.034*** (0.010)	-0.008	-0.003 (0.019)	-0.001
Mother is employed	0.386***(0.088)	0.012	0.153* (0.079)	0.028	-0.315 * (0.173)	-0.059	0.172 *** (0.065)	0.040	0.199*** (0.072)	0.047	0.145 (0.153)	0.033
Delivered in hospital	0.415***(0.088)	0.072	0.464***(0.097)	0.082	0.114 (0.221)	0.021	-0.258 *** (0.072)	-0.061	-0.266*** (0.079)	-0.063	-0.184*** (0.088)	-0.042
Constant	2.408***(0.561)	-----	3.052***(0.639)	-----	-0.450 (1.217)	-----	-0.914 * (0.491)	-----	-0.837 (0.549)	-----	-1.635 (1.154)	-----
Number of observations	12821		10250		2564		12821		10250		2564	
LR chi2 [Prob > chi2]	147.72 [0.0000]		128.37 [0.0000]		46.16 [0.0000]		41.89 [0.0000]		38.32 [0.0000]		36.08 [0.0002]	
Pseudo R2	0.0228		0.0246		0.0368		0.0156		0.0163		0.0253	

Legend: ** p<.1; ** p<.05; *** p<.01 and (…) robust standard errors*

Results from the table shows that access to farmland affects positively and significantly the probability for a woman having a normal body mass index at 1% level of significance both in the full sample and the sub-sample of male headed households. The indications are that as women (no!men) gain access to farmland the likelihood that their body mass becomes normal is about 0.04 and 0.05 in the full sample and in the subsample of male-headed households respectively. The variable was however not significant for the female headed subsample. Regarding the anemia model, the table further indicate that access to farmland significantly affects the risk of anemia for women aged 15-49 years in the subsample of female-headed households only. However, the significance of the effect was negative thus, suggesting that as women gain access to farmland there is a likelihood of about 0.02 decrease in the risk associated with anemia among women. From the forgone? it is clear that the effect of access to agricultural land on the women nutritional status can be quite positive in DRC. In spite of the fact that access to farmland was not significant in some cases, for example in the subsample of female-headed households for the BMI equation, it remains a significant determinant of women nutritional status particularly with its significant effect on anaemia.

Among the socioeconomic variables, we observe that household wealth, access to improved and unshared toilet, access to piped water, women education and women access to maternal health care are significant determinants of women nutritional status. For example, in the BMI equation, household wealth index has a positive and significant effect in all the subsamples while the access to improved and unshared toilet is associated with likelihood for a woman to have a normal BMI in both the full sample and the subsample of households headed by men. Furthermore, we observed that women education is significant in the BMI equation in the full sample so that, a unit increase in the year of women educational attainment is associated with about 0.01 likelihood of women having normal BMI. In the anemia equation, women education is significant in the full sample and in the subsample of male headed households. Thus, a unit increase in the year of women educational attainment is associated with about 0.01 and 0.03 likelihood of decreases in the risk of anemia in the full sample and the subsample of households headed by men respectively.

6. Conclusion

This study aimed to answer the question of how access to agricultural land influences the nutritional outcomes at the household level in the DRC. Therefore, we have estimated the effect of access to agricultural land on (i) children dietary diversity, (ii) children nutritional status and, (iii) women nutritional status by examining gender disparities in effect. A series of statistical methods were used and the linear regression and the logit regression model appeared to be the most appropriate given the nature of our dependent variables and the nature of relationship between access to farmland and nutrition as well.

Results suggest that access to agricultural land is an important determinant of nutritional outcomes at the household level in DRC. The sign and magnitude of the effect depend on the gender of the household head. Access to farmland has been found to be positively associated with the measures of nutritional outcomes of children and women in the full sample and in the sub-samples of male and female-headed households. Access to farmland appears to be more beneficial for the dietary diversity of children from female-headed households, while children's height-for-age z-score improves with access to farmland in households headed by men. The likelihood of having a normal BMI among women reacts positively to access to agricultural land in male-headed households, while the risk of anemia decreases with access to agricultural land and mother delivery in hospital in female-headed households.

These results are mixed about the role of gender. In the context of DRC however, where female-headed households are often single-parent, the effect of access to farmland on nutritional outcomes in the men's sub-sample could include an unobserved contribution of women. Therefore, results of this study have public policy implications for the nutrition-agriculture nexus promotion and more specifically for the nutrition of people with special needs such as children under 5 and pregnant women and / or those of childbearing age. The role of farmland as a factor of improving nutrition outcomes at household level in the DRC should be highlighted. It is therefore necessary for the public policy maker to reinforce the tenure security of farmland for households by applying the prescriptions of the Family Code without gender discrimination. In this way, the land tenure security of farm households could have a positive impact on agricultural productivity, income, food security and household-level nutrition outcomes in the DRC.

References

Akakpo, K., Randriamamonjy, J., & Ulimwengu, J. M., 2015. *Comprehensive food security and vulnerability analysis (CFSVA)*: Democratic Republic of Congo.

Ali, D.A., Deininger, K., Goldstein, M., 2014. Environmental and gender impacts of land tenure regularization in Africa: pilot evidence from Rwanda. *Journal of Development Economics* 110, 262-275.

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., Vaz, A., 2013. The women's empowerment in agriculture index. *World Development* 52, 71-91.

Allendorf, K., 2007. Do women's land rights promote empowerment and child health in Nepal?. *World development*, 35(11), 1975-1988.

Arimond, M., Hawkes, C., Ruel, M., Sifri, Z., Berti, P.R., Leroy, J., Low, J.W., Brown, L.R., Frongillo, E.A., 2011. Agricultural interventions and nutrition: lessons from the past and new evidence. eds B. Thompson and L. Amoroso, 41-75.

Balagamwala and Gazdar, 2013. Agriculture and Nutrition in Pakistan: Pathways and Disconnects, *IDS Bulletin*, 44-3).

Benfica, R., Ofosu-Amaah A. W., A., T., 2010. *Liberia: Gender-Aware Programs and Women's Roles in Agricultural Value Chains. A Policy Memorandum*. World Bank Washington DC.

Carletto, G., Ruel, M., Winters, P., & A. Zezza, 2015. *Farm-level pathways to improved nutritional status*.

Deere, C.D., León, M., 2003. The gender asset gap: land in Latin America. *World Development* 31, 925-947.

Dillon, A., McGee, K., & G. Oseni, 2015. Agricultural production, dietary diversity and climate variability. *The Journal of Development Studies*, 51(8), 976-995.

Doss, C., 2006. The effects of intrahousehold property ownership on expenditure patterns in Ghana. *Journal of African economies* 15, 149-180.

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., & M. Bold, 2015. Gender inequalities in ownership and control of land in Africa: myth and reality, *Agricultural Economics*, 46(3), 403-434.

FAO (Food and Agriculture Organization), (2011). *The state of food and agriculture*. Rome: FAO

FAO, 2012. *Making Agriculture Work for Nutrition: Synthesis of Guiding Principles*. Rome, Italy.

FAO, 2013. *The State of Food Insecurity in the World 2013*.

FAO, 2017. *Rural women: a driving force against hunger, malnutrition and poverty*. http://www.fao.org/zhc/detail-events/en/c/471293/.

Fortmann, L., 2009. Gender in agriculture sourcebook. Experimental Agriculture 45, 515 Haddad, L., Hoddinott, J., Alderman, H., 1998. Intrahousehold resource allocation in developing countries: Models, methods, and policies. *Food and Nutrition Bulletin-United Nations University*- 19, 71-72.

Frempong, R. and S. Annim, 2017. Dietary diversity and child malnutrition in Ghana. *Heliyon* 3 (2017) e00298.

Garrett, J. L., & M.T. Ruel, 1999. Are determinants of rural and urban food security and nutritional status different? Some insights from Mozambique. *World Development*, 27(11), 1955-1975.

Gillespie, S. & S. Kadiyala, 2012. Exploring the agriculture-nutrition disconnect in India. In *Reshaping agriculture for nutrition and health*, S. Fan and R. Pandya-Lorch (eds.) Washington, DC: International Food Policy Research Institute.

Gillespie, S.; Harris, J. and S. Kadiyala, 2012. The Agriculture–Nutrition Disconnect in India: What Do We Know? IFPRI Discussion Paper 01187, Washington DC: International Food Policy Research Institute (IFPRI).

Haddad, L., Ruel, M. and J. Garrett, 1999. Are urban poverty and undernutrition growing? Some newly assembled evidence. *World Development*, forthcoming.

Herderschee, J., Samba, D. M., & M.T. Tshibangu, (Eds.). 2012. *Résilience d'un géant africain: accélérer la croissance et promouvoir l'emploi en République démocratique du Congo*. Mediaspaul.

Herforth, A., 2010. *Promotion of Traditional African Vegetables in Kenya and Tanzania: A Case Study of an Intervention Representing Emerging Imperatives in Global Nutrition*. Cornell University, Ithaca, NY.

Herforth, A., Jones, A., Pinstrup-Andersen, P., 2012. Prioritizing nutrition in agriculture and rural development: guiding principles for operational investments. Health, Nutrition and Population Discussion Paper Series. Washington, DC: World Bank.

Hirvonen, K., & Hoddinott, J., 2017. Agricultural production and children's diets: Evidence from rural Ethiopia. *Agricultural Economics*, 48(4), 469-480.

Hoddinot, J., 2012. Agriculture, Health and Nutrition: Towards Conceptualising the Linkages, in S. Fan and R. Pandya-Lorch (eds), *Reshaping Agriculture for Nutrition and Health: An IFPRI 2020 Book*, Washington DC: International Food Policy Research Institute (IFPRI).

IFPRI, 2012. Women's empowerment in agriculture index. International Food Policy Research Institute (IFPRI).

Jones, A. D., Shrinivas, A., & R. Bezner-Kerr, 2014. Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data. *Food Policy*, *46*, 1-12.

Kinkela, S. S., & Bahandi, C. A., 2011. Gender Issues and Perspectives in Agricultural Research and Development Projects in Democratic Republic of Congo. Influencing Change: Mainstreaming Gender Perspectives in Agricultural Research and Development in Eastern and Central Africa.

Kismul, H., Acharya, P., Mapatano, M. A., & A. Hatløy, 2018. Determinants of childhood stunting in the Democratic Republic of Congo: further analysis of Demographic and Health Survey 2013–14. *BMC public health*, *18*(1), 74.

Koppmair, S., Kassie, M., & M. Qaim, 2017. Farm production, market access and dietary diversity in Malawi. *Public health nutrition*, *20*(2), 325-335.

Kumar, N., Harris, J., & R. Rawat, 2015. If they grow it, will they eat and grow? Evidence from Zambia on agricultural diversity and child undernutrition. *The Journal of Development Studies*, *51*(8), 1060-1077.

Malapit, H. J. L., Kadiyala, S., Quisumbing, A. R., Cunningham, K., & P. Tyagi, 2015. Women's Empowerment Mitigates the Negative Effects of Low Production Diversity on Maternal and Child Nutrition in Nepal, *The Journal of development studies*, *51*(8), 1097-1123.

Mearns, R., 1999. *Access to land in rural India*. The World Bank.

Ministère du Plan et Suivi de la Mise en œuvre de la Révolution de la Modernité (MPSMRM), Ministère de la Santé Publique (MSP) and ICF International, 2014. *Enquête Démographique et de Santé en République Démocratique du Congo 2013–2014*. Rockville, Maryland, USA: MPSMRM, MSP and ICF International.

Mukasa, A., Salami, A., 2016. Gender equality in agriculture: What are really the benefits for sub-Saharan Africa? *Africa Economic Brief* 7, 1-12.

Mwisha-Kasiwa, J.M., 2018. Household Economic Well-being and Child Health in the Democratic Republic of Congo. *Journal of African Development*, 20(1), 48-58.

Nyamu-Musembi, C., 2002. *Are Local Norms and Practices Fenses or Pathways? The Example of Women's Property Rights*.

Phuna, M., 2008. Information and Communication Strategies to Fight Gender Inequalities in Access to Land in Africa: The Case of the Democratic Republic of Congo. In *Land Access in Rural Africa: Strategies to Fight Gender Inequality*. Brussels, Belgium: FAO Dimitra Project.

Pinstrup-Andersen, P., 2013. Guiding food system policies for better nutrition. Background paper for the State of Food and Agriculture. FAO, WHO.

Quisumbing, M.A.R., McClafferty, B.F., 2006. *Food security in practice: Using gender research in development.* Intl Food Policy Res Inst.

Ragasa, C., Kinwa-Muzinga, A., J. Ulimwengu, 2012. *Gender assessment of the agricultural sector in the Democratic Republic of the Congo*. Citeseer

Remans, R., Wood, S.A., Saha, N., Anderman, T.L., R.S. DeFries, 2014. Measuring nutritional diversity of national food supplies. *Global Food Security* 3, 174-182.

Ruel, M.T., Alderman, H., Maternal, Group, C.N.S., 2013. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *The Lancet*, 382, 536-551.

Sahn, D. and Alderman, H., 1997. On the determinants of nutrition in Mozambique: The importance of age-specific effects. *World Development*, 25 (4), 577-588.

Shively, G., & C. Sununtnasuk, 2015. Agricultural diversity and child Stunting in Nepal. *The Journal of Development Studies*, *51*(8), 1078-1096.

Sibhatu, K. T., Krishna, V. V., and M. Qaim, 2015. Production diversity and dietary diversity in smallholder farm households. Arizona State University, Tempe, AZ.

Size, H. (2018). Composition Around the World 2017. *United Nations' Data Booklet. URL: https://www. un. org/en/development/desa/population/publications/pdf/ageing/household_size_and_ composition_around_the_world_2017_data_booklet. pdf. Title from the screen*, *18*.

Sraboni, E., Malapit, H.J., Quisumbing, A.R., Ahmed, A.U., 2014. Women's empowerment in agriculture: What role for food security in Bangladesh? *World Development* 61, 11-52.

Tiruneh, A., Tesfaye, T., Mwangi, W., H. Verkuijl, 2001. Gender differentials in agricultural production and decision-making among smallholders in Ada, Lume, and Gimbichu Woredas of the Central Highlands of Ethiopia. Cimmyt.

Udry, C., 1996. Gender, agricultural production, and the theory of the household. *Journal of political Economy* 104, 1010-1046.

Udry, C.R., E. Duflo, 2004. Intrahousehold resource allocation in Côte d'Ivoire: Social norms, separate accounts and consumption choices. Yale School of Management.

USAID, 2010. *USAID Country Profile: Property Rights and Resource Governance, the Democratic Republic of Congo (DRC)*.

USAID, 2017. *Food Assistance Fact Sheet Democratic Republic of the Congo*. Available at: https://www.usaid.gov/sites/default/files/documents/1866/FFP_Fact_Sheet_DRC_2017.12.27.pdf.

USAID, 2018. "Democratic Republic of the Congo nutrition profile." https://www.usaid.gov/what-we-do/global-health/nutrition/countries/drc-nutrition-profile.

Valverde, V., Martorell, R., Mejia-Pivaral, V., Delgado, H., Lechtig, A., Teller, C., & Klein, R. E., 1977. Relationship between family land availability and nutritional status. *Ecology of Food and Nutrition*, 6(1), 1-7.

Vlassenroot, K., Huggins, C., 2004. Land, migration and conflict in Eastern DR Congo. *African Centre for Technology Studies* 3, 1-4.

Webb, P., 2013. *Impact pathways from agricultural research to improved nutrition and health: literature analysis and research priorities*. Rome: Food and Agriculture Organization and Geneva: World Health Organization.

WFP, 2014. *Analyse approfondie de la sécurité alimentaire et de la vulnérabilité (CFSVA) au départ de données collectées en 2011-2012*, République démocratique du Congo.

WFP, 2016. *El Nino: Undermining Resilience: Implications of El Nino in Southern Africa from a Food and Nutrition Security Perspective.* http://documents.wfp.org/stellent/groups/public/documents/ena/wfp282004.pdf?iframe.

World Bank, 2008. *Gender in agriculture sourcebook*. World Bank.

World Bank, 2016. *Women, Business and Law report. Getting to equal*. World Bank Group

World Bank, FAO, IFAD, 2008. *Gender in Agriculture Sourcebook* World Bank, Washington, DC.

World Bank, 2016. *Women, Business and Law report. Getting to equal*. World Bank Group, Washington, DC.

World Health Organization (WHO), 2008. *Indicators for Assessing Infant and Young Child Feeding Practices. Part I: Definitions.* Conclusions of a consensus meeting held 6-8 November 2007 in Washington, DC, USA. http://whqlibdoc.who.int/publications/2008/9789241596664_eng.pdf.

World Health Organization (WHO), 2010. "Indicators for assessing infant and young child feeding practices: part 2: measurement", https://apps.who.int/iris/bitstream/handle/10665/44306/9789241599290_eng.pdf, accessed 01 March 2019.

World Population Review, 2018. World Population. http://worldpopulationreview.com/countries-in-africa.