

Access to Agricultural Land and Nutritional Outcomes at the Household Level: A Gender Perspective Analysis in Democratic Republic of The Congo (DRC)

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Abstract

Despite the huge DRC's agricultural potential, the majority of the Congolese population remains largely vulnerable to food insecurity, malnutrition and hunger. While 71% of the labour force are employed in agriculture, there is a contrast between that proportion and the outcomes in terms of food and nutrition security.

Using the 2014 DRC's Demographic and Health Survey, this study attempt to examine the empirical linkages between access to farmland and household-level nutritional outcomes by examining gender differences in effects. Therefore, we use a series of statistical tools and estimate the effect of access to agricultural land on (i) the dietary diversity of children 6-23 months, (ii) the nutritional status of children under 5 years and, (iii) the nutritional status of women aged 15-49 years.

Results suggest significant effects of access to agricultural land on nutritional outcomes in the full sample and in male and female-headed households' subsamples as well. However, we note some gender differences. While the access to farmland constitutes a significant determinant of the children dietary diversity among female-headed households, it also associated with a significant increase in the children height-for-age z-score in the male-headed households. Moreover, access to farmland affects positively the probability for a woman to have a normal body mass index in the male-headed households while it is associated with a significant decrease in the risk of woman anaemia among the female-headed households.

In the DRC's context where most female-headed households are single-parent, the effect of access to farmland on nutritional outcomes in the men's sub-sample could in fact include the unobserved contribution of women. Thus, the results of this study suggest some public policy implications for improving nutritional outcomes at the households' level; especially for people with special needs such as children under 5 and lactating and / or pregnant women.

Keywords: *Access to farmland, dietary diversity, nutrition status, Democratic Republic of the Congo.*

1. Introduction

Investment in agriculture is widely considered as being critically 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; it provides food, it constitutes a source of income and it 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 women's needs are taken into account in the 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. Because they produce and process food commodities, and they prepare a large part of the available food, women are the guarantors of the food security of their families and their 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 60% in some Africa and Asia regions. In addition, the 2011 FAO report estimates that reducing gender inequalities in access to productive resources such as farmland 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 Democratic Republic of the Congo (DRC), 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 in decision-making could be beneficial for household food and nutritional 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 analyses 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 DRC; the country ranks poorly on the Gender Inequality Index (149th out of 188 countries ranked in 2014). It's therefore necessary to examine the relationship between access to productive resources in agriculture, especially access to agricultural land, and nutrition outcomes of Congolese households by highlighting the gender differences in effects.

The rest of the paper is therefore structured as follow: section 2 states the research problem and objectives, section 3 presents an overview of agriculture and nutrition policies in the DRC while section 4 leads with the literature review. Section 5 presents the methodology, section 6 presents the results while section 7 concludes and presents some implications of public policy.

2. Research problem and objectives

Despite the huge DRC's agricultural potential and the apparent macroeconomic performance over the past decade, the majority of the Congolese population remains largely vulnerable to food insecurity, malnutrition and hunger. The DRC has significantly slid into a situation of extremely alarming hunger with negative consequences for nutritional outcomes at the household level and especially for children under 5, pregnant and lactating women.

There is a contrast between the active population employed in agriculture and the outcomes in terms of food and nutrition security. According to the World Bank (2016) Women, Business and Law report, the DRC is a low-income country with a population of 77.3 million, and 71.2% of them are employed in agriculture. In addition, 50.5% of the Congolese population are women with 72% of them economically active and mainly in the agricultural sector. Unfortunately, gender inequalities persist in the Congolese agricultural sector especially in terms of access to productive resources including agricultural land. Although women are able to claim the same rights under the law, in practice men are better positioned in terms of access and control of productive resources in the agricultural sector.

Since then, gender perspective analysis of the access to agricultural land and its implications on household nutritional outcomes is crucial in the context of DRC, where land is considered as one of the motives for armed conflicts.

An increasingly body of literature has shown that gender disparities in access to essential inputs and resources, knowledge and markets contribute to low agricultural productivity and nutritional insecurity in developing countries and particularly in the DRC (See for example, Kinkela & Bahandi, 2011). Taking into account the specific needs of women and men 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% of households with adequate diets have access to agricultural land, 70% 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 to access, the amount of cultivated land, 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 this study is therefore to investigate the relationship between access to agricultural land and nutrition outcomes by examining gender differences.

Specifically, the study seeks to:

- (i) Assess the extent of gender inequalities in access and control of agricultural land.
- (ii) Estimate the effect of access to agricultural land by men and women on their households' level nutritional outcomes.

3. 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 potential for stock farming (Herderschee et al., 2012).

Agriculture including fisheries generates income to 97% of households in rural DRC (WFP, 2014). 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% of rural households have access to land to cultivate during the agricultural seasons, 52% of them use less than 2 hectares and only 19% cultivate on more than 2 hectares. While the country has 25 million hectares of arable land and 66% 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% own their own land, 11% rent land and the rest 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 could explain 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.

In the year 2000, following the deterioration of the nutritional situation, the DRC has adopted a National Nutrition Policy. This policy provides the general guidelines for combating malnutrition in all its forms. In 2001, in accordance with this policy, the National Nutrition Program (PRONANUT) has 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 that could contribute to reducing the extent of malnutrition in the country. However, these efforts had 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. That number 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% of SAM cases in the world. Although the proportion of children under 5 who are stunted has decreased in recent years, 43% remain stunted, which is considered very high by the WHO and UNICEF. 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 DHS, the rate of overweight/obesity among women has increased by 5% points between 2007 and 2014.

To cope with these 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:

- Multi-sectoral Nutrition Strategic Plan (PNSMN) 2016–2020.
- National Health Development Plan (PNDS) 2016–2020.
- National Policy on Food Security and Nutrition (2017).
- Health Investment Framework (2017)

The PRONANUT (National Nutrition Programme) within the Ministry of Health, leads 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 takes into account 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 aged 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:

- To halve the prevalence of chronic malnutrition among children 0-23 months in all the provinces;

- To reduce the prevalence of global acute malnutrition below the alert threshold (10%) in all the provinces;
- To reduce by one third the prevalence of overweight among women due to over-nutrition;
- To reduce the prevalence of non-insulin-dependent diabetes by one-third and;
- 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:

Year	Name of commitment	Description
2009	Declaration of the World Summit on Food Security	The declaration provides a strategy for coordinated action by global, regional and national-level stakeholders. DRC has adopted the third principle, which calls for a dual track approach of immediately addressing hunger among the most vulnerable and eliminating the root causes of hunger and poverty through medium and long-term programs in sustainable agriculture, food security, nutrition, and rural development.
2011	Comprehensive Africa Agriculture Development Programme (CAADP) Compact	CAADP is an Africa-led program bringing together governments and diverse stakeholders to reduce hunger and poverty and promote economic growth in African countries through agricultural development.
2012	Ending Preventable Child and Maternal Deaths: A Promise Renewed	DRC pledged to reduce under-5 mortality to 20 or fewer deaths per 1,000 live births by 2035 by reducing the leading preventable causes of child mortality, including under-nutrition.
2013	Scaling Up Nutrition (SUN) Movement	SUN is a global movement that unites national leaders, civil society, bilateral and multilateral organizations, donors, businesses, and researchers in a collective effort to improve nutrition.
2013	Nutrition for Growth	The first Nutrition for Growth summit was held in London in 2013, where a Global Nutrition for Growth Compact was endorsed by 100 stakeholders, who pledged US\$4 billion for nutrition-specific projects and US\$19 billion in nutrition-sensitive projects. As part of the summit, DRC committed to exempt imported therapeutic nutritional products from taxation.
2014	Malabo Declaration	At the African Union Summit in Malabo, Equatorial Guinea, in 2014, heads of state and government adopted the Declaration on Accelerated Agricultural Growth and Transformation in Africa for Shared Prosperity and Improved Living Conditions. In the declaration, countries committed to reduce stunting to 10 percent and reduce underweight to 5 percent by 2025.
2016	Sub-regional Repositioning Workshop on Nutrition, Brazzaville	Several ministries, including health, agriculture, and finance, committed to eliminate hunger and prevent all forms of malnutrition by: investing in more effective nutrition interventions; strengthening sustainable food systems; including more nutrition in national strategies, policies, plans, and programs; and allocating significant national resources to combat malnutrition.

4. Literature review

Access to farmland may influence nutritional status through attribute of agriculture. In fact, agriculture influences the production of subsistence food crops or animals that households can consume directly or sale in the market (World Bank, 2007). Therefore, we focus on two aspects in this literature. The first is related to gender in agriculture and the second establishes the relationship between agriculture and human nutrition.

Gender in agriculture

The economic literature addressing gender issues in agriculture and their implications for household food and nutrition security assumes that 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 (Ragasa et al., 2012; Mukasa and Salami, 2016; FAO, 2017). 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). For the Latin America, Deere and León (2003), note that gender inequality in land ownership is linked to men's preference for inheritance, male privilege in marriage, and community and state bias in land distribution and gender prejudices in the land market. 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, Udry, (1996), reports that women's agricultural productivity in Burkina Faso is 20-40% lower compared to men, but these differences are mainly

due to lower use of productive inputs, because social norms are based on gender. 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 program 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; and 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 of 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.

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; Pinstруп-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 and Kadiyala, 2012; World Bank, 2007). 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 found 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.

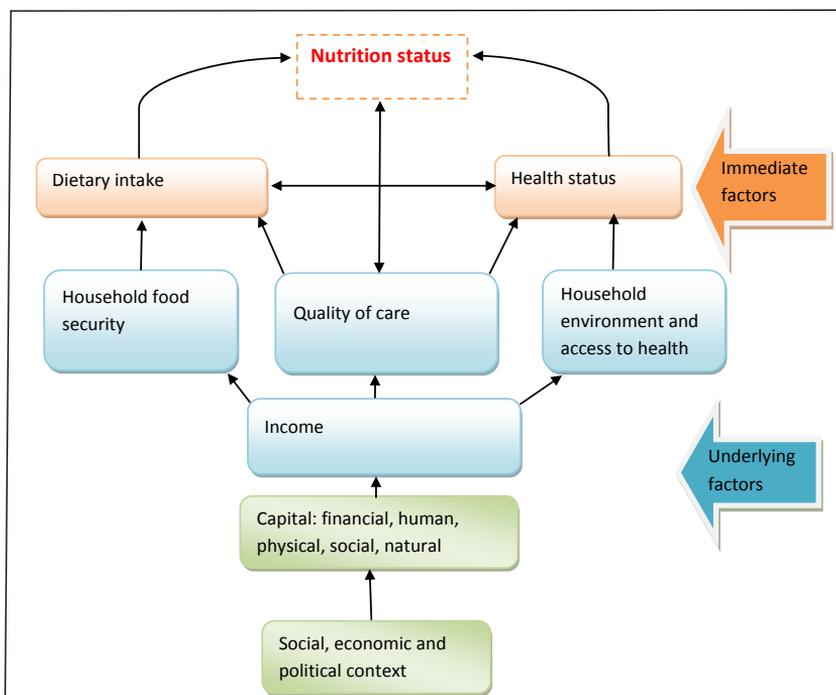
5. Methodology

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 has 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 attained by household in Democratic Republic of Congo.

Figure 1: Conceptualizing causal pathways from agriculture to nutrition



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.

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.

In light of the framework presented above and knowing the nature of our dependent variables, we can now express 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:

$$N_{ih} = \alpha + \beta L_h + \delta X_{ih} + \varepsilon_{ih}$$

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:

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

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).

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 discrete change. For the logit estimation, the interpretation is in terms of probability.

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.

Dietary diversity score

Children's dietary diversity is a qualitative measure of food consumption that reflects access to a variety of foods and it's also a proxy for nutrient adequacy of diet. Access to food depends on whether the household has enough income to buy at prevailing prices or does have sufficient amount of land and other resources to grow and produce its own food. A household can also receive assistance from formal programmes or informal networks to compensate for any shortfall.

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.

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).

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 farmland and zero otherwise.

However, analyses on gender disparities in access to agricultural land, rather than using a single indicator, we use two types of variables, including the method of access to land and the amount of land held. The method of access to agricultural land include family land, owned land and rented land (leased or sharecropped). We also analyze gender disparities in the amount of land held measured in terms of cultivable hectares.

Control variables

We use a number of control variables to control socioeconomic characteristics at the community, household and individual levels. These socioeconomic characteristics include a set of household variables (household size, place of residence, household wealth index), community and environmental factors (proportion of household with improved and unshared toilet, proportion of household with piped water), child characteristics (age, gender, birth size, birth weight, and twin birth) and maternal characteristics (age, educational attainment, employment status, use of antenatal health care). 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 childcare 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 and 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.

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 Measure DHS, and other UN and International donors. The DHS are national household surveys administered by host country governments with technical assistance from the ICF International and other 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 has collected data that enabled the calculation of maternal health indicators and nutritional status of children under five and women aged 15-49.

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.

6. Results and discussion

Descriptive analyses

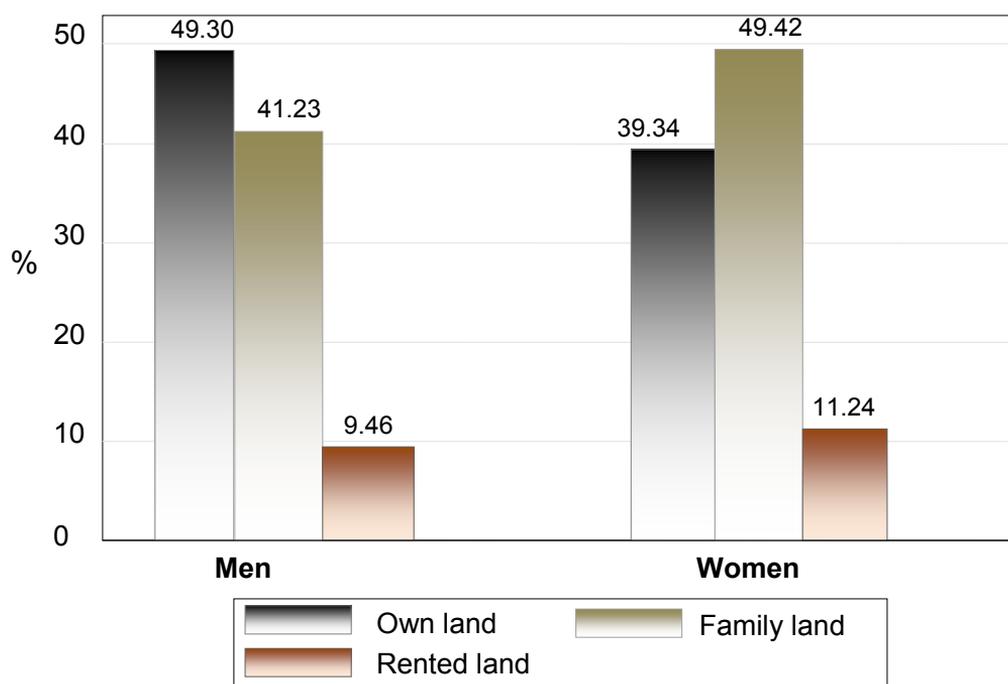
Access to agricultural land: a gender disparities description

Land is a critically important resource in agricultural production and improving household nutritional security. Studies on farmland access suggest significant gender disparities in accessible land area and tenure security (Benfica et al., 2010; Deere and León, 2003; Nyamu-Musembi, 2002). Thus, improving women's access to and control over land could be beneficial for economic development outcomes and particularly to improving the population nutrition.

In the DRC, women often access agricultural land through family relationships, marriage and rent to some extent; being owners could strengthen their power of action and protect them in case of separation or break-up (Ragasa et al., 2012). The conflicts that the DRC has experienced for more than two decades have accentuated the problems of access to farmland and control over land, particularly among women.

As shown in Figures 2, the percentage of women who own farmland is 39% compared to 49% for men. In rural areas, these percentages are 42% and 50% 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% 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 9% 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 and Ruel, 1999).

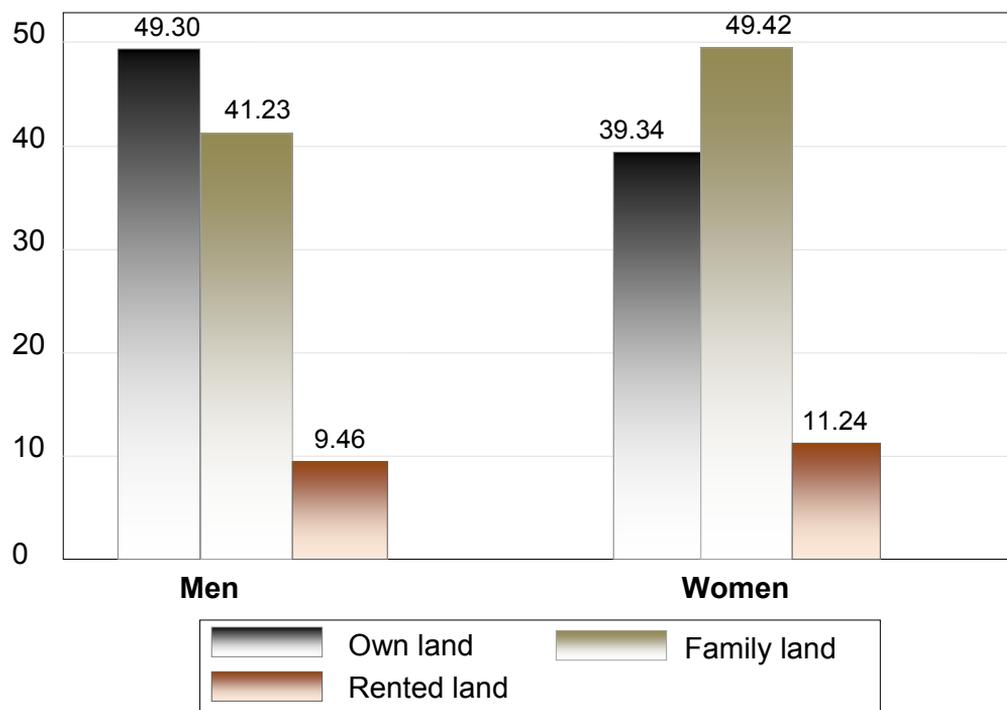
Figure 2: Access to farmland by sex of household head in DRC

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 (CFSVA) survey. 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 1.8 hectares of arable land compared to 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 3.2 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.

These statistical results are similar to those found in the CFSVA survey, which states that 52% of households who cultivated land during the reference farming season, used less than 2 hectares and only 19% 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% of all households cultivated on less than 2 hectares of land.

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.

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.

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% among households. These statistics confirm the deficiency of dietary intake of children under 5 in the Democratic Republic of Congo, a country where, according to the recent data, nearly 2 million children are suffering from severe acute malnutrition which accounts for 12% 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 sample 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

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Table 1 Continued

Food groups and food items	DRC	Urban	Rural	Male hh	Female hh	Boys	Girls
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

Source: Calculations from DHS-2014 dataset. Note: Male hh=Male headed household and Female hh=Female headed household.

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

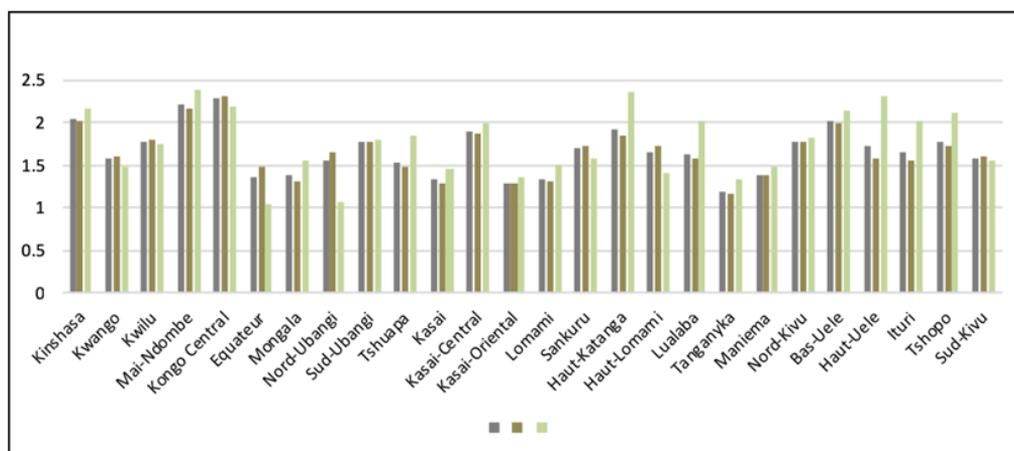
Source: Calculations from DHS-2014 dataset. Male hh=Male headed households; Female hh=Female headed households.

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 well nourished than those of rural areas. Although the disparities are relatively small, these trends in the overall level could hide large disparities between regions in terms of dietary diversity of children; Figure 5 presents the evidence.

In some provinces, children from households headed by women have higher dietary diversity score than those headed by men particularly in the provinces of Haut-Katanga, Tanganyika, Lualaba, Bas-Uele, Haut-Uele, Ituri and Tshopo. Regional disparities are quite important ranging from a minimum value of 1.2 for the Province of Tanganyika to a maximum value of about 2.3 for the Province of Kongo Central.

Figure 4: Children dietary diversity score by province and by gender of head of household



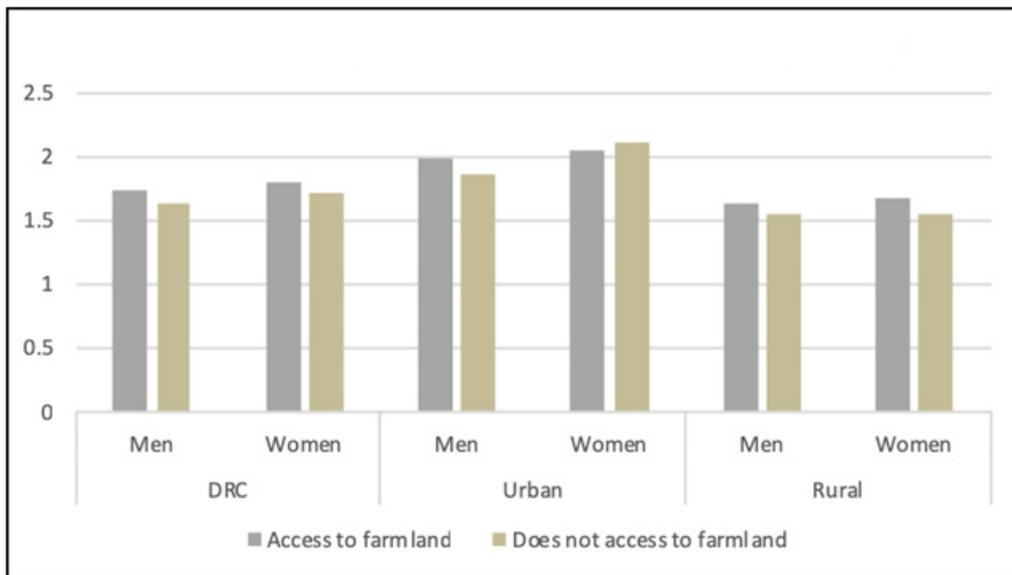
Source: Computations from DHS-2014 dataset

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

Descriptive statistics of variables short-listed for regression analysis

Table 3 provides summary statistics describing the analytic sample of the study. About 74% of women have a normal body mass index (BMI), this means that they have a BMI ranged in the interval from 18.5 to 25. However, 40% of women in the sample were anaemic. Furthermore, children nutritional outcomes seem to be poor.

Even if 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, high than the mean value. The average value for the dietary diversity score 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 29% of households are urban. On the average, children captured in the sample are aged about 27 months and slightly over 50% of them are girls, while about 76% of women are employed. Among the community and environmental characteristics, only 30% of households have improved and unshared toilets and about 38% have access to piped water. The size of households is about 7 members, which is high than the African average.

Table 3: Descriptive statistics of variables short-listed for 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
Childbirth 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: Calculations from DHS-2014 data set

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.

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.

Prior to reporting econometric results, it is important to recall the diagnostic statistics results of the models. As can be seen at the bottom of the table, the Fischer statistics are 22.12; 17.39 and 8.09 respectively for the full sample, the subsample of male headed households and the subsample of female headed households. The R-squared and the Adjusted R-squared are 0.9549 and 0.9524; 0.9543 and 0.9511; 0.9799 and 0.9733 respectively for the full sample, the subsample of male headed households and the subsample of female headed households. With these diagnostic statistics, we can conclude that the models fit the dataset.

The econometric results suggest that access to farmland is a significant determinant of children dietary diversity 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.

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*** (0.057)	0.097 (0.066)	0.343*** (0.110)
Household size	0.002 (0.009)	-0.008 (0.011)	0.038* (0.020)
Type of place of residence	0.188** (0.078)	0.179 ** (0.088)	0.209 (0.160)
Household wealth index	0.815*** (0.264)	0.857 *** (0.305)	0.656 (0.477)
Household has improved and unshared toilet	0.204*** (0.056)	0.188 *** (0.063)	0.282** (0.121)
Household has access to piped water	-0.073 (0.062)	-0.119 (0.071)	0.036 (0.125)
Child age	0.087*** (0.005)	0.087 *** (0.006)	0.083*** (0.011)
Child age squared	-0.139*** (0.009)	-0.139 *** (0.011)	-0.136*** (0.019)
Child sex	0.003 (0.048)	0.005 (0.056)	-0.042 (0.095)

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Table 4 Continued

Variable	All	Male	Female
Child birth size	-0.066 (0.073)	-0.059 (0.085)	-0.118 (0.139)
Childbirth weight (low birth)	0.184 (0.127)	0.291 * (0.151)	-0.218 (0.221)
Child is twin	-0.033 (0.132)	0.052 (0.162)	-0.352** (0.161)
Mother's age	0.006 (0.028)	-0.008 (0.032)	0.084 (0.059)
Mother's age squared/100	-0.001 (0.047)	0.029 (0.053)	-0.154 (0.099)
Mother's year of educational attainment	0.018*** (0.008)	0.013 (0.009)	0.035** (0.014)
Mother is employed	0.106* (0.060)	0.140 ** (0.070)	-0.083 (0.114)
Mother delivered in hospital	0.106* (0.055)	0.128 ** (0.064)	0.034 (0.106)
Constant	0.115 (0.407)	0.302 (0.470)	-0.803 (0.821)
Number of 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]

Source: Result output from computations of DHS-2014 data set. Legend: * p<.1; ** p<.05; *** p<.01 and (...) robust standard errors.

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 marginal effect is 0.34 while there is no significant effect in male headed households. With these results, one can note 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. 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, 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 Kasiwa, 2018).

Among the control variables, we note that the household assets (wealth index constructed by the DHS) influences positively the children dietary diversity score at 1% level of significance both in the full sample and the male sub-sample. Access to improved and unshared toilet affects positively and significantly the dietary diversity score in the full sample and in the male and female sub-samples

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. As diagnostic statistics of the models, Table 5 indicates that the Fischer statistics are 44.14; 37.19 and 10.61 respectively for the full sample, the subsample of male headed households and the subsample of female headed households. The R-squared and the Adjusted R-squared are 0.7748 and 0.7738; 0.7819 and 0.7808; 0.7605 and 0.7557 respectively for the full sample, the subsample of male headed households and the subsample of female headed households. From these diagnostic statistics results, one can conclude that the models provide the better fits and we say that the model is well specified.

Moreover, Table 5 reports OLS estimates of the structural parameters of the child nutrition (HAZ) function. These estimates indicate that access to farmland increases significantly the child nutrition by 0.15 standard scores in the subsample of male headed households, controlling for other covariates. This is indication that child nutrition is strongly positively associated or correlated with access to farmland within households headed by males. Among the female-headed households, results suggest a negative effect of access to farmland on the nutritional status of children, but the effect is not statically significant.

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 access to farmland gain from their food production. Instead of using income as a regressor, we use the household wealth index as a proxy for income because the DHS does not provide income in the dataset.

Thus, if household wealth is a significant pathway, the inclusion of household wealth in the child nutrition model should diminish the effect of access to farmland, making its coefficient in the regression less 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 (proxy of income) is a major pathway from household access to farmland to better child nutrition.

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.

The observed relationship between sex and nutritional status could be justified by biological differences as well as socio-cultural differences. Indeed, socio-culturally gender preferences and preferential treatment may account for the observed coefficient. For example, Fuse (2010), has shown that daughter preference is slightly high than son preference in the less-developed countries. We also observe a negative relationship between child's low birth and nutritional status in the full sample and in the male headed households subsample.

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)
Childbirth size	-0.172**	-0.189*	-0.082
	(0.086)	(0.098)	(0.183)
Childbirth weight (low birth)	-0.265*	-0.201	-0.489
	(0.137)	(0.154)	(0.306)

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Table 5 Continued

Variable	All	Male	Female
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]

Source: Result output from computations of DHS-2014 data set. Legend: * p<.1; ** p<.05; *** p<.01 and (...) robust standard errors.

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

Table 6 displays 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 ($BMI = \text{weight} / \text{height}^2$) and its normal value for adults is between 18.5 and 25.

Therefore, we use logit model to estimate not only the probability 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. When looking at the diagnostic statistics of the model in Table 6, one can conclude that the estimated models are well specified. For example, all the probabilities of the likelihood ratio test are 0.0000; this is an indication of the goodness of fit even if the Pseudo R2 are weak. The weakness Pseudo R2 is not a matter because the regression is done on qualitative dependent variables and estimated with logit.

Table 6: 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*** (0.143)	-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	0.174*** (0.224)	0.220	0.933*** (0.265)	0.174	0.255*** (0.570)	0.421	0.030 (0.224)	0.007	0.094 (0.248)	0.022	0.173 (0.533)	0.039
Access to improved toilet	0.031** (0.064)	0.006	0.003** (0.071)	0.001	0.166 (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's age	-0.037 (0.038)	-0.007	-0.083* (0.043)	-0.015	0.138* (0.084)	0.026	-0.009 (0.034)	-0.002	-0.022 (0.037)	-0.005	0.070 (0.080)	0.016
Mother age squared/100	0.031 (0.063)	0.006	0.101 (0.071)	0.019	-0.245* (0.142)	-0.046	0.018 (0.056)	0.004	0.044 (0.062)	0.010	-0.142 (0.137)	-0.032

continued next page

Table 6 Continued

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
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	0.837*** (0.554)	0.072	0.442*** (0.097)	0.082	0.114 (0.221)	0.021	-0.258*** (0.072)	-0.061	-0.266*** (0.079)	-0.063	-0.184*** (0.188)	-0.042
Constant	1.845*** (0.556)	-----	2.490*** (0.632)	-----	-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	

Source: Result output from computations of DHS-2014 data set. Legend: * p<.1; ** p<.05; *** p<.01 and (...) robust standard errors.

In line with the econometric results in Table 6, 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. Indeed, the discrete change from non-access to access to farmland is associated with 0.038 and 0.052 increases in the probability of having a normal body mass index for women in the full sample and in the subsample of male-headed households respectively. Regarding the anemia model, results of Table 6 indicate that access to farmland affects negatively and significantly the risk of anemia for women aged 15-49 years in the subsample of female-headed households. Thus, compared to households without access to farmland, access to farmland is associated with a -0.078 decrease in the risk (probability) of anemia among women.

From the above, we can highlight the positive effect of access to agricultural land on the women nutritional status in the DRC. Even though access to farmland is 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 since its effects is significant in the anaemia equation.

Among the socioeconomic variables, we observe that the household wealth, the access to improved and unshared toilet, the access to piped water, the women education and the 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 an increase in the probability for a woman to have a normal BMI in the full sample and in the subsample of households headed by men as well. Furthermore, we observed that women education is significant in the BMI equation in the full sample so that, a unit increase (one year) in the women educational attainment is associated with 0.005 increase in the probability of having a 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 (one year) in the women educational attainment is associated with 0.006 and 0.034 decreases in the risk (probability) of anemia in the full sample and the subsample of households headed by men respectively.

7. Conclusion and public policy implication

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 and 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.

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