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Master's Thesis of Science in Agriculture

**How the Gender of Household's Head Influences
Household Food Security in the Developing Countries:
An Evidence from Rwanda**

르완다 사례를 통해 본 가구주의 성별 차이가
개발도상국 가구의 식량안보에 미치는 영향에 대한 분석

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**How the Gender of Household's Head Influences
Household Food Security in the Developing Countries:
An Evidence from Rwanda**

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Submitted in partial fulfillment of the requirements to the faculty
of Graduate School of International Agricultural Technology
for the Degree of Master of Science in Agriculture

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Abstract

How the Gender of Household's Head Influences Household Food Security in the Developing Countries: An Evidence from Rwanda

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The gender gap in food security draws serious attention from international communities to achieve the 'Zero Hunger' level of Sustainable Development Goals of the United Nations. Without closing the gender gap in Agriculture and Food Security, the Zero Hunger goal is hard to be achieved. This study aims to further examine the role of gender in household food security of the developing countries by shedding light on household food security in Rwanda.

It makes use of two waves of cross-sectional survey data, the Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2012 and 2015 collected by the National Institute of Statistics of Rwanda, and the Food Consumption Scores developed by the World Food Program (WFP) as the indicator of the food security status.

The study employs the Blinder-Oaxaca decomposition method and Ordered Probit model in the analysis of the data to capture the structural cause of the food security between male-headed households

(MHHs) and female-headed households (FHHs),

The empirical result demonstrates that the food security status of FHHs is about five point three percent (5.3%) lower in the Food Consumption Score than that of MHHs in the samplings of CFSVA 2015, which slightly dropped from the results of CFSVA 2012. The average probability of households belonging to the food secure (acceptable) group for MHHs is seventy-three percent (73%) and sixty-four percent (64%) for FHHs, which also decreased from the result of the previous survey in CFSVA 2012.

The household's assets, endowment and income activities, and the educational level of the Household's head are the major positive factors affecting the food security while the marital status of the FHH and crisis coping strategies are restricting factors to household food security. The study also found significant gaps in the food security status of the households between urban and rural areas as well as regions.

It is recommendable to develop programs targeting the areas with a higher marginal effect such as strengthening livelihood activities, vegetable gardening, and small livestock raising to address the gender gap in food security.

Keywords: Food Security, Food Consumption Score, Gender Gap in Food Security, Blinder-Oaxaca decomposition, Ordered Probit, Rwanda

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List of Abbreviations

CFS	Committee on World Food Security
CFSVA	Comprehensive Food Security and Vulnerability Analysis and Nutrition Survey
FAO	Food and Agriculture Organization
FCS	Food consumption Score
FCG	Food Consumption Group
GoR	Government of Rwanda
GSF	Global Strategic Framework for Food Security and Nutrition
HLPE	High-Level Panel of Experts on Food Security and Nutrition
IFPRI	International Food Policy Research Institute
MINAGRI	Ministry of Agriculture and Animal Resources
NFNP	National Food and Nutrition Policy
NISR	National Institute of Statistics Rwanda
RWF	Rwanda Franc (Currency)
VUP	Vision 2020 Umurenge Program
WFP	World Food Program
WSFS	World Summit on Food Security

1. Introduction

1.1 Background

Along with climate change, food security is perceived as one of the greatest challenges humanity is facing (The Committee on World Food Security, 2012). In spite of putting Zero Hunger as the second goal on the list of Sustainable Development Goals of the United Nations, Hunger and malnutrition have been on the rise since 2015, returning to the levels of a decade ago. According to the State of Food Security and Nutrition in the World 2017 released by the Organizations of the United Nations, “the number of undernourished people has reached 821 million, around 11 percent of the world population”. In particular, Sub-Saharan Africa remains the region with the highest prevalence of hunger, with the rate increasing twenty point seven percent (20.7%) in 2014 to twenty-three point two percent (23.2%) in 2017.

The Committee on World Food Security (CFS) summarized the structure and underlying cause of food insecurity and malnutrition in its Global Strategic Framework for Food Security and Nutrition(GSF) 2017 as follows;

Firstly, in the area of governance, war, conflict, and political instability and weak institutions in fragile states play a major role in exacerbating hunger and food insecurity. Secondly, in the area of economic and

production issues, poverty and inadequate access to food, unequal distribution of productive resources such as land, water, and knowledge as well as lack of an open, nondiscriminatory multilateral trading system in the agricultural goods are counted as major barriers to food security. Thirdly, in the area of demographic and social issues, besides population growth and urbanization, insufficient attention paid to the role of women and their vulnerabilities with regards to malnutrition, and the many forms of legal and cultural discrimination they suffer, are regarded as an important obstacle to food security. Finally, climate change affects all dimensions of food security. In particular, the impact of climate change on agriculture, such as land degradation, increasing uncertainty about crop yields and the increase of floods and droughts affect the most vulnerable people who depend on agriculture for their livelihood.

With the premises mentioned above, this study focuses on the role of women in household food security. Food Agriculture Organization (FAO) reported details of the gender gap in agriculture in the developing countries with its annual report of “The State of Food and Agriculture. Women in Agriculture: Closing the Gender Gap for Development” in 2011. Even though women farmers comprise over 40 percent of the agricultural labor forces in developing countries, they face severe constraints compared to men in accessing productive

resources such as land and water, market, and services. If women had the same access to productive resources, they could increase yields on their farms by 20-30 percent, and this could raise total agricultural output in the developing countries by 2.5-4 percent.

According to Tibesigwa and Visser(2015), women in Sub-Saharan Africa who head small-scale subsistence farming households have two fundamental reasons for their vulnerability of food security. They are mostly the poorest in society, thereby lacking the resources to withstand poor harvest and make adjustments to climate change. Second, small-scale farm households are heavily dependent on rain-fed agriculture to supplement household dietary needs, and small-scale farming has low adaptive capacity due to high poverty levels. Therefore, it is necessary to acknowledge the gender-differentiated climate impact and promote gendered mitigation strategies to improve food security.

In this aspect, the study of household food security through the gender factors in Rwanda could provide insightful observations on the issue of household food security due to its unique circumstances. Rwanda is a small landlocked country in Central-eastern Africa, which has an estimated population of 12 million on about 26,000 km² of land in 2018. Its high population density of about 490 persons per km² and 2.3% annual growth rate poses a potential threat to the household food security of the country, especially because of its hilly and fragile

terrains and limited irrigation systems in the country. Land degradation is a severe problem in Rwanda, contributing to low agricultural productivity. Soil erosion is a major cause of land degradation (Clay, 1995).

Under these circumstances, Rwanda has made remarkable socio-economic development with about an 8% annual economic growth rate during the last two decades. With its ambitious Vision 2020 development strategy, Rwanda has recorded significant achievements in poverty reduction, food security, and various socioeconomic developments after overcoming the civil conflict in the early 1990s, the 1994 Rwanda Genocide, and the following aftermath of the Rwandan society. In particular, according to the Global Gender Gap index 2017 of the World Economic Forum, Rwanda has become a model case for Africa in the area of gender equality by assessing females' economic participation, education, political empowerment, and health.

In the agricultural sector, the Government of Rwanda has taken significant steps to protect women's rights to land. Women in Rwanda formerly had land-use rights only through their husbands' lineage. However, the 1999 inheritance law has eliminated all gender bias in three respects: first, daughters and sons have equal rights to inherit parental property; second, the property rights of women in a legal marriage are protected; and third, for the transfer of any matrimonial

property spousal consent is required. Based on these family law reforms, the Government of Rwanda (GoR) has successfully conducted Land Tenure Reform in the 2010s, which strengthened the principles of equity and fairness as far as women are concerned (Ngoza, 2018).

On the other hand, the Government of Rwanda has developed the National Food and Nutrition Policy (NFNP) since 2006 to put the food and nutrition security as a fundamental component of the economic development and poverty reduction. Furthermore, the Comprehensive Food Security and Vulnerability Analysis (CFSVA) was conducted to monitor and assess the food security status of the population since 2006.

1.2 Purpose of the Study

In consideration of the Rwanda's efforts to improve gender equality and food security, examining the gender gap in food security finds its meaning in related literature.

The prime purpose of this study is to investigate structural relations between the factors affecting the gender gap and the gender gap in the household food security in Rwanda by using two-wave data set of national food security survey in 2012 and 2015, and Food Consumption Scores (FCS) developed by the World Food Program as a proxy indicator of food security status.

This paper presents three questions. How big is the gender gap represented by MHH and FHH in household food security in Rwanda, and is the food security gap between MMHH and FHH closing? Additionally, why the food consumption score of the CFSVA 2015 has dropped from the result of CFSVA 2012 in spite of robust economic growth during the period?

To examine the structural cause of the gender gap in food security, the study begins by understanding the conceptual framework of the household food security and then analyzes the structural link between factors affecting food security and their gender gaps.

This paper consists of 6 chapters. Besides the current chapter, the second chapter explains selected literature on household food security with a focus on the gender gap in food security as well as on Rwanda. Then, in the following chapter, the theoretical background and the conceptual framework of the study are elaborated. The fourth chapter covers the data, variables, and descriptive statistics, and chapter 5 presents empirical results, and finally, chapter 6 concludes the paper with discussion, policy implications and the limitation of the study.

2. Review of Literature

2.1 Household food Security

There has been a rich foundation of literature covering the issues related to food security, such as concepts and definitions of determinants and drivers, which go back to the world food crisis of 1972-1974 (Abdulla, 2015). The complexity of the food security concept makes it difficult for a practical analysis of food security status. For this study, this chapter focuses on the literature devoted to Household Food Security in Sub-Saharan Africa.

There are numerous studies focused on the relationship between farming endowment, activities, and household food security. Agricultural land ownership is a significant determinant associated with food security. The relationship between agricultural growth and land tenure system in Africa has been a longtime topic of debates and analysis (Barrow and Roth, 1990; Sitko *et al.*, 2014). A land title can increase the security of tenure for farmers, which may make them long term investments in the land. Headey and Jayne (2014) explored adaptations of African farmers to falling land-labor ratios using a comprehensive theoretical framework in Africa and found that land constraints are strongly associated with agricultural intensification, and

land tenure systems are part of that concern to ensure food security. Despite the strong theoretical argument in favor of formal land titling in Africa, due to information asymmetries, the titling program has often resulted in an unsatisfactory outcome for the poor and marginal households. Barrow and Roth(1990) made research on land tenure and investment in African agriculture and concluded that the effect of land tenure registration depends on the market environment and economic opportunities open to farmers. Sitko *et al.* (2014) analyzed the effects of land titling among smallholder farmers to determine whether it enhanced growth in agriculture in Zambia. Their results did not demonstrate any statistical differences between title and non-title holders.

Livestock ownership also plays a significant role in securing household food security. Ellis and Freeman(2004) made comparative research on the rural livelihood and poverty reduction via Poverty Reduction Strategy Plans(PRSP) in Uganda, Kenya, Tanzania, and Malawi and found that livestock ownership closely associated with livelihood and poverty reduction leading to food security. Livestock contributes directly to household nutrition security by providing animal-sourced foods such as milk, meat, and eggs. Apart from nutrition security, livestock in the developing countries contributes to food security by generating cash incomes from sales of animals, their

products or other services (Smith *et al.* 2013). Even though livestock is an important contributor to the incomes and livelihoods of poor and vulnerable producers and consumers, the sector has also been criticized for its inefficiencies and environmental performance: larger use of land and water, a reservoir of disease, and polluter in the environments(Herrero *et al.*, 2013).

An agricultural cooperative or group membership is also considered as a vital pathway for smallholder farmers to participate in marketing, income-raising, and eventual reduction of poverty. The group membership can provide networking and connections which may empower individuals or groups with various business opportunities to enhance income generating activities and nutritional programs to address food insecurity. Nugusse *et al.* (2013) investigated the impact of cooperative activities on ensuring household food security in Northern Ethiopia by using Heckman two-stage model and confirmed that cooperatives have played substantial roles in ensuring food security through increasing income sources, creating employments, and supplying inputs and consumer goods at a reasonable price. The study by Fischer and Qaim (2012) in Kenya also demonstrated that members of banana farmer groups had a higher income by marketing their produce collectively at a higher price than non-members who marketed individually.

There is also a considerable number of literature devoted to the determining factors of households' characteristics of food security. Bulawayo *et al.* (2019) investigated the socioeconomic determinants of food insecurity among Zambian households by using the Zambian National household survey collected in 2010. The study indicates that household income, level of education, has a significant positive impact on household food security, and the location of a household can also potentially influence household food security. Kabunga *et al.* (2014), using the Household Food Insecurity Access Scale to measure household food security, found that larger household sizes are associated with higher food insecurity in Kenya. In contrast, the study by Maitra and Rao (2015) in India showed that a larger household size had less likely to be found in a food-insecure category. With a bigger household, the number of breadwinners the household depends on, the food security of the households seems to be higher.

In many developing countries, non-agricultural income as alternative livelihood activities is considered as an opportunity to expand the livelihood base and contribute to food security (Barrett *et al.* 2001). Owusu *et al.* (2011) studied the impact of off-farm works on household food security in northern Ghana and found that off-farm activities positively contributed to household food security. Fransen and Mazzucato (2014) highlighted the relationship between remittances and

household wealth for post-conflict households in Burundi. The findings revealed that the remittance-receiving household increased their financial capabilities, and the food security status had improved.

Concerning access to credit, Aidoo *et al.* (2013) investigated the determinants of household food security in rural Ghana, and the results revealed that access to credit had a positive influence on a household's food security. Hidrobo *et al.* (2018) investigated the role of social protection in food security using a meta-analysis of 75 studies and found that social protection programs improve the quantity and quality of food consumed by the beneficiary and the average social protection program increases the value of food consumed by 13% and caloric acquisition by 8%.

2.2 Food Security and Gender Gap

Conventionally, it has been considered that the female-headed households are more vulnerable to food insecurity than their counterparts, the male-headed households, and prone to be quickly affected by insecure food elements. Duflo (2012) advocated gender equality in food security as an effective tool to support agricultural and economic growth and enhance food security. Owing to growing attention to the role of gender in agriculture and food security, the number of literature dealing with gender issues in agriculture and food security is increasing.

Kassie *et al.* (2014, 2015) assessed how the gender of household heads was associated with food security in Kenya using data of 605 households and in Malawi using 1,925 households with employing Exogenous Switching treatment Regression. They documented that female-headed households were more vulnerable to food insecurity than male-headed households and the mean differences in food security between MHHs and FHH was 15% in Kenya and 16% in Malawi. Similarly, Tibesigwa and Visser (2015) evaluated the impacts of gender inequality among smallholder households in South Africa on food security. Their results revealed similar results of the study by Kassie *et al.* (2014) and mean differences in food security between MHHs and FHHs in South Africa were about 9%. Besides, they also found that the food security gap between MHHs and FHHs is higher in rural than in urban area, where rural households are more likely to report than urban households. However, Clement *et al.* (2019) examined the gender role in food security in Bangladesh, Nepal, and Tajikistan, and their cross country study found that, notwithstanding the conventional view, socioeconomic structure plays a more significant role in determining the linkage between women's role and food security achievement. Mallick and Rafi (2009) examined the food security status of male- and female-headed households in Bangladesh by using the generalized threshold model. Their results revealed that the gender of households'

heads had no significant effect on household security and there was no cultural and social restriction for women's participation in the labors for the Bengali and other indigenous groups.

2.3 Household Food Security in Rwanda

The Government of Rwanda has developed the National Food and Nutrition Policy (NFNP) since 2006 in aligning with its ambitious Rwanda Vision 2020 and the Economic Development and Poverty Reduction Strategy. The NFNP recognizes food and nutrition as universal rights essential for the physical, mental, and emotional development of children and quality of life for adults. According to the Presidential Initiative to eliminate malnutrition in 2009, the first national Nutrition Summit was held in 2009, and the second National Nutrition Summit was held in 2011, and food and nutrition have become a fundamental issue of Rwanda's plan for economic development and poverty reduction. The updated NFNP 2013-2018 emphasizes the importance of food and nutrition during pregnancy and the first two years of a child's life(Rwanda-MINALOC, 2014).

Along with the Rwandan government's effort to improve the food security status of the population, there are several works of literature focused on the food security status in Rwanda. Chigbu *et al.* (2019) conducted a study on the impact of the land tenure programs introduced

in the 2010s on household food security in the Musanze district. He made a household survey with qualitative and quantitative questionnaires to compare the food security impact of before and after the situation of land use consolidation program. The majority of the household members (49%) reported suffering from insufficient food availability after the introduction of Land Use Consolidation, while key informants confirmed the decrease in food quality, food sustainability.

Verhofstadt and Maetens (2015) analyzed the benefits of farmer membership in a cooperative on poverty reduction in Rwanda. The results demonstrated that farmers belonging to cooperatives had better income and reduced levels of household poverty. Bidogeza *et al.* (2015) investigate the potential impact of alternative agricultural technologies to ensure food security using green manure by five different farm household types. They found that alternative agricultural technologies enhance the resources used in all types of farm households, and off-farm income is critical for farm households to adopt alternative technologies.

Habyarimana (2015) examined the determinants of household food insecurity using the Probit Model with the data of CFSVA 2012. His study found that household size, size of livestock, household asset index, household food acquisition level, land suitability, household spending level, soil erosion index, and cooperative membership are

major factors affecting food security in Rwanda. It also found that the household headed by females are more likely to be exposed to food insecurity than those headed by males. The mean and median of the predicted probability of becoming food insecure among rural households headed by males and females is 0.21 and 0.28, respectively (Habyarimana, 2015).

3. Conceptual framework

3.1 Theoretical background

The analysis in this study is based on the demand and production theory of the households. According to Singh *et al.* (1986), agricultural households combine the household and the firm, two fundamental units of microeconomic analysis. Households derive utility from the consumption of foods through the satisfaction found in a set of taste characteristics and the health effects of the nutrients consumed. Among the various nutrients derived from the consumption of foods, only calories are considered in this study.

Following Singh *et al.* (1986) and Feleke *et al.* (2005), the household utility function is specified as:

$$u = u(\mathbf{F}_i, \mathbf{F}_m, l) \quad (1.1)$$

Where \mathbf{F}_i is a vector of household-produced goods and consumed by the household; \mathbf{F}_m is a market-purchased good consumed by the

household, and F_l is leisure. The household, as both producer and consumer, maximize its utility from the consumption of these goods subject to farm production, cash income, and time constraints specified as:

$$G(Q_i, L, A^0, K^0) = 0 \quad (1.2)$$

$$P_i(Q_i - F_i) - P_m F_m - \omega(L - L_f) + N = 0 \quad (1.3)$$

$$T = L_f + l \quad (1.4)$$

where $G(.)$ is the implicit production function, Q_i is a vector of quantities of the goods produced on-farm, L is total labor input to the farm, A^0 is the household's fixed quantity of land, K^0 is the fixed stock of capital, P_i is price of good i , P_m is the price of a market-purchased good; $(Q_i - F_i)$ is marketed surplus of good i ; w is the wage rate; L_f is the household labor supply for on-farm use; N is non-farm income which adjusts to ensure that equation (1.3) equals zero, and T is total time available to the household to allocate between work and leisure.

The income and time constraints can be combined into one by incorporating the time constraint (1.4) into the income constraint (1.3)

as:

$$P_i(Q_i - F_i) - P_m F_m - \omega(L - l) + N = 0 \quad (1.5)$$

Rearranging (1.5) gives

$$P_i F_i + P_m F_m + \omega L = P_i Q_i + \omega T - \omega L + N \quad (1.6)$$

The left-hand side of the equation (1.6) is the household expenditure on food and leisure, and the right-hand side is the 'full' income equation.

The expenditure side includes purchases of its own farm-produced good i ($P_i F_i$), the household's purchase of the market good ($P_m F_m$), and the household purchase of its own leisure time (wl). The full income side consists of the value of total agricultural production $P_i Q_i$, the value of the household's entitlement of time wT , the value of labor on the farm including hired labor wL , and non-farm income N .

Given the assumption of separability between the production and consumption decisions (Strauss, 1983), we can mathematically derive the production side and consumption-side equations separately. Starting with the production side, the first-order conditions can be solved for the input demand (L^*) and output supply (Q^*) in terms of all prices, the wage rate, technology, fixed land, and capital as:

$$L^* = L^*(P_i, w, A^0, K^0) \quad (1.7)$$

and

$$Q^* = Q^*(P_i, w, A^0, K^0) \quad (1.8)$$

These solutions involve the decision rules for the quantities of labor input and the output produced (production-side). Once the optimum level of labor is chosen, the value of full income when profits have been maximized can be obtained by substituting L^* and Q^* into the right-hand side of the income constraint Eq.(1.6) as:

$$Y^* = P_i Q_i + wT - wL^* + N \quad (1.9)$$

and

$$Y^* = wT + \pi (P_i, w, A^0, K^0) + N \quad (1.10)$$

Where Y^* is the ‘full’ income under the assumption of maximized profit π^* . The first-order conditions can be solved for consumption demand in terms of prices, the wage rate, and income as:

$$F_k = F_k (P_i, P_m, w, Y^*) \quad (1.11)$$

Where $k = i, m$.

3.2 Definition and Components of Household Food Security

The term ‘food security’ first appeared in the mid-1970s, when the World Food Conference (1974) defined food security in terms of the food supply problem, assuring the availability and price stability of basic foodstuffs at the international and national levels (FAO policy brief June 2006). In the early 1980s, a paradigm shift occurred in the field of food security following Amartya Sen’s claims (1981) that food insecurity is more of a demand concern, affecting the poor’s access to food than a supply concern, affecting the availability of food at the national level.

The measurement of food insecurity at the national level refers to a nation’s ability to meet the nutritional needs of its population and is generally measured by agricultural production divided by per capita food consumption in the past. However, national food availability is unevenly distributed, and although food stocks may be sufficient to

meet the population's energy requirements, access to food is often not equal for all people.

At the World Food Summit in 1996, food and nutrition security was defined as the situation “when *all people at all times have both physical and economic access to sufficient food to meet their dietary needs and food preferences for an active and healthy life*’ (FAO, 1998). Since then, the unit of analysis of food security has shifted from the global and national level to household and individual level and encompassed vulnerability to future disruption in access to adequate and appropriate food. (Barrett, 2010).

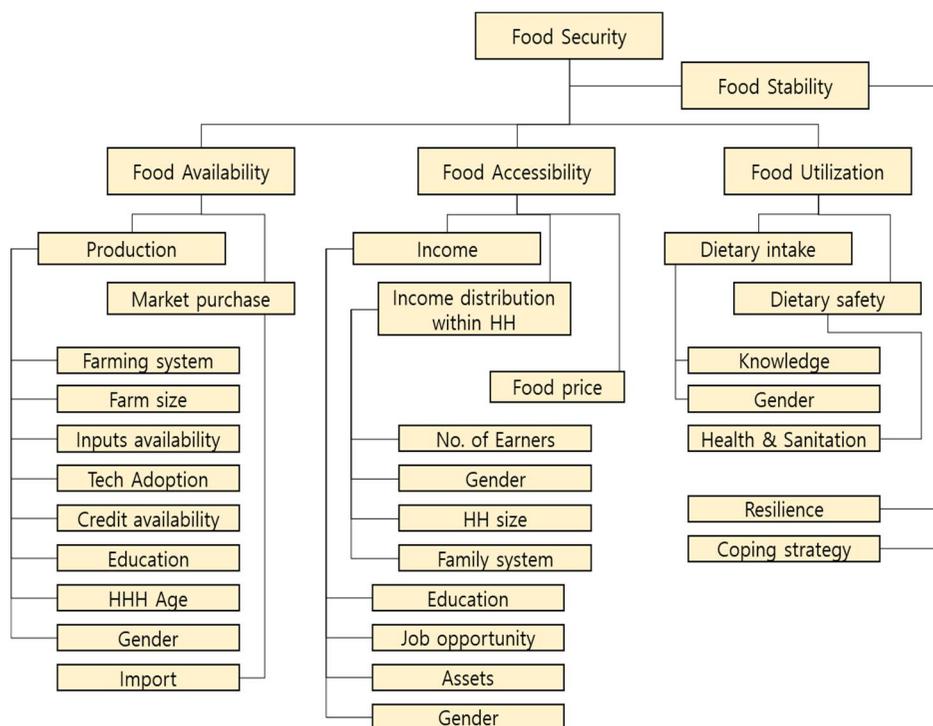
Food Security is commonly conceptualized on four pillars of i) food availability, ii) food access, iii) food utilization, and stability, which is strongly interconnected. The realization of food availability is a necessary but not sufficient for the realization of food access. In turn, the realization of food access is a necessary but not sufficient condition for the realization of food utilization (Barrett, 2010). As mentioned in section 2, the World Food Summit in 2009 revised the definition of food security by adding “safe and nutritious food” and stability as the fourth pillar of food security as follows;

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and

healthy life. The four pillars of food security are availability, access, utilization, and stability. The nutritious dimension is integral to the concept of food security and the work of CFS (Committee on World Food Security, 2017)

Figure 1 shows how the components of food security operate within the framework of the household food security at different dimensions.

Figure 1: Conceptual Framework of Household Food Security



(Source: Author’s modification based on the work of Bashir and S. Schilizzi, 2013)

Food availability refers to the physical existence of food, and reflects the supply side of food security and is determined by domestic food

production and commercial food imports(Barret and Lentz, 2010). These are also influenced by domestic policies regarding food production, such as agricultural subsidy programs related to policies focusing on food self-sufficiency.

Food access is the ability to have enough resources to obtain food for a nutritious diet and healthy living(Mustapha et al., 2016) and largely influenced by food prices and household resources. Every household has resources at its disposal, including assets, human capital, and natural resources. Access to natural resources such as land and water resources is a significant determinant of the productive capacity of the household. On the other hand, income generation and food production capacities of the household are directly affected by the characteristics of the households, such as the education level and health status of the household' members. Education is connected to the development of capacities to support income generation and food production. The distribution of income within the household may further be dependent on household size, total earning members as well as family structure. Household size is an essential factor affecting household food security in terms of the distribution of limited resources. An increase in family size puts more pressure on consumption than it contributes to the production (Bashir, M. K., and S. Schilizzi, 2013).

Food utilization relates to how food consumed is translated into

nutritional health benefits to the individuals. Utilization is categorized into the socio-economic and biological aspects. The sufficient and nutritious food availability and accessibility of the households lead to the decision concerning what food consumed and how the food is allocated among the household members. Discriminatory distribution within household members leads to some individuals suffering from food security (Mustapha *et al.*, 2016).

The quantity and quality of food that a household can acquire with its resources depends on domestic food prices. With given prices and income, individual preferences will determine the consumption of different commodities, including food. Proper food utilization from an early age is fundamental for the physical and mental development of an individual and determines future income generation possibilities.

Other important determinants of food utilization are the individual health status and intra-household choices regarding the distribution of food. The health status of an individual depends on his /her health environment, such as water supply, sanitation, and housing conditions and access to health services. Intra-household food distribution patterns also determine the dietary intake and nutrition level of individual members. Many developing countries maintain the traditional patriarchal culture, and thus, the male members are favored even in terms of food intake (Haddad *et al.* 1996). Many studies showed that

improving women's empowerment in the household decision-making process could reduce the discrimination between children of different sex within households.

Besides the above three components of food security, the stability of food and nutrition status gains considerable attention from the researchers. Stability refers to the susceptibility of individuals to food insecurity due to interruptions in availability, accessibility, and utilization (Barret and Lentz, 2010). When Households experience temporary adverse shocks, they take particular livelihood strategies to mitigate the welfare impact and reduce the vulnerability to food security.

The livelihood strategies will depend on the households' resources and their abilities to access credit and insurance markets, as well as informal social networking. By adopting particular livelihood strategies to mitigate these shocks, households can ease the welfare impact and reduce their vulnerability to food and nutrition insecurity. Coping strategies include reducing the diversity of the diet, purchasing food on credit, consuming seed stock, selling animals and assets, seeking temporary employment, withdrawing children from school, and migrating (Maxwell *et al.*, 2003; Mjonono *et al.* 2009).

While 'vulnerability' is the probability of a household becoming food and nutrition insecure after a food shock, 'resilience' is the time

needed for the household to get back to its food and nutrition status as it was before the shock in food security. Households can increase resilience against weather variability by joining drought insurance and thereby reducing vulnerability (Pieters *et al.*, 2013).

Education also plays a significant role in household production decisions through a better knowledge of nutrition and health practices (Feinstein *et al.* 2006). For instance, better knowledge about the essential micronutrients contained in different crops might lead households to increase their production of nutritious crops.

As a safety net, social protection policies and food aid also play an essential role in preventing and mitigating the adverse effects of nutritional and non-nutritional shocks at the household level. Social protection policies have the primary goal of easing the negative impact of shocks on household livelihoods. There is a wide range of social protection programs, such as social safety nets, insurance mechanisms, social assistance programs, and other inclusion programs for the most vulnerable people (Pieters *et al.*, 2013).

The various causes of food insecurity can be mitigated by a broad range of social protection programs. In particular, cash transfers provide recipients with the freedom to choose whatever they wish to consume, and it can stimulate local agricultural production and non-agricultural activities. However, the provision of cash transfer requires well-

functioning local food markets to avoid inflationary effects, and efficient delivery systems to minimize risks of corruption.

Public works programs have proven to be an effective instrument to deal with unexpected food security shocks such as floods and droughts, enabling consumption stabilization.

Agricultural input subsidies generally have positive impacts on agricultural production and farmers' incomes, reducing rural poverty and enhancing household food security. However, national-scale input subsidy programs are extremely expensive and inefficient when generalized.

Complementing these social protection programs with other options such as job creation and agricultural extension services may offer better sustainable solutions in the long term. Many works of literature also emphasize that instead of a single social protection instrument, comprehensive programs combined with several instruments to satisfy the different needs of different groups are a more practical approach.

3.2 Gender Gap in Agriculture and Food Security

Food security and hunger eradication are among the top priorities on international agendas because of the impact on agricultural productivity under climate change. However, women's potentials in agricultural

production have not been fully utilized (FAO 2011).

Women assume a critical role in agricultural growth in developing countries, but they face persistent obstacles and economic constraints, limiting further inclusion in agriculture. According to Tibesigwa and Vissier (2015), there are several persuasive arguments to explain the gendered impact on food security. First, women account for close 80 % of small scale subsistence farmers in sub-Saharan Africa, and they are disproportionately vulnerable to climate change. Second, female-headed households have low incomes, less access to the job market as well as credit and extension services. Third, most female-headed households depend on common property resources such as farming on communal land or natural resources, and any depletion of these common property results in a serious threat to household food security and livelihoods. Fourth, female-headed households cultivate on smaller land and often have limited labor available to attend to their farm. Lastly, temporary economic out-migration of men in search of employment in cities, which is prevalent in sub-Saharan Africa, promotes household headship by the women who are left behind. Women are less mobile relative to men and remain locked in agricultural activities.

Women farmers comprise over 40% of the world's agricultural labor force and forms the majority of rural poor in many developing

countries. They dominate the production of vegetables in small plots, raising poultry and small animals and provide most of the labor for harvest activities such as storage, handling, and processing grains (Ajani, 2008; FAO, 2011).

Despite significant improvements in building women's capacity, gender gaps in entitlement continue to persist. Gender inequality hinders women's opportunity in employment, education, access to decision making, and affects her household food security (IFPRI, 2012).

In this sense, the Women's Empowerment in Agriculture Index (WEAI) developed by the US Agency for International Development (USAID), International Food Policy and Research Institute (IFPRI), and Oxford Human Development Institute is a significant innovation in this field. It measures the roles and extent of women's engagement in the agriculture sector in five domains: (1) decisions about agricultural production, (2) access to and decision-making power over productive resources, (3) control over use of income, (4) leadership in the community, and (5) time use. It also measures women's empowerment relative to men within their households. It will contribute to better understanding the connection between women's empowerment, food security, and agricultural growth. According to the Women's empowerment Index published by FEED the FUTURE, the Rwandan women farmers have achieved a slightly better empowerment status in

Agriculture compared to neighboring countries (Malapit *et al.*, 2014). Challenging the constraints women face must be treated as a critical component in the fight against hunger and malnutrition(Asian Development Bank, 2013).

3.3 Food Consumption Scores

Due to its complexity and multidimensional concept, measuring food security has been a longstanding challenge to researchers and practitioners alike. The study by Hidrobo *et al.* (2018) found that there are over 30 different types of food security measures which are divided into six groups: caloric intake or availability; the value of food consumed or food expenditures; dietary diversity; food insecurity; food share of total consumption; protein and micronutrient intake; and other. There are also several different food security indicators such as Food Insecurity Experience Scale (FIES), Household Dietary Diversity

Scores (HDDS), Household Hunger Scale (HHS), and Latin American and Caribbean Food Security Scale (ELCSA) developed by various development organizations or research institutes to suit for their objectives.

The Food Consumption Score (FCS) is an index developed by the World Food Program (WFP) in 1996 and widely used as a food security indicator across different countries. In the survey, households were asked about what food items they had consumed in the past seven days out of a comprehensive list of food items. The FCS combines diet diversity, frequency of consumption, and the relative nutritional importance of different food groups. Therefore, the FCS allows comparisons of frequency and diversity of food eaten within a household and established a threshold of dietary quality dividing the population into three groups of food consumption, namely poor, borderline and acceptable. To calculate the FCS from these results, the consumption frequencies are summed and multiplied by the standardized food group weight. Food consumption Scores (FCS) can be written with the following function:

$$FCS = \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \dots + \alpha_8 x_8 \quad (2)$$

Where x is the frequency of the food consumed during the last seven days recall period, subscript 1 to 8 denotes each food group such as staple, pulses, vegetable & fruits, etc., and α indicates food group

weight 4 for meat, milk, and fish, 3 for pulses, 2 for staples, 1 for vegetable & fruits, and 0.5 for oil and sugar.

The thresholds for the FCS classifies households into the following three categories: poor (< 21.5), borderline ($21.5\sim 35$), and acceptable (>35).

The WFP's goal with Food Consumption Scores is to develop a standard instrument for food consumption data collection and analysis approach that is flexible enough for different needs and contexts.

According to Rwanda's Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2015, the Rwandan Government classifies the cut-off point of the food consumption group as follows;

Poor households with inadequate food consumption scores ($FCS < 21.5$) have a diet limited to starch and vegetables, which are consumed on average five and three times a week, respectively. Besides, pulses and oil are consumed once a week. Borderline households with borderline food consumption score ($FCS 21.5-35$) consume starches and vegetables almost daily. Besides, they consume pulses and oil three times a week. Sugar is consumed once a week, while items such as meat and milk are rarely consumed. The acceptable group ($FCS > 35$) consumes starches, pulses, vegetables, and oil almost daily with the addition of sugar, milk, fruits, and meat a few times a week (CFSVA 2015).

Lovon and Mathiassen (2014) studied the applicabilities of food consumption score as a proxy indicator of household food security in six countries and concluded that the thresholds of the Food Consumption Group are set too low because the prevalence of poor and borderline food consumption is considerably lower than the levels of food insecurity estimated by other indicators.

Table 1. Summary of Household Food Security Status

Food Consumption group	Description of Food Consumption Groups In 2015 CFSVA	FCS cut-off point
Poor	Households with poor food consumption have a diet limited to starches and vegetables, which are consumed on average five and three times a week, respectively. Besides, pulses and oil are consumed once a week	≤21
Borderline	Households with borderline food consumption, consume starches and vegetables almost daily. Besides, they consume pulses and oil three times a week. Sugar is consumed once a week, while items such as meat and milk are rarely consumed	21.5~35
Acceptable	Those with acceptable food consumption, consume starches, pulses, vegetables, and oil almost daily with the addition of sugar, milk, and meat a few times a week	> 35

(Source; CFSVA 2015)

4 Data and Procedure

4.1 Data in the Study

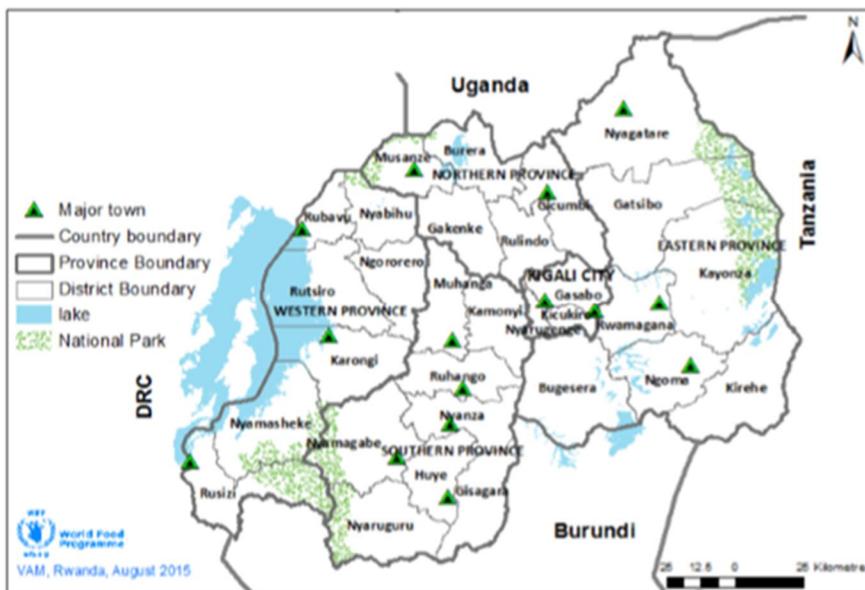
The Household-level data used in this study are from the two-wave datasets of the Comprehensive Household's Food Security and Vulnerability Analysis (CFSVA) 2012 and 2015 of Rwanda, collected by the National Institute of Statistics of Rwanda (NISR) and Ministry

of Agriculture with the support of World Food Program (WFP). The Government of Rwanda has conducted the Food Security and Vulnerability Analysis Survey every three years since 2006. The CFSVA 2006 survey only covered rural households, while the CFSVA 2009 survey excluded Kigali city and only included households with children under five years. In contrast to the previous two surveys, the CFSVA 2012 and 2015 used the same sampling frame, and therefore the results from the two surveys are comparable (NISR, 2015).

The CFSVA 2012 and 2015 sampled a total of 7,500 households in 30 districts and employed a stratified two-stage sample design. In the first stage, 25 villages per district were randomly selected with probability proportional to population size. In the second stage, ten households in each of the 25 villages in the 30 districts were selected for participation in the survey. A systematic random sampling technique was applied for this stage. The CFSVA 2015 survey was conducted in April and May 2015, while the CFSVA 2012 data were collected in March-April, 2012. Households' food security status is commonly influenced by the seasonality of staple crop prices, with a better situation around and after harvest and a worse situation during the lean season. Primary data collection for the 2015 CFSVA took place in April/May 2015, just before the Agricultural Season B harvest. While April is considered as one of the months when households experience more difficulties in

securing food, and the situation generally starts to improve again in June (NISR, 2015). In considering the variability of food price on food security, the data set is complemented with the consumer food price index of the survey period in March 2012 and April 2015 obtained from FAOSTAT.

Figure 2: The Administrative map of Rwanda (Provinces and Districts)



(Source: NISR, 2015)

4.2 Methodology

The Study makes use of the Food Consumption Score with continuous value and its Food Consumption Group with three categories of ordered values as dependent variables representing household food security status. In the beginning, the study employs Ordinary Least Square

regression (OLS) to investigate the effect of the explanatory variable on Food Consumption Scores, and then the Blinder-Oaxaca decomposition technique to capture the gender gap in household food security of the samplings. After that, the data are regressed with the Ordered Probit Regression Model to examine how the explanatory variables influence the categorical status of the household in its food security group.

The OLS equation of this study is expressed as:

$$Y_{ij} = \alpha_0 + \beta_1 D_{1ij} + \beta_2 D_{2ij} + \mathbf{X}'_{ij} + \epsilon_{ij} \quad (3)$$

Where Y_{ij} is the food security status of the i th household in Province j ; i represent household; D_{1ij} is a dummy variable of the gender of household head, and takes one if the gender of the household's head is male, 0, otherwise; D_{2ij} is a dummy variable of the year, which takes one if the year is 2015, zero otherwise (the year 2012); The Blinder-Oaxaca(B-O) decomposition technique has been widely used in the labor economics literature. It is especially useful for identifying and quantifying the separate contributions of group differences in measurable characteristics, such as education, experience, material status, and geographical location, to racial and gender gaps in outcomes (Fairlie, 2006).

Based on the Ordinary Least Square regression Eq.(3), the standard B-

O decomposition of the male/female gap in the average value of the outcome variable can be expressed as:

$$\overline{FCS}_M - \overline{FCS}_F = [(\bar{X}_M - \bar{X}_F)\hat{\beta}_M + \bar{X}_F(\hat{\beta}_M - \hat{\beta}_F)] \quad (4)$$

where \overline{FCS} represents the mean Food consumption score of the sampling households, \bar{X} is a vector of mean values of the observable characteristics in variables and $\hat{\beta}$ is the vector of coefficient estimating for the households' food consumption scores. The subscript M and F denote the male-headed and female-headed household.

The first term of Eq. (4) represents the part of the gender gap that is due to gender differences in observable characteristics. The second term captures the portion of the gender gap that is due to differences in unmeasurable or unobservable characteristics.

Then, the ordered probit model regression is calculated with the following equation:

$$Y^*_i = \mathbf{X}'\beta + \epsilon_i \quad (5.1)$$

where y^* is the unobserved dependent variable. \mathbf{X}' is the vector of independent variables assuming a normal distribution, $\epsilon_i = N(0,1)$ and $i = 1, 2, \dots, N$. β is the vector of regression coefficients that we wish to

estimate. The continuous latent variables Y^* has various threshold points(κ is the small Greek letter Kappa.) The value on the observed variable Y depends on whether or not the respondent has crossed a particular threshold. For example, when $M=3$

$$\begin{aligned}
 Y_i &= 1 \text{ if } 0 < Y_1^* \leq \kappa_1 \\
 Y_i &= 2 \text{ if } \kappa_1 < Y_2^* \leq \kappa_2 \\
 Y_i &= 3 \text{ if } \kappa_2 < Y_2^*
 \end{aligned} \tag{5.2}$$

The following probabilities are included

$$\begin{aligned}
 Prob(y = 1|\mathbf{x}) &= \Phi(\kappa_1 - \mathbf{x}'\beta) - \Phi(-\mathbf{x}'\beta) \\
 Prob(y = 2|\mathbf{x}) &= \Phi(\kappa_2 - \mathbf{x}'\beta) - \Phi(\kappa_1 - \mathbf{x}'\beta) \\
 Prob(y = 3|\mathbf{x}) &= 1 - \Phi(\kappa_2 - \mathbf{x}'\beta)
 \end{aligned} \tag{5.3}$$

Φ is the cumulative distribution function of the standard normal distribution. The parameters β are estimated by maximum likelihood and \mathbf{x}' is a vector of exogenous variables which explains households measures for the food security

The following condition is required for all of the probabilities to be positive.

$$0 < \kappa_1 < \kappa_2 \tag{5.4}$$

The sign of parameters β shows whether the latent variable y increases or decreases with the regressors x . The marginal effects can be explained as each unit increase in the independent variable increases or decrease the probability of selecting an alternative status by the marginal and is expressed as a percentage.

4.3 Variables in the Study

Dependent Variables

The analysis uses Food Consumption Scores (FCS) and Food

Consumption Group (FCG) calculated from the survey CFSVA 2012 and 2015 as dependent variables for household food security indicators. The FCS indicator adopts continuous variables from zero to one hundred and twelve points and the Food Consumption Group (FCG) is formulated based on three categories of Food Consumption scores with poor ($FCS < 21$), borderline ($FCS > 21.5$ & $FCS < 35$), and acceptable group ($FCS > 35$).

Explanatory Variables

In order to find out the factors affecting household food security, 22 explanatory variables are constructed based on the findings of previous researches. The explanatory variables consist of three groups: (i) Household characteristics, (ii) Agricultural activities characteristics, (iii) Social and institutional characteristics, and others.

The house characteristics consist of the size of the household and gender, age, education level, and marital status of the house head. The educational level consists of seven levels, from no formal education to some university education. The marital status of the household head consists of five levels of married, partners, divorced, widow(er), and unmarried. The household characteristics as a supplier of the labor in income-generating activities, as well as consumers of food, play a fundamental role in the food security equation. In terms of the quality of labor and knowledge to utilize the limited resources effectively, the

educational level of the household members also plays a significant role. In particular, the gender factor plays a particular role in food utilization.

As a sub-components of household characteristics, the household's asset and livelihood characteristics included per capita monthly expenditure, the share of food expenditure among total expenditure (%) representing Engel index, and the share of agricultural and non-agricultural income among the household expenditure. The food security is closely related to the poverty status of the household. The asset of the household provides mitigating resources during the period of food shock.

The farming characteristics included variables representing per capita land size and livestock ownership and the adoption of vegetable gardening and crop diversities, and membership of agricultural cooperatives. The per capita land size was calculated in a log. Livestock plays a significant role in diversifying and expanding the agricultural activity bases and greatly contributes to improving the food security of the households. Tropical Livestock unit is calculated with weight of cattle (0.8), pig (0.3), sheep and goat (0.1), chicken, duck, and rabbit (0.07). Vegetable garden and crop diversity are considered to influence household food security. In particular, vegetable garden contributes a lot to household food by providing micro-nutrition rich

food. In terms of technology adoption and purchasing input material as well as marketing the produced agricultural goods, the cooperative activities provide the farmers with enhanced bargaining power. However, women farmers are less represented in cooperative activities.

The social and institutional characteristics included the locality of household (urban or rural), distance to the main market categorized in 1) less 2 km, 2) 2-5 km, 3) 5-10 km, 4) more than 10 km, access to credit (volume of outstanding loan in a log), coverage of social protection program VUP (Vision 2020 Umurenge programs). The crisis coping strategy has three categorical values representing how many times the responding household experienced the difficulties during the last 12 months. Considering the impact of weather shock and price variability in food security, the households' experience of weather shock, as well as the consumer food price index retrieved from FAOSTAT, are also included. Table 3 presents an explanation of the variables used in the study.

Table 2. Explanation of the Variables in the Study

Value	Type of variable
-------	------------------

Variable Group (name)		
Dependent Variable		
Food Score	Consumption	Last 7days food consumption score (0-112) Continuous
Food ConsumptionGroup		1= Food security poor 2= borderline, 3= acceptable Ordinal
Independent Variables		
Household Characteristics		
Household size	Number of Household member (1-15)	Discrete
Household head age	Age of Household Head (18-105)	Continuous
Household head gender	Gender of Household Head, Female= 0, Male=1	Binary
hh head education level	1(no education)-3(Primary complete.)-7(Uni.)	Ordinal
Hh head _marital status	HH Marital status; 1(married),5(Never married)	Nominal
Per capita monthly expenditure	per capita monthly expenditure(0-	Continuous
Share_food/expenditure	Share of food expenditure/expenditure (%)	Continuous
Share_Agri_Income/Expenditure	Share of agricultural income/Expenditure (%)	Continuous
Non_agri_Income/Expenditure	Share of non_agricultural income/Expenditure (%)	Continuous
Farming Characteristics		
Per capita Land size	Land category; 0 (no) -5 (more than 1 ha)	Continuous
Livestock (TLU)	Tropical Livestock Unit, Scale (0-12.6)	Continuous
Vegetable_garden	Yes=1/no=0	Binary
Coop Membership	Yes=1/no=0	Binary
Crop diversification	1: 1 crop, 2, 3, 4 (more than 4 crops)	Ordinal
Social-institutional characteristics		
Ln_total loan	Log Household total outstanding loan	Continuous
VUP_social protection	VUP social protection receiving Yes=1 no=0	Binary
Distance to market	Distance to market: 1(less than km). 4(over 10km)	Ordinal
Urban (Rural)	Household Location Urban=1 Rural=2	Binary
District	30 districts	Nominal
Province	Kigali, South, West, North, East	Nominal
(Others)		
Coping strategies	Coping strategy category, 0,1(low),2(M), 3(high)	Ordinal
Weather_shock	Experiencing Flood or drought Yes=1/no=0	Binary
Price Index	Food Price Index; March 2012, April 2015	Continuous

4.4 Descriptive Statistics

Dependent Variables

The food security status of the sampling households in CFSVA 2015 estimated by the mean score of Food Consumption recorded at forty-seven point six (47.6) in May 2015 and has decreased by about 0.5% compared with forty-eight point two (48.2) in April 2012. Considering the annual economic growth rate of more than 6% between the survey period of 2012 and 2015, and the increments of monthly household expenditure, the decrease in food security indicator are quite unusual. It is necessary to examine whether there are other factors exacerbating household food insecurity in CFSVA 2015 besides the seasonality of food supply explained by the Rwandan government (NISR, 2015).

By reviewing the retreated food security status of Rwandan households at the gender and regional factors, the apparent gap between MHH and FHH, as well as urban and rural households, draws the particular attention of this study. The food consumption scores of FHH with forty-three point three (43.3) in 2015 is about 6% lower than that of MHH with forty-nine point two(49.2). In particular, the decreasing rate of food consumption scores of FHH was much greater than that of MHH.

Figure 3 A and B show an apparent gap between the food consumption score of the MHHs and FHH in kernel density estimation.

Figure 3 A Kernel density estimation of Food Consumption Score in CFSVA 2012

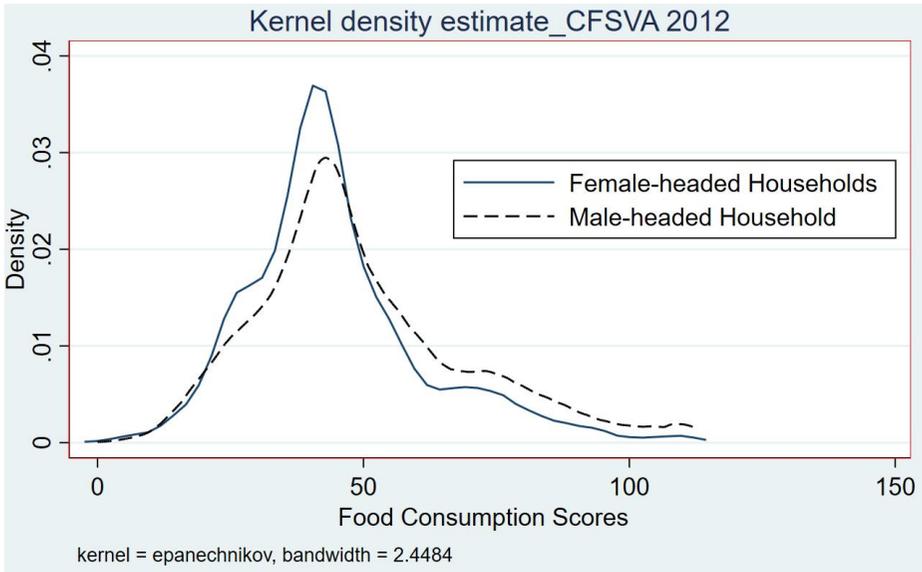
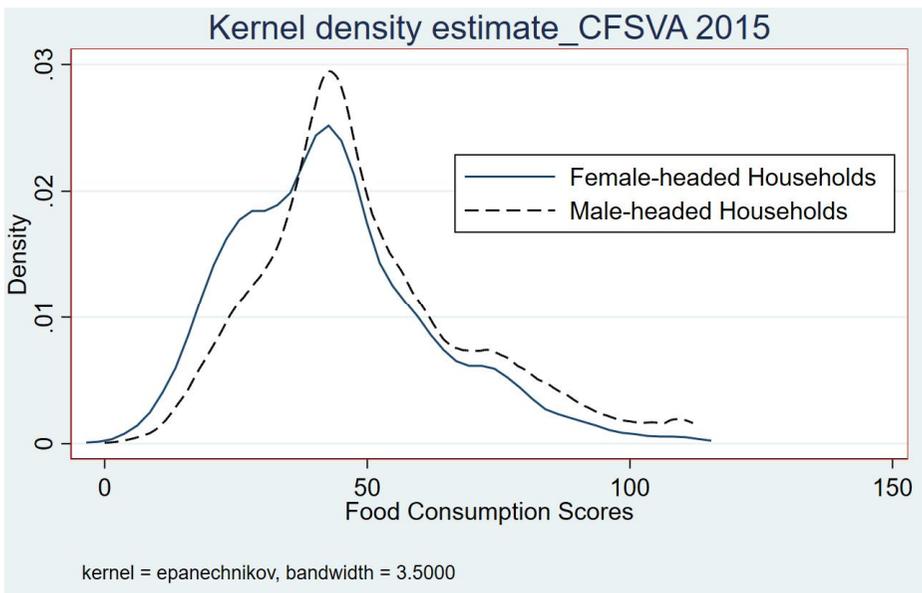


Figure 3 B Kernel density estimation of Food Consumption Score in CFSVA 2015



By converting the food consumption scores into the food consumption groups, about 8% of households are classified as poor, and 21% of households stay in the borderline area, and about 70% are in the food acceptable area. In the case of FHHs, about 36 % belong to food-insecure groups, while 27% of MHHs belong to food insecure. Table 3 shows the changing differences in food consumption scores between FHH and MHH in the years 2012 and 2015, while Table 4 presents the average probability of households belong to a certain food security group.

Table 3. Average Food Consumption Score of the Sampling Households

Variable	2012			2015			Diff. (A-B)
	Obs.	Mean(A)	Std. Dev.	Obs.	Mean(B)	Std. Dev.	
Pooled Sample	7,461	48.253	18.717	7,453	47.679	20.987	-0.573
Ur/MHH (C)	722	66.481	23.65	918	66.062	24.717	-0.419
Ur/FHH (D)	265	57.709	20.115	368	54.273	21.824	-3.436
Ru/MHH (E)	4,606	47.081	16.911	4,533	45.864	19.028	-1.217
Ru/FHH(F)	1,868	42.755	15.696	1,634	40.901	17.327	-1.854
Diff. (C-D)		8.771			11.789		
Diff. (E-F)		4.326			4.963		

Note: Ur=Urban, Ru=Rural, MHH=male-headed household, FHH=female-headed household

Table 4. Average Probability of the household Being Food Secure

Variable	Obs.	2012		Obs.	2015		Diff. (A-B)
		Mean (A)	Std. Dev.		Mean (B)	Std. Dev.	
Pooled	7,461	0.789	0.408	7,453	0.706	0.456	-0.083
Ur/MHH (C)	722	0.942	0.234	918	0.89	0.313	-0.052
Ur/FHH (D)	265	0.917	0.276	368	0.81	0.393	-0.107
Ru/MHH (E)	4606	0.791	0.407	4533	0.698	0.459	-0.092
Ru/FHH(F)	1868	0.706	0.456	1,634	0.600		

Diff. (C-D)	0.025	0.08
Diff. (E-F)	0.085	0.1

Note: Probability of Being Food Secure means the status of food security acceptable by the Food Consumption Score. Ur=Urban, Ru=Rural, MHH=male-headed household, FHH=female-headed household

Independent Variables

Before examining the household food security status of the samplings, it is necessary to look into the characteristics of the household demography of the samplings as well as its economic and institutional situations.

The sampling data consist of about 85% of rural households and 15% of urban households. In CFSVA 2015, 82% of the sampling household is from the rural area, while it was close to 87% of the sampling in CFSVA 2012. This figure indicates a robust migration trend from rural to urban areas in Rwanda. Among the samplings, the female household shared about 27% of the total households. This figure of the female-headed households is similar to the statistics of the Rwanda Population and Housing Census 2012 in which the female-headed represent about 25% of total households, and there was an estimation of an extra 6% of de facto female-headed households whose husbands stayed a long time in the distant places(NISR, 2015).

Household Characteristics

The mean size of household members in the female-headed households is 3.9 and much smaller than that of male-headed households with 5.2.

This means that FHHs have less available labor to use in income-generating activities than MHHs.

The mean age of FHHs in the samplings is 54.7 years, and about ten years older than their male counterpart whose mean age is about 44.2 years. In terms of the level of educational attainment, the average educational level of households' heads did not finish primary school. The educational attainment gap between MHH and FHH is about 0.6 points. Considerable numbers of the FHH did not have any opportunities for formal education. Rwandan smallholders have more than one livelihood activities, and FHHs depend on more remittances from their household members and relatives. With the above household demography, we could interpret that there exists a considerable gap in the quantity and quality of the available labor force between MHH and FHH. These differences make the gap in production capability and, eventually, food security between them.

The livelihood activities and consumption patterns of the household also play significant roles in household food security. The average per capita monthly expenditure reported about 14,879 Rwandan Franc equivalent to 22 US Dollars (1USD=687 RWF) in 2015, which has increased from 11,856 Rwanda Franc equivalent 20 US Dollars (1 USD=606 RWF) in 2012. The per capita monthly expenditure of FHH recorded about 75% of MHH's per capita monthly expenditure, with

15,919 RWF (23 USD) in May 2015 (CFSVA 2015). In terms of share of food expenditure among total household expenditure known as Engel index, FHH recorded at 0.58 while MHH recorded at 0.53 in CFSVA 2015. This Engel index represents a similar level of the Rwandan households' poverty headcount of 56.8 % published by the World Bank in 2013 (\$1.90 per day, 2011 PPP %). These numbers indicate that the fundamental gap in the poverty status between MHH and FHH inevitably results in an observable gap in food security between them.

Agricultural Activities

Concerning the agricultural activities, 82% of the total households participate in agriculture while 37% of the urban household and 88% of the rural households practice agricultural activities. The number of households practicing farming activities has reduced from about 84% to 79% in 2015. The migration trend of households from rural areas to urban areas might be the main cause of decreasing farming households. As explained in Section 3, due to the out-migration trend of men in Africa searching for jobs in the cities, the women left behind take headship of the household and take care of the agricultural activities.

Due to limited land space and high population density, the average farm size owned by Rwandan farm households is less than 0.3 ha while

only 14% of the farm household has more than 1ha, and about a similar number of households own less than 0.1 ha. The land size of the farm ownership in 2015 has been reduced from 2.5 points (about 0.35 ha) in 2012 to 2.2 points (0.26 ha). The pressure of population growth might be the main cause of the decreasing trend of land size.

Interestingly, though the average land size owned by the FHH is about 10% smaller than that of MHH, due to the smaller household size, the average land size per capita owned by FHHs is about 50% bigger than that of MHH. In particular, the gap in land size between MHHs and FHHs at the household level is also closing. Though any information concerning land tenure reform was not included in the analysis, the effect of land tenure reform implemented from 2009 to 2013 might indirectly influence the ownership of the land. In livestock ownership, FHH owned about 0.34 Tropical Livestock Units, equivalent to 61% of the MHH in 2015, which has increased from about 59% of the TLU of MHHs.

Concerning the diversification of agricultural activities, kitchen gardening and crop diversification play a considerable role in food security. The kitchen garden provides significant micronutrients and contributed significantly to the food security of the household. About 78 % of the farming households cultivate any kitchen gardens in 2015, of which number has increased from 69% in 2012. FHHs cultivate

vegetable garden about at the 92% level of MHH. Crop diversities are also important in dietary diversity. Most of the Rwandan households cultivate more than two crops.

With regard to the cooperative membership, about 14 % of the MHHs have participated in cooperative activities in 2015 while about 10% of FHHs participated in agricultural cooperatives. The results of cooperative membership have slightly decreased from that of 2012. The Cooperative membership is closely related to the extension of farming technology, enhancing productivity as well as bargaining power in purchasing input materials and in selling produced agricultural goods.

Social Institutions and Others

The access to credit is a very important factor to enhance investment in agricultural activities as well as to mitigate the effects of any unpredicted crisis. About 20 % of the sampling household has an outstanding loan from the credit institution in 2015, and the number has increased from 16% in 2012. However, only 13 % of the FHH have a loan from credit facilities, while 22 % of MHH have obtained loans from financial systems. These constraints in social networking could also negatively affect the food security of FHHs.

As shown in chapter 2, the Rwandan Government provides socially vulnerable groups with social protection schemes such as VUP (Vision

2020 Umurenge Program) social protection program. About 14% of FHHs are recipient households of VUP support in CFSVA 2015, while only 8% of the MHH receive the program coverage. Relating to market accessibility, more than 55% of the households take more than an hour to reach the market, and about 27% of the households take more than two hours to reach the market by walking.

It is also essential for the households how to adapt to a crisis when it occurs. The households take several mitigating measures known as crisis coping strategies, as explained in the literature reviews. In these survey questionnaires, about 41% of the household reported some measures taken to mitigate the shortage of food, and about 51 % of households reported the experiences of challenging time for food security. Among them, 10 % of households experienced severe concerns about food shortage. This fact reveals that there is a considerable gap between the food security status represented by the food consumption score and the experience of the food shortage by the households.

As explained in chapter 3, the food supply is significantly influenced by harvest season, and the food crop price varied considerably. The consumer food price index in April 2015 recorded one hundred thirty-seven point fifty-three (137.53) points and increased by about 20% in comparison with one hundred and fourteen point fifty-eight (114.58) in

March 2012 (the baseline price index was one hundred points in January 2010). Concerning weather-shock, about 21% of farm households reported experiences of flood in 2012, and 15% of households experienced drought in 2015.

A more alarming gap exists between urban and rural households. About 32% of households in the rural area where the majority of the population lives belong to food poor and borderline groups and are vulnerable to food shortage shock while only 13% of households in the urban areas with poor and borderline groups. By comparing the distribution of food security groups (food consumption group) between districts, there is a significant gap between the three districts in Kigali and five districts in the western province. More than 90% of FHHs in Kicukiro, Nyrugenge, Gasabo district of Kigali belong to the food acceptable group while less than 50 % of FHHs in Karongi, Rutsiro, Nyabihu, Rusizi, Nyamasheke belong to the acceptable food group. In these districts, the gender gap in food security between MHHs and FHHs is also bigger than in other districts.

The Student's paired t-tests were applied to evaluate differences in the mean score of the variables between male-headed households and female-headed households. All variables except distance to market, Weather-shock, and Food Price Index reject the null hypothesis which assumed that the mean scores of MHH and FHH are not different.

Overall, the results are in line with the researcher's expectation and consistent with the current literature. Table 5 shows the descriptive statistics of the data in CFSVA 2012 and CFSVA 2015.

The distribution status of the food consumption group is attached in the appendix (Figure 4).

Table 5. Descriptive Statistics of CFSVA 2012, 2015

Gender	2012			2015			T-test by gender (2015)
	MHH (A)	FHH (B)	Diff (A-B)	MHH (C)	FHH (D)	Diff (C-D)	
<i>Dependent variables</i>							
FCS	49.73 (19.18)	44.58 (17.06)	5.14	49.24 (21.48)	43.28 (18.95)	5.96	***
FCG	2.78 (0.49)	2.68 (0.56)	0.09	2.66 (0.61)	2.53 (0.68)	0.13	***
<i>Independent Variables</i>							
<i>Household Characteristics</i>							
Household size	5.34 (2.12)	3.93 (1.91)	1.41	5.33 (2.13)	3.84 (1.98)	1.48	***
Hhead_age	44.11 (14.72)	54.15 (15.42)	-10.04	44.28 (14.32)	55.33 (14.70)	-11.05	***
Hhead_edulevel	2.39 (1.32)	1.79 (1.16)	0.6	2.51 (1.46)	1.85 (1.16)	0.67	***
Hhead_marital status	1.35 (0.80)	3.82 (0.71)	-2.47	1.40 (0.95)	4.49 1.16	-3.09	***
agri_income (%)	72.77 (36.88)	77.06 (36.89)	-4.29	72.83 (37.80)	76.41 (38.10)	-3.58	***
nonagri_income (%)	24.82 (35.71)	17.09 (32.23)	7.73	24.08 (36.48)	17.73 (34.15)	6.35	***
ln_hh_expense_H	8.60 (1.20)	8.28 (1.24)	-0.31	8.84 (1.24)	8.50 (1.30)	0.33	***

Food_expense (%)	0.47 (0.24)	0.51 (0.25)	-0.04	0.54 (0.23)	0.58 (0.25)	-0.04	***
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/ Continued/

/Table 5 continue/

Gender	2012			2015			T-test by gender (2015)
	MHH (A)	FHH (B)	Diff (A-B)	MHH (C)	FHH (D)	Diff (C-D)	
<i>Agricultural activities</i>							
Landsize_H	0.58 (0.49)	0.77 (0.76)	0.19	0.49 (0.50)	0.72 (0.81)	-0.23	***
Livestock (TLU)	0.64 (1.30)	0.38 (0.74)	-0.26	0.55 (1.01)	0.34 (0.71)	0.21	***
Vegetable garden	0.60 (0.49)	0.54 (0.50)	0.05	0.64 (0.48)	0.59 (0.49)	0.05	***
Crop diversity	2.59 (1.38)	2.46 (1.36)	0.13	2.23 (1.45)	2.03 (1.44)	0.2	***
Coop member	0.16 (0.37)	0.12 (0.32)	0.05	0.14 (0.34)	0.10 (0.30)	0.04	***
<i>Social Institutions & Others</i>							
ln_total loan	1.99 (4.40)	1.18 (3.40)	0.81	2.59 (4.89)	1.36 (3.58)	1.24	***
VUP-social program	0.05 (0.26)	0.07 (0.32)	-0.02	0.09 (0.29)	0.14 (0.35)	-0.05	***
Coping strategies	0.80 (1.03)	1.05 (1.08)	-0.25	0.77 (1.10)	1.02 (1.16)	-0.25	***
Distance_market	2.59 (1.09)	2.67 (1.08)	-0.08	2.80 (0.92)	2.77 (0.91)	0.03	
Weather shock	0.19 (0.40)	0.16 (0.37)	0.03	0.09 (0.29)	0.10 (0.31)	-0.01	

Food Price index	114.58	114.58	0	137.53	137.53	0
	(0.00)	(0.00)		(0.00)	(0.00)	

Note: Standard deviation in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%), MHH=male-headed household, FHH=female-headed household,

5. Empirical Results

5.1 Ordinary Least Square Regression Result of Food Consumption Scores

Table 6 presents the results of OLS regression, in which factors were affecting the Food Consumption Scores of the sampling households. The model explains about 46% to 52% of the causal relations between the explanatory variables and the food consumption scores (FCS) in CFSVA 2012 and 2015, respectively. Among 20 explanatory variables, ten variables are significant at 99% confidence level, and four variables are significant at 95% confidence level in CFSVA 2015 while 14 variables are significant at the 99% confidence level and one variable at the 95% confidence level in CFSVA 2012.

Among household characteristics, household size, age and educational level of household head as well as per capita monthly expenditure and the share of food expenditure among total household expenditure affect positively on the food consumption scores while the

marital status of the household head, share of agricultural income and non-agricultural income among expenditure influence negatively.

All variables related to agricultural activities show positive value, except per capita land size, which shows insignificant value. Most of the social and institutional variables show negative values. In the case of gender, compared to female-headed households, male-headed households are about 2% lower in food consumption scores, and the food consumption score in CFSVA 2015 is about 2.1 % lower than that of CFSVA 2012. Concerning the regional factors, comparing to Kigali, the food consumption score of the Western province is about 10.2 percent point lower and followed by the Northern province (-7.8 %), the Southern province (-4.4%), and the Eastern province (-4.0%). Among determining factors, the per capita expenditure shows the highest positive coefficient, and the crisis coping strategies are the highest negative coefficient. 2015.

Table 6. OLS results of the Food Consumptions Score (CFSVA 2012, 2015)

/Table 6 (continued) /

Note: Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * P < 0.1 (significance level)

FCS	2012			2015		
	Pooled Sample Coef.	MHH Coef.	FHH Coef.	Pooled Sample Coef.	MHH Coef.	FHH Coef.
<i>Household Characteristics</i>						
Household size	0.821*** (0.107)	0.686*** (0.127)	1.692*** (0.203)	1.019*** (0.105)	1.109*** (0.125)	0.819*** (0.196)
Hhead_gender	-2.226*** (0.643)	(omitted)	(omitted)	-1.524** (0.673)	(omitted)	(omitted)
Hhead_age	0.022 (0.012)	0.017 (0.014)	0.048** (0.021)	0.026** (0.013)	0.010 (0.015)	0.052** (0.026)
Hhead_edulevel	1.658*** (0.164)	1.620*** (0.189)	1.561*** (0.323)	1.572*** (0.162)	1.471*** (0.184)	1.567*** (0.343)
Hhead_marital status	-0.767*** (0.225)	-1.019*** (0.271)	-0.449 (0.417)	-0.424** (0.187)	-0.927*** (0.247)	0.377 (0.287)
agri_income (%)	-0.070*** (0.017)	-0.062** (0.029)	-0.090*** (0.020)	-0.061*** (0.012)	-0.067*** (0.016)	-0.039** (0.018)
nonagri_income (%)	-0.038** (0.017)	-0.024 (0.029)	-0.078*** (0.021)	-0.010 (0.012)	-0.011 (0.015)	-0.012 (0.020)
ln_hh_expense_H	5.977*** (0.182)	6.264*** (0.228)	5.371*** (0.294)	6.130*** (0.210)	6.709*** (0.261)	5.107*** (0.342)
food_expense (%)	3.410*** (0.754)	3.955*** (0.938)	2.865** (1.223)	2.573*** (0.810)	4.017*** (1.009)	0.651 (1.348)

at 1%, 5%, 10%), MHH=male-headed household, FHH=female-headed household

FCS	2012			2015		
	Pooled Sample Coef.	MHH Coef.	FHH Coef.	Pooled Sample Coef.	MHH Coef.	FHH Coef.
<i>Agricultural Activities</i>						
Landsize_H	-0.083 (0.382)	-0.137 (0.581)	0.279 (0.507)	0.158 (0.357)	0.403 (0.525)	-0.065 (0.499)
Livestock (TLU)	2.205*** (0.293)	2.136*** (0.317)	2.622*** (0.612)	3.291*** (0.377)	3.035*** (0.425)	4.465*** (0.580)
Vegetable garden	1.059*** (0.335)	1.400*** (0.411)	0.587 (0.562)	2.031*** (0.364)	2.641*** (0.436)	0.427 (0.653)
Crop_diversity	0.329* (0.177)	0.233 (0.215)	0.463 (0.309)	0.678*** (0.153)	0.813*** (0.182)	0.279 (0.287)
Coop_member	1.354*** (0.467)	1.990*** (0.551)	-0.169 (0.832)	1.476** (0.575)	1.258* (0.666)	2.342** (1.126)
<i>Social Institutions & others</i>						
ln_totalloan	0.053 (0.044)	0.045 (0.050)	0.002 (0.091)	-0.033 (0.042)	-0.068 (0.046)	0.009 (0.094)
VUP_social program	-0.718 (0.685)	-0.871 (0.820)	0.113 (1.203)	-1.387** (0.538)	-1.248* (0.688)	-1.326 (0.866)
Coping strategies	-2.982*** (0.167)	-3.114*** (0.205)	-2.540*** (0.279)	-3.687*** (0.163)	-3.662*** (0.195)	-3.423*** (0.290)
Distance_market	-1.069*** (0.165)	-1.050*** (0.202)	-1.069*** (0.281)	-0.719*** (0.206)	-0.871*** (0.245)	-0.317 (0.372)
Weather_shock	-1.227*** (0.393)	-1.761*** (0.507)	-0.265 (0.607)	-1.269** (0.548)	-1.007 (0.676)	-1.803* (0.918)
Urban	-3.922*** (0.764)	-3.481*** (0.923)	-4.782*** (1.301)	-1.189* (0.661)	-1.418* (0.815)	-1.275 (1.100)
normalized_weight	-0.945* (0.532)	-1.147* (0.640)	-0.620 (0.922)	1.106*** (0.322)	1.146** (0.369)	0.893 (0.645)
<i>Province</i>						
SOUTH	-1.805* (0.987)	-3.074*** (1.184)	2.109 (1.735)	-6.419*** (0.833)	-6.278*** (1.010)	-6.999*** (1.421)
WEST	-6.807*** (0.975)	-7.758*** (1.171)	-3.653** (1.724)	- (0.809)	- (0.974)	- (1.411)
NORTH	-3.730*** (1.013)	-4.988*** (1.209)	0.490 (1.827)	- (0.849)	- (1.015)	- (1.496)
EAST	-0.110 (1.001)	-1.809 (1.203)	5.073*** (1.770)	-6.881*** (0.845)	-6.944*** (1.019)	-7.123*** (1.452)
_cons	9.705*** (3.148)	6.216 (4.265)	8.137 (5.102)	-0.538 (3.149)	-6.046 (3.873)	4.102 (5.018)
Observation	7,370	5,270	2,100	7,443	5,445	1,998
R ²	0.463	0.4692	0.4462	0.5218	0.5359	0.4624

5.2 Estimation Result of Gender Gap in Food Consumption

Scores by Oaxaca decomposition

Table 7 presents the estimation result of the gender gap in Food Consumption Scores by Oaxaca decomposition. According to the results (in Panel C), the gender gap in food consumption scores between MHH and FHH is about five-points, nine points (5.9%) in favor of MHH in CFSVA 2015, which increased from five points (5.01%) in CFSVA 2012. These gender gaps derived from observable endowment effects as well as unobservable coefficient- and the interaction effect, which is shown in Table 7 panel B (aggregate decomposition). The differences in endowment effects explain 150.1% (8.8 percent point) of the gap, and the structural effects (coefficient- and interaction effects) compensated the remaining gap (-50.1%) in CFSVA 2015. The gap in the food consumption score between MHH and FHH in CFSVA 2015 is widened compared to that of CFSVA 2012 due to the enlarged negative endowment effects for the FHH. Panel A shows the detailed decompositions of the gap from the explanatory variables in CFSVA 2012 and 2015. Among the variables, per capita expenditure, marital status of the household head, household size, house head's education level, crisis coping strategies, livestock ownership are considered to be major endowments leading to the gender gap.

Table 7. Estimation of Gender Gap in Food Consumption Score by Oaxaca decomposition (CFSVA 2012, 2015)

	2012			2015		
	Endowment Effect	Coefficient Effect	Interaction Effect	Endowment Effect	Coefficient Effect	Interaction Effect
A. Detailed decomposition						
<i>Household Characteristics</i>						
Household_size	-0.87*** (0.16)	5.12*** (1.18)	-1.33*** (0.31)	-1.61*** (0.18)	-0.95 (1.21)	0.26 (0.34)
Hhead_age	0.263* (0.14)	0.71 (1.12)	0.16 (0.25)	0.27 (0.17)	1.75 (1.33)	0.43 (0.33)
Hhead_edulevel	-0.99*** (0.12)	0.17 (0.80)	-0.04 (0.20)	-1.00*** (0.12)	0.58 (0.94)	-0.15 (0.25)
Hhead_marital_status	-2.03*** (0.65)	0.49 (0.65)	0.90 (1.19)	-2.445*** (0.73)	1.56*** (0.52)	3.44*** (1.15)
agri_income (%)	-0.25 (0.16)	-1.27 (3.06)	-0.08 (0.19)	-0.269*** (0.09)	2.10 (2.50)	0.10 (0.13)
nonagri_income (%)	0.09 (0.24)	-1.20 (1.12)	0.33 (0.31)	0.07 (0.10)	0.15 (0.83)	-0.04 (0.22)
ln_hh_expense_H	-1.95*** (0.21)	- 10.87*** (3.09)	0.39*** (0.12)	-2.42*** (0.26)	-14.62*** (3.37)	0.55*** (0.14)
Food_expenses (%)	0.163*** (0.05)	-0.31 (0.75)	-0.03 (0.07)	0.19*** (0.05)	-2.04** (0.92)	-0.17** (0.08)
<i>Agricultural Activities</i>						
Landsize_H	-0.10 (0.10)	0.35 (0.43)	0.12 (0.14)	0.01 (0.12)	-0.14 (0.36)	-0.07 (0.17)
Livestock (TLU)	-0.54*** (0.07)	0.38 (0.29)	-0.15 (0.12)	-0.65*** (0.08)	0.81*** (0.30)	-0.31*** (0.12)
Vegetbale_garden	-0.05** (0.03)	-0.33 (0.43)	0.03 (0.04)	-0.12*** (0.04)	-1.35*** (0.52)	0.10** (0.05)
Crop_diversity	-0.05* (0.03)	1.34 (0.96)	-0.05 (0.04)	-0.115*** (0.04)	-1.10 (0.79)	0.09 (0.07)
Coop_member	-0.11*** (0.03)	-0.31* (0.17)	0.09* (0.05)	-0.07** (0.03)	0.05 (0.17)	-0.02 (0.05)
<i>Social Institutions & Others</i>						
ln_totalloan	-0.01 (0.04)	0.01 (0.20)	0.00 (0.08)	0.137** (0.06)	0.23 (0.27)	-0.11 (0.13)
VUP_social program	-0.01 (0.01)	0.03 (0.07)	0.01 (0.02)	-0.05 (0.04)	-0.03 (0.11)	-0.01 (0.06)

/continued/

/Table 7 (continued) /

	2012			2015		
	Endowment Effect	Coefficient t Effect	Interaction Effect	Endowment Effect	Coefficient Effect	Interaction Effect
Coping strategies	-0.83*** (0.11)	0.46 (0.29)	0.14 (0.09)	-0.97*** (0.13)	0.24 (0.29)	0.08 (0.09)
Distance_market	0.03 (0.03)	-0.84 (0.96)	0.01 (0.01)	0.04 (0.03)	1.77 (1.30)	-0.02 (0.02)
Weather_shock	-0.19*** (0.06)	0.27* (0.14)	0.16* (0.09)	0.00 (0.01)	-0.06 (0.12)	-0.01 (0.01)
Urban	-0.07 (0.05)	-0.68 (2.48)	0.00 (0.02)	0.03 (0.02)	0.51 (2.50)	0.00 (0.02)
normal_weight	0.01 (0.01)	0.02 (1.09)	0.00 (0.01)	-0.02 (0.03)	-0.48 (0.68)	0.01 (0.01)
District	0.01 (0.01)	3.19*** (0.96)	0.03 (0.04)	0.08** (0.04)	0.13 (1.00)	0.00 (0.03)
_cons		5.02 (6.68)			9.74 (6.49)	
B. Aggregate decomposition						
	-7.41*** (0.72)	1.75 (1.07)	0.65 (1.20)	-8.87*** (0.80)	-1.15 (0.97)	4.10*** (1.14)
C. Mean Gender differential in FCS						
FHH	44.71*** (0.37)			43.33*** (0.42)		
MHH	49.72*** (0.27)			49.24*** (0.29)		
Difference	-5.01*** (0.46)			-5.91*** (0.51)		
Observations	7,370			7,443		

Notes: Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%), MHH=male-headed household, FHH=female-headed household

5.3 Estimation Results of Food Consumption Groups by Ordered Probit

From the results of OLS regression and Oaxaca decomposition, it is difficult to estimate the probability of households belonging to a certain household food security group. We need to use the Food Consumption Group as the indicator of food security status and regress them with the Ordered probit model.

Tables 8 and 9 comprise the coefficients of Ordered probit regression results by CFSVA 2012 and CFSVA 2015 separately. Among 20 variables except for weight and Province, thirteen variables of CFSVA 2012 and eleven variables of CFSVA 2015 responded significantly at 99% or 95% confidence level. The crisis coping strategies, the distance to market, weather shock, and locality(urban) negatively affect the probability of households belonging to a higher food security group in both CFSVA 2012 and 2015, while the gender and the marital status of the household head and weather-shock, living in rural areas in CFSVA 2012 and the share of agricultural income among household expenditure additionally affect negatively in CXFSVA 2015 respectively. The household size, the educational level of household head, monthly per capita expenditure and all variables related to agricultural activities except per capita land size show

positive responses. The variable representing per capita land size shows insignificant value.

The food security group categorized into three sub-group, such as poor, borderline, and acceptable. Therefore, the cut-points for classification are important. The cut-points of CFSVA 2015 between poor and borderline, and borderline and acceptable are 1.09 and 2.26 points for the MHHs and 0.88 and 2.06 for FHHs. These cut-points have increased from those in CFSVA 2012, which was 0.61 and 1.80 points for MHHs and -0.07 and 1.31 points for FHHs, respectively. The increased cut-point may have pushed down the household in border areas between three groups to the lower groups.

In the Ordered Probit model, the coefficients represent only the direction of the effect of the variables, while the marginal effects represent the marginal influence between the dependent variable and explanatory variables. Tables 10 and 11 summarize the marginal effects of the explanatory variables on the probability of sampling households belonging to the food security group of Poor, Borderline, and Acceptable in CFSVA 2012 and 2015.

The predicted probability of FHHs and MHHs belonging to food security groups is 11% vs 7% (Poor), 25% vs 20% (Borderline), and 64% vs 73% (Acceptable) in CFSVA 2015 while they were 4.4% vs 3.5% (Poor), 22% vs 15% (Borderline), and 73% vs 81% (Acceptable) in

Pooled Sample

MHH

FHH

	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Household characteristics						
Household_size	0.040***	0.012	0.019	0.014	0.108***	0.022
Hhead_gender	-0.220***	0.071	0.000	(omitted)	0.000	(omitted)
Hhead_age	0.001	0.001	0.001	0.002	0.003	0.002
Hhead_edulevel	0.037**	0.019	0.035	0.022	0.044	0.038
Hhead_marital status	-0.085***	0.025	-0.100***	0.029	-0.056	0.047
agri_income (%)	-0.002	0.002	0.001	0.003	-0.004	0.002
nonagri_income (%)	-0.002	0.002	0.001	0.003	-0.004	0.002
ln_hh_expense_H	0.392***	0.020	0.410***	0.025	0.370***	0.033
Food_expenses (%)	0.117	0.085	0.204*	0.105	-0.037	0.146
Agricultural Activities						
Landsize_H	0.042	0.044	0.034	0.066	0.091	0.063
Livestock (TLU)	0.156***	0.035	0.181***	0.041	0.065	0.067
Vegetable_garden	0.091***	0.037	0.113**	0.045	0.052	0.065
Crop_diversity	0.060***	0.019	0.053**	0.023	0.063*	0.034
Coop_member	0.273***	0.062	0.266***	0.073	0.333***	0.116
Social Institutions & Others						
ln_totalloan	0.010*	0.006	0.015**	0.006	-0.008	0.011
VUP_social program	0.136	0.083	0.188*	0.106	0.094	0.137
Coping strategies	-0.209***	0.018	-0.202***	0.022	-	0.225***
Distance_market	-0.046***	0.019	-0.034	0.023	-0.065**	0.032
Weather_shock	-0.167***	0.043	-0.236	0.055	-0.022	0.070
Urban	-0.465	0.097	-0.466***	0.121	-	0.492***
normalized_weight	-0.053	0.057	-0.082	0.068	-0.004	0.106
Province						
SOUTH	0.053	0.127	0.036	0.156	0.111	0.217
WEST	-0.451***	0.125	-0.426***	0.152	-0.505**	0.219
NORTH	0.079	0.131	0.119	0.159	0.048	0.232
EAST	0.322***	0.130	0.316**	0.160	0.386*	0.225
/cut 1	0.001	0.338	0.614	0.457	-0.066	0.555
/cut 2	1.246	0.339	1.804	0.457	1.314	0.558
Observations	7,370		5,270		2,100	
Pseudo R ²	0.200		0.201		0.200	

Table 8. Estimation Results of Household Food Security Group by Ordered Probit (CFSVA 2012)

Note: *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%), MHH=male-headed household, FHH=female-headed household

Table 9 Estimation Results of Household Food Security Group by

Ordered Probit (CFSVA 2015)

FCG	Pooled Sample		MHH		FHH	
	Coef.	Robust Std.Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
<i>Household Characteristics</i>						
Household_size	0.058***	0.011	0.058***	0.013	0.061***	0.019
Hhead_gender	-0.056	0.065	(omitted)		(omitted)	
Hhead_age	0.002*	0.001	0.001	0.002	0.006**	0.002
Hhead_edulevel	0.037**	0.017	0.03	0.02	0.061	0.034
Hhead_marital status	-0.025	0.018	-0.068***	0.023	0.038	0.027
agri_income (%)	-0.005***	0.001	-0.006***	0.002	-0.003	0.002
nonagri_income (%)	-0.001	0.001	-0.002	0.002	-0.001	0.002
ln_hh_expense_H	0.384***	0.02	0.405***	0.025	0.354***	0.034
Food_expenses (%)	0.173**	0.079	0.244**	0.1	0.074	0.134
<i>Agricultural activities</i>						
Landsize_H	0.028	0.036	0.044	0.054	0.031	0.05
Livestock (TLU)	0.170***	0.062	0.138**	0.068	0.299***	0.071
Vegetable garden	0.199***	0.035	0.255***	0.042	0.063	0.062
Crop_diversity	0.089***	0.015	0.106***	0.018	0.043	0.027
Coop_member	0.114**	0.057	0.127*	0.067	0.088	0.106
<i>Social Institutions & Others</i>						
ln_totalloan	0.001	0.004	-0.002	0.005	0.008	0.009
VUP_social program	-0.091*	0.051	-0.051	0.067	-0.127	0.082
Coping strategies	-0.264***	0.016	-0.259***	0.019	-0.264***	0.028
Distance_market	-0.057***	0.019	-0.073***	0.023	-0.031	0.035
Weather_shock	-0.05	0.052	-0.044	0.063	-0.054	0.093
Urban	-0.002	0.067	0.016	0.084	-0.074	0.113
normalized_weight	0.080**	0.037	0.097**	0.043	0.05	0.074
Province						
SOUTH	-0.613***	0.115	-0.529***	0.137	-0.803***	0.208
WEST	-1.096***	0.114	-1.011***	0.135	-1.308***	0.207
NORTH	-0.902***	0.117	-0.834***	0.139	-1.069***	0.215
EAST	-0.655***	0.118	-0.611***	0.139	-0.769***	0.214
/cut1	0.924	0.313	1.092	0.392	0.877	0.499
/cut2	2.081	0.315	2.247	0.394	2.056	0.503
Observations	7,443		5,445		1,998	
Pseudo R ²	0.225		0.2315		0.2088	

Note: *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%)
MHH=male-headed household, FHH=female-headed household

The portion of the food secure group in CFSVA 2015 has decreased by

8-9 % compared to CFSVA 2012. In terms of the food secure group, the signs of marginal effects changed considerably according to the food security status of the households.

In Marginal effects, the poor group and borderline group share the same direction of the determinants' influence and change for the acceptable in most cases. These signs indicate that poor groups and borderline groups share the same response toward the determining variables. Among 20 variables, ten variables are significant for MHHs and six variables for FHHs in CFSVA 2012, while five variables for MHHs and ten variables for FHHs are significant in CFSVA 2015. The male-headed households responded with a higher marginal effect in variables of the size of per capita expenditure, livestock ownership, the crisis coping strategies on the probability of belonging to the food security group. Female-headed households showed a higher marginal effect on the share of food expenditure among total expenditure, vegetable garden, crop diversities, cooperative membership in addition to the above three variables. In this sense, the policy programs targeting these areas with higher marginal effects are effective in reducing the gender gap in food security. From the regional aspects, the western province shows a relatively higher marginal effect, and this indicates that the investment in western provinces brings higher returns.

Table 10. Marginal Effect of CFSVA 2012 on Food Security group by

Ordered Probit

_predict	MHH			FHH		
	Poor	Borderlin e	Acceptabl e	Poor	Borderlin e	Acceptabl e
FCG	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
<i>Household characteristics</i>						
Household_size	-0.0012	-0.0029	0.0041	- 0.0079** *	- 0.0194** *	0.0273***
Hhead_age	0.0000	-0.0001	0.0001	-0.0002	-0.0005	0.0007
Hhead_edulevel	-0.0021	-0.0051	0.0072	-0.0033	-0.0080	0.0113
Hhead_marital status	0.0060** *	0.0148** *	- 0.0208***	0.0041	0.0101	-0.0142
agri_income (%)	-0.0001	-0.0001	0.0002	0.0003*	0.0006*	-0.0009*
nonagri_income (%)	-0.0001	-0.0001	0.0002	0.0003*	0.0007*	-0.0010*
ln_hh_expense_H	- 0.0248** *	- 0.0606** *	0.0854***	- 0.0273** *	- 0.0666** *	0.0939***
Food_expenses (%)	-0.0123*	-0.0301*	0.0425*	0.0027	0.0066	-0.0094
<i>Agricultural Activities</i>						
Landsize_H	-0.0021	-0.0050	0.0071	-0.0067	-0.0164	0.0231
Livestock (TLU)	0.0109** *	0.0267** *	0.0376***	-0.0048	-0.0117	0.0165
Vegetable_garden	-0.0068**	-0.0167**	0.0235**	-0.0038	-0.0094	0.0132
Crop_diversity	-0.0032**	-0.0079**	0.0111**	-0.0046*	-0.0113*	0.0160*
Coop_member	0.0160** *	0.0393** *	0.0553***	0.0246** *	0.0599** *	0.0845***
<i>Social Institutions & Others</i>						
ln_totalloan	-0.0009**	-0.0022**	0.0031**	0.0006	0.0014	-0.0020
VUP_social program	-0.0114*	-0.0279*	0.0392*	-0.0069	-0.0169	0.0238
Coping strategies	0.0122** *	0.0299** *	- 0.0421***	0.0166** *	0.0404** *	- 0.0570***
Distance_market	0.0020	0.0050	-0.0070	0.0048**	0.0117**	-0.0164**
Weather_shock	0.0142** *	0.0348** *	- 0.0490***	0.0016	0.0039	-0.0055
Urban	0.0281** *	0.0689** *	- 0.0971***	0.0363** *	0.0886** *	- 0.1249***
normalized_weight	0.0049	0.0121	-0.0170	0.0003	0.0008	-0.0011
Province						
South	-0.0019	-0.0055	0.0074	-0.0069	-0.0216	0.0286
West	0.0328** *	0.0704** *	- 0.1032***	0.0490** *	0.0991** *	-0.1481
North	-0.0061	-0.0180	0.0241	-0.0031	-0.0094	0.0125
East	-0.0140	-0.0450*	0.0590*	-0.0197	-0.0718	0.0915
Predicted Probability	0.0350** *	0.1524** *	0.8126***	0.0441** *	0.2218** *	0.7341***
Observation	5,270			2,100		

Note: *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%)
MHH=male-headed household, FHH=female-headed household

Table 11. Marginal Effect of CFSVA 2015 on Food Security group by Ordered Probit

_predict FCG	MHH			FHH		
	Poor dy/dx	Borderline dy/dx	Acceptable dy/dx	Poor dy/dx	Borderline dy/dx	Acceptable dy/dx
<i>Household characteristics</i>						
Household_size	- 0.0085***	- 0.0085***	0.0170***	- 0.0059***	- 0.0082***	0.0140***
Hhead_age	-0.0008**	-0.0008**	0.0015**	-0.0001	-0.0001	0.0002
Hhead_edulevel	-0.0085*	-0.0085*	0.0171*	-0.003	-0.0042	0.0071
Hhead_marital status	-0.0053	-0.0053	0.0106	0.0068***	0.0094***	- 0.0162***
agri_income (%)	0.0004	0.0004	-0.0008	0.0006***	0.0009***	- 0.0015***
nonagri_income (%)	0.0001	0.0001	-0.0003	0.0002	0.0002	-0.0004
ln_hh_expense_H	- 0.0493***	- 0.0494***	0.0987***	- 0.0406***	- 0.0566***	0.0971***
Food_expense (%)	-0.0103	-0.0104	0.0207	-0.0244**	-0.0340**	0.0585**
<i>Agricultural Activities</i>						
Landsize_H	-0.0043	-0.0043	0.0086	-0.0044	-0.0061	0.0104
Livestock (TLU)	- 0.0416***	- 0.0417***	0.0833***	-0.0138**	-0.0192**	0.0330**
vegetable_garden	-0.0088	-0.0089	0.0177	- 0.0256***	- 0.0357***	0.0612***
Crop_diversity	-0.006	-0.006	0.012	- 0.0106***	- 0.0148***	0.0253***
Coop_member	-0.0122	-0.0122	0.0244	-0.0127*	-0.0177*	0.0305*
<i>Social Institutions & Others</i>						
ln_totalloan	-0.0012	-0.0012	0.0023	0.0002	0.0003	-0.0005
VUP_social program	0.0177	0.0177	-0.0354	0.0051	0.0071	-0.0123
Coping strategies	0.0369***	0.0369***	- 0.0738***	0.0259***	0.0361***	- 0.0620***
Distace_market	0.0044	0.0044	-0.0087	0.0073***	0.0102***	- 0.0175***
Weather_shock	0.0075	0.0075	-0.015	0.0044	0.0062	-0.0106
Urban	0.0103	0.0103	-0.0206	-0.0016		0.0038
normalized_weight	-0.007	-0.007	0.0139	-0.0097**	-0.0136**	0.0233**
Province						
South	0.0604***	0.1261***	- 0.1864***	0.0299***	0.0703***	- 0.1002***
West	0.1389***	0.2009***	- 0.3399***	0.0807***	0.1423***	- 0.2230***
North	0.0970***	0.1682***	- 0.2652***	0.0588***	0.1159***	- 0.1748***
East	0.0564***	0.1206***	- 0.1770***	0.0367***	0.0824***	- 0.1191***
Predicted Probability	0.0709***	0.1960***	0.7330***	0.1062***	0.2541***	0.6397***
Obsevation	5,445			1,998		

Note: *** p < 0.01, ** p < 0.05, * p < 0.1 (significance level at 1%, 5%, 10%)

6. Discussion and Conclusion

This study sets out to explore what factors in the gender gap and how they influence the house food security of the rural farmers in Rwanda as a case study of developing countries. By analyzing descriptive statistics and Ordinary Least Squares regression of the sampling data, the study finds that the household food security status and the gender gap in food security between male-headed households and female-headed households are in broader terms consistent with current literature which revealed that female-headed households are more food insecure than male-headed families. Most of the determining factors on food security mentioned in the chapter 2 literature review, such as household size, education level of house head, household expenditure level, ownership of livestock, vegetable garden, cooperative membership, and crisis coping strategies, are significant in the regression. Interestingly, the land size per capita of the household representing ownership of land does not show any significant values in all regressions of OLS, Oaxaca decomposition, and the Ordered probit. It could be interpreted that the land size is too small to influence household food security in Rwanda. Due to limited land space, the mean size of the land owned by the farming household is less than 0.3 ha. Though the male-headed households own bigger land size, owning

to small household size, the female-headed household has more land in terms of per capita land size. During the two survey periods of 2012 and 2015, the gap of per capita land size between MHH and FHH has increased in favor of FHH. Further investigations are needed for clarification. However, the land tenure reform of the Rwandan government might have influenced the gender equality of land ownership

Concerning the gender gap in food security, the results of Oaxaca decomposition indicate that there exist about 5.1 (CFSVA 2012) to 5.9 (CFSVA 2015) points gap in the food consumption score in favor of MHH. This gap consists of the endowment effect (-7.4 points in 2012 and -8.9 points in 2015) in favor of MHH and is modified by the structural effect of coefficients and interactions. The marital status of the house head and per capita expenditure play significant roles in the endowment effect as well as in structural effect. Household size also influences considerably in the endowment effect.

Though Oaxaca decomposition provides a useful explanation for the structural cause of the gender gap in food security, it does not estimate the probability of households belonging to a certain food security status. The descriptive statistics of food consumption scores show that the food consumption score of MHH and FHH show about a 5.3 % gap in favor of MHH. The three food consumption groups divided by the food

consumption score represent the food security status of the household. In order to compare with other cases, the study divides the three food security statuses of poor, borderline, and acceptable into two categories of food-secure and food-insecure by combining the poor and borderline into food insecure. According to CFSVA 2015, the mean probability of male-headed households belonging to a food-insecure group is 26.9%, while the probability of female-headed households is about 36%, which has been deteriorated by about 8-10% from 19% probability of MHHs and 26% probability of FHHs in 2012 respectively.

However, the study demonstrates that the gender gap in food security is more serious in the remote and poor districts. The mean probability of households belonging to the food secure group in most districts of the western province is less than 50%, in contrast to the household in the districts of Kigali, where more than 90% of the household are food secure.

In spite of the serious gender gap of food security in remote and poor areas, the study finds some positive signs in improving food security and reducing the gender gap in Rwanda. Beside per capita land size, gaps in non-agricultural income, vegetable garden, and cooperative membership have reduced during the two surveying periods, and will bring considerable returns to the household food security in the coming days.

Concerning the background for the retreated result of the food consumption score in CFSVA 2015 compared to CFSVA 2012, besides the explanation of the National Institute of Statistics for the seasonality of the crop price, the study could not specify any other factors affecting the deterioration of the household food security. However, the Rwanda government and private sector continue to make efforts to mitigate the seasonality of food security issues by expanding crop storages and market facilities.

The study also finds that there is a nonnegligible gap between the food security status estimated by the food consumption score and the experience of food shortage by the respondents. According to the survey results by the food consumption score, almost 80 % of the sampling household is food secure, while more than 40 % of the respondents reported their difficulties in securing food last 12 months. This finding is consistent with the research result of Lovon and Mathiassen about problems of the thresholds of Food Consumption Scores (2014). In this sense, to assess the status of food security properly, the food consumption score also needs some other complementary indicators.

Food security is a multi-dimensional issue, and gender issues are also a cross-cutting factor influencing in various areas than influencing as an independent determinant. Bearing this in mind, more efforts on

women's empowerment in agriculture and food security are imperative in enhancing food security in the sub-Saharan Africa regions facing climate change.

In short-term mitigating measures to enhance household food security and closing the gender gap in food security, it is necessary to diversify and broaden the income-generating base even in rural areas. Bee-keeping, horticulture, mushroom raising, small animal raising would enhance the food security and poverty reduction in the rural area along with crop intensification program. As long term measures, the land tenure consolidation program and high enrollment of female students at the secondary schools will get proper returns in the household food security in the coming year. In particular, Kitchen gardening, small animal rearing are useful tools for FHHs to improve their food security. Considering that significant portions of the FHHs are aged and the poorest social group, proper social protection needs to be extended to them.

The limitation of this study is that only a national level of secondary data was used to delve into a specific aspect of food security. In the case of food security research, a specified study about vulnerable groups and regions may be further recommended. Some other literature mentioned that due to the outmigration of the male searching for jobs in the cities, there is a huge number of de facto female house heads in

the rural areas in sub-Saharan Africa. When this fact is not into account, there might be a serious gap between the result of the study and the actual situation. However, due to a shortage of data, the study was not able to include any information about de facto female house heads.

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Appendix:

Food Security Status of Households in Districts by Gender (CFSVA 2015)

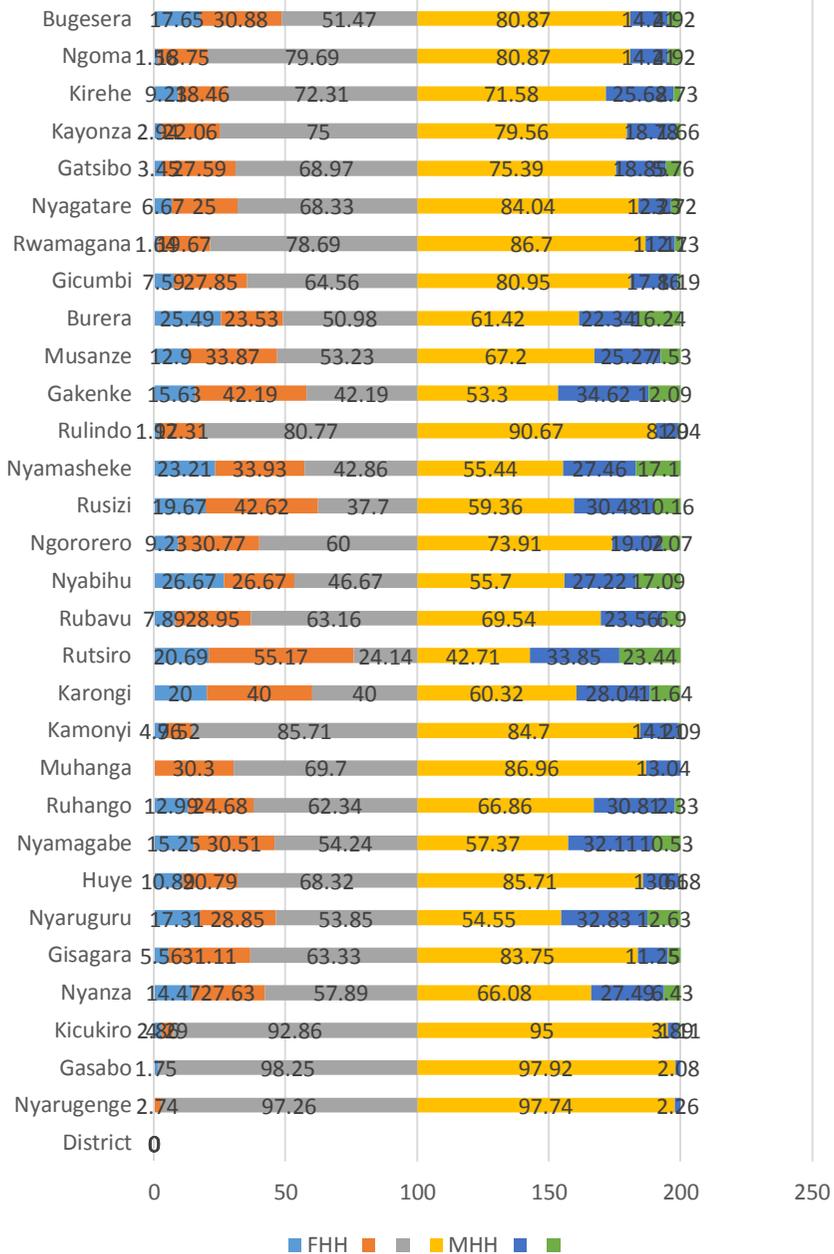
2015 Province	District	FHH			MHH		
		Accept Able(%)	Border Line(%)	Poor (%)	Accept Able(%)	Border Line(%)	Poor (%)
Kigali	Nyarugenge	97.3	2.7		97.7	2.3	
	Gasabo	98.3		1.8	97.9	2.1	
	Kicukiro	92.9	4.3	2.9	95.0	3.9	1.1
South	Nyanza	57.9	27.6	14.5	66.1	27.5	6.4
	Gisagara	63.3	31.1	5.6	83.8	11.3	5.0
	Nyaruguru	53.9	28.9	17.3	54.6	32.8	12.6
	Huye	68.3	20.8	10.9	85.7	13.6	0.7
	Nyamagabe	54.2	30.5	15.3	57.4	32.1	10.5
	Ruhango	62.3	24.7	13.0	66.9	30.8	2.3
	Muhanga	69.7	30.3		87.0	13.0	
West	Kamonyi	85.7	9.5	4.8	84.7	14.2	1.1
	Karongi	40.0	40.0	20.0	60.3	28.0	11.6
	Rutsiro	24.1	55.2	20.7	42.7	33.9	23.4
	Rubavu	63.2	29.0	7.9	69.5	23.6	6.9
	Nyabihu	46.7	26.7	26.7	55.7	27.2	17.1
	Ngororero	60.0	30.8	9.2	73.9	19.0	7.1
	Rusizi	37.7	42.6	19.7	59.4	30.5	10.2
North	Nyamasheke	42.9	33.9	23.2	55.4	27.5	17.1
	Rulindo	80.8	17.3	1.9	90.7	8.3	1.0
	Gakenke	42.2	42.2	15.6	53.3	34.6	12.1

	Musanze	53.2	33.9	12.9	67.2	25.3	7.5
	Burera	51.0	23.5	25.5	61.4	22.3	16.2
	Gicumbi	64.6	27.9	7.6	81.0	17.9	1.2
East	Rwamagana	78.7	19.7	1.6	86.7	11.2	2.1
	Nyagatare	68.3	25.0	6.7	84.0	12.2	3.7
	Gatsibo	69.0	27.6	3.5	75.4	18.9	5.8
	Kayonza	75.0	22.1	2.9	79.6	18.8	1.7
	Kirehe	72.3	18.5	9.2	71.6	25.7	2.7
	Ngoma	79.7	18.8	1.6	80.9	14.2	4.9
	Bugesera	51.5	30.9	17.7	80.9	14.2	4.9

Note: MHH= Male-headed Household, FHH=Female-headed household

Food Security Status of Households in Districts by Gender (CFSVA 2015)

Household Food Security Status by District in CFSVA 2015



Abstract (Korean)

국문 초록

르완다 사례를 통해 본 가구주의 성별 차이가 개발도상국 가구의 식량안보에 미치는 영향에 대한 분석

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식량안보 부문에서 성별 격차에 대한 문제가 유엔 지속가능개발 목표를 달성하려는 국제사회의 높은 관심을 모으고 있다. 농업과 식량안보 부문에서 젠더(gender) 간의 격차를 줄이는 것 없이는 기아로부터의 해방(Zero Hunger)이라는 목표달성이 어려울 것으로 보이기 때문이다.

본 연구는 르완다 가구의 사례분석을 통해 개발도상국내 가구주의 성별 차이가 가구의 식량안보에 어떻게 영향을 미치는지를 분석하는 데 그 목적이 있다. 본 연구를 위해 르완다 통계청에서 2012년 및 2015년에 수집한 Comprehensive Food Security and Vulnerability Analysis(CFSVA) 2012 와 동 2015를 활용하였으며 가구 식량 안보 측정을 위한 지수로 World Food Program이 개발한 식품소비지수 Food Consumption Scores(FCS)를 사용하였다. 분석 모형으로 식량안보에서 성별 차이에 따른 구조적 격차를 파악하기 위해 Blinder-Oaxaca decomposition method와 Ordered Probit 모형을 활용하였다.

분석 결과 CFSVA 2015 조사에서 여성 가구주의 식품 소비 지수는 남성 가구주에 비해 약 5.3% 정도 낮은 것으로

나타났으며 이는 2012년 조사시 보다 약간 후퇴하였다. 2015년 조사 당시 식량 안보를 확보한 그룹(식품 소비 지수 상 acceptable 그룹)에 속할 가능성은 남성이 가구주인 경우 73%, 여성이 가구주인 경우에는 64%로 나타났는데 2012년 조사 당시보다 후퇴하였다. 가구의 식량안보에 미친 요인으로는 가구의 생활비 수준, 소득활동 및 가구주의 교육수준, 농업활동 등이 식량안보에 긍정적인 요소로 작용하였으며 가구주의 결혼관계, 위기 극복방법 등이 식량안보를 제약하는 요소로 나타났다.

본 연구에서 식량안보 부문에서 가구주의 성별 차이외에도 르완다 내 도시와 농촌간 그리고 지역간 상당한 격차가 있음을 발견하였다. 식량안보 부문에서 성별 차이를 좁히기 위해서는 여성들의 비농업 활동 활성화, 키친 가든(Kitchen garden), 소규모 동물 사육 등과 같이 해당 활동의 한계효과(Marginal effect)가 높은 분야를 중심으로 개발하는 것이 바람직 하다.

주요 개념: 가구 식량 안보, 식품 소비 지수(Food Consumption Scores), 식량 안보에서의 성별 격차(Gender Gap in Food Security), Blinder-Oaxaca decomposition, Ordered Probit, 르완다

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