

**EFFECT OF WOMEN EMPOWERMENT IN AGRICULTURE ON FARM  
COMMERCIALIZATION AND HOUSEHOLD DIETARY DIVERSITY IN RWANDA**

**OLIVE UWINEZA**

**A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirements  
for the Master of Science Degree in Agribusiness Management of Egerton University**

**EGERTON UNIVERSITY**

**AUGUST, 2021**

## DECLARATION AND RECOMMENDATION

### Declaration

This thesis is my original work and has not been presented in any university or institution of higher learning for any award.

Signature:



Date: 24<sup>th</sup> August 2021

Olive Uwineza

KM19/12085/17

### Recommendation

This thesis has been submitted with our approval as the university supervisors.

Signature:



Date: 30<sup>th</sup> August 2021

Prof. Job Kibiwot. Lagat, PhD

Department of Agricultural Economics and Agribusiness Management,

Faculty of Agriculture, Egerton University.

Signature ..



Date: 1<sup>st</sup> September 2021

Dr Risper Berem, PhD

Department of Economics,

Faculty of Arts and Social Sciences, Egerton University.

## **COPYRIGHT**

© 2021 Olive UWINEZA

All Rights Reserved. No part of this thesis may be reproduced, stored in a retrieval system or transmitted in any form or means photocopying, scanning, recording or otherwise, without the permission of the author or Egerton University

## **DEDICATION**

This research work is dedicated to my family and friends.

## **ACKNOWLEDGEMENTS**

Above all, praise and glory to the Almighty God for his everlasting love and blessings towards me.

I would like to thank Egerton University for offering me the opportunity to pursue the program of Agribusiness management (AGBM). I am also grateful to CESAAM which has sponsored my studies. Furthermore, my sincere gratitude goes to the international center for tropical agriculture (CIAT Rwanda) through FATE project for their technical and financial support during data collection.

I also give my special appreciation to my supervisors, Professor Job Kibiwot. Lagat, PhD and Dr Risper Berem, PhD for their quality guidance and commitment to make this research idea concrete today. My special appreciations also go to Dr. Eliud Abucheri Birachi, Dr. Ingabire Chantal and Musafil Ildephose for their technical support.

I would like to express my gratitude to all staff members of the Department of Agricultural Economics and Agribusiness Management of Egerton University for their support throughout my studies.

I am also thankful to my husband Ntegerejimana Adrien for his financial and moral support. my father Rwabukamba Juvenal, my mother Uwimana Pelagie, my brother Bizimana Bernard and my sisters; Solange Munezero, Denyse Manishimwe and Adeline Iradukunda for their advice, prayers and moral support during entire period of my study. My sincere gratitude also goes to my friends Alice Mukamugema and Kubwimana Jean Jacques for assisting me technically in data analysis of this work.

## ABSTRACT

In Sub Saharan Africa, agricultural commercialization is a major factor in household food diversification and household income. Toward agricultural transformation, Rwanda has focused in shifting from subsistence based farming to market oriented agriculture through different farming systems, crop intensification production system, promotion of farmers' cooperatives, and enhancement of farmers' access to markets. Various studies have been conducted on agricultural commercialization, however women's role in commercialization of agriculture has received little attention and none of the studies have associated it with women's empowerment in agriculture. Yet in Rwanda, women are principal players in agriculture and food security. Rwanda aims to achieve commercialized agriculture. Therefore, it is important to understand the influence of women empowerment in agriculture on its commercialization and household dietary diversity. To achieve this study, a sample size of 252 households from Musanze and Burera districts in Northern Province of Rwanda was used. It was obtained using multistage and random sampling techniques. The study intended to contribute toward agribusiness development through agricultural commercialization and rural women empowerment in agriculture in Rwanda. It was guided by specific objectives which are: to determine the level of women empowerment in agriculture in Northern Province of Rwanda; to determine the effect of women empowerment in agriculture on farm commercialization, and to assess the effect of women empowerment in agriculture on dietary diversity. To analyze data, fractional regression model and instrumental variables for count data model was used. To measure women empowerment, women empowerment in agriculture index (WEAI) was used. Data was processed using, Ms Excel and STATA15. The results revealed that women empowerment in agriculture index in Northern Province of Rwanda are 84.2%. The five domain of empowerment (5DE) index is 83% and Gender parity index is 95%. Farm commercialization in Northern Province of Rwanda was positively and significantly influenced by WEAI score, farm size and prices of maize, potatoes and beans. On the other hand, the index has a negative relationship with access to extension services. Household dietary diversity was positively and statistically significant with women empowerment score, female control of the use of income and total farm size of the household. It was negatively and statistically significant with female workload, household size and gender parity. Referring to findings from this study. The government should strengthen policies of empowering women in agriculture. They should also consider using it as a tool to develop other agricultural aspect.

## TABLE OF CONTENT

<b>DECLARATION AND RECOMMENDATION .....</b>	<b>ii</b>
<b>COPYRIGHT .....</b>	<b>iii</b>
<b>DEDICATION.....</b>	<b>iv</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>v</b>
<b>ABSTRACT.....</b>	<b>vi</b>
<b>LIST OF TABLES .....</b>	<b>x</b>
<b>LIST OF FIGURES .....</b>	<b>xi</b>
<b>LIST OF ABBREVIATIONS AND ACRONYMS.....</b>	<b>xiii</b>
<b>CHAPTER ONE .....</b>	<b>1</b>
<b>INTRODUCTION.....</b>	<b>1</b>
1.1 Background of the study .....	1
1.2 Statement of the problem .....	3
1.3 Objectives .....	4
1.3.1 General objective .....	4
1.3.2 Specific objectives .....	4
1.5 Justification of the study .....	4
1.6 Scope and limitation .....	5
<b>CHAPTER TWO .....</b>	<b>7</b>
<b>LITERATURE REVIEW .....</b>	<b>7</b>
2.1 Women in agriculture .....	7
2.2 Women empowerment .....	8
2.2.1 Women empowerment in agriculture.....	8
2.2.2 Measuring women empowerment in agriculture .....	9
2.2.3 Women empowerment and Gender Parity .....	15
2.3 Agricultural commercialization .....	16
2.3.1 Gender and agricultural commercialization.....	17
2.3.2 Measuring agricultural commercialization .....	19
2.3.3 Women empowerment in agriculture (WEAI) and agricultural commercialization.....	20
2.4 Food security.....	20
2.4.1 Women empowerment in agriculture and Food security .....	21

2.4.2 Household Dietary Diversity .....	22
2.4 Empirical studies.....	25
2.5 Theoretical framework.....	27
2.5.1 Kabeer’s women’s empowerment framework .....	27
<b>CHAPTER THREE .....</b>	<b>30</b>
<b>METHODOLOGY .....</b>	<b>30</b>
3.1 Study area.....	30
3.2 Research design .....	31
3.3 Sampling procedure and sample size .....	31
3.4 Method of data collection .....	32
3.5 Data analysis .....	32
3.5.1 Analytical framework .....	32
<b>CHAPTER FOUR.....</b>	<b>38</b>
<b>RESULTS AND DISCUSSION .....</b>	<b>38</b>
4.1 Level of women empowerment in agriculture in Northern Province of Rwanda.....	39
4.1.1 Contribution of each indicator to disempowerment of women and men.....	40
4.2 Effect of women empowerment in agriculture on household commercialization .....	44
4.2.2 Description of continuous variables affecting household commercialization ..	47
4.2.3 Econometric results of effect of women empowerment in agriculture on household dietary diversity in Northern Province of Rwanda.....	48
4.3 Effect of women empowerment in agriculture on household dietary diversity in northern province of Rwanda.....	51
4.3.2 Household dietary diversity .....	51
<b>CHAPTER FIVE .....</b>	<b>55</b>
<b>CONCLUSIONS AND RECOMMENDATIONS.....</b>	<b>55</b>
5.1.1 Summary .....	55
5.1.2 Conclusions.....	56
5.2 Recommendations.....	57
5.2.1 Areas for further research .....	57
<b>REFERENCES.....</b>	<b>57</b>

APPENDIX A: Questionnaire .....	71
APPENDIX B: Results of fractional regression model .....	87
APPENDIX C: Results of instrumental variable poisson regression model for count data ..	88
APPENDIX D: Research permit.....	90
APPENDIX E: Abstract of published paper .....	91

## LIST OF TABLES

Table 1: Domains and indicators of women empowerment in agriculture index (5DE).....	10
Table 2: Sample size distribution in Burera and Musanze districts.....	32
Table 3: Model, Variables, Measurement and Expected variables.....	37
Table 4: WEAI in the Northern province of Rwanda.....	39
Table 5: Farmer grouping by commercialization index.....	44
Table 6: Descriptive statistics of continuous variables affecting household farm commercialization in Northern Province of Rwanda.....	47
Table 7: The link test result .....	48
Table 8: Econometric results of effect of women empowerment in agriculture on household farm commercialization in Northern Province of Rwanda.....	49
Table 9: Econometric results of effect women empowerment in agriculture on household dietary diversity in northern Rwanda.....	52

## LIST OF FIGURES

Figure 1: conceptual framework .....	29
Figure 2: Map of Rwanda .....	31
Figure 3: contribution of each indicator to disempowerment .....	41
Figure 4: Contribution of each of domains to empowerment of women .....	43
Figure 5: Size of the households .....	45
Figure 6: Empowerment score .....	46
Figure 7: Gender .....	46

## **LIST OF ABBREVIATIONS AND ACRONYMS**

<b>CAADP</b>	Comprehensive Africa Agriculture Development Program
<b>DE</b>	Domains of Empowerment
<b>DIM</b>	Dietary Intake Method
<b>FANTA</b>	Food and Nutrition Technical Assistance.
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>FATE</b>	Feminization Agricultural Transition and Employment
<b>FIEMS</b>	Food Insecurity Experience-based Measurement Scales
<b>GMO</b>	Gender Monitoring Office
<b>GPI</b>	Gender Parity Index
<b>HCI</b>	Household Commercialization Index
<b>HDDS</b>	Household Dietary Diverse Score
<b>MDGs</b>	Millennium Development Goals
<b>NISR</b>	National Institute of Statistics of Rwanda
<b>SPSS</b>	Statistical Package for Social Sciences
<b>WEAI</b>	Women in Agriculture Index

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background of the study**

Agriculture is the backbone of rural Africa's economy (World Bank, 2007). The transition from subsistence (or semi-subsistence) to commercialization of agriculture is important for low-income countries' development. It is one of the major ways to economic growth and welfare improvement at the national level. Furthermore, it is expected to raise household income, improve consumption, food security and nutritional outcomes inside rural households (Carletto, 2017). Agricultural commercialization is the transformation process in which farmers shift from mainly consumption-oriented (subsistence production) towards market and profit oriented agricultural production systems through progressive substitution of subsistence with commercial practices (Pingali *et al.*, 2005). In Rwanda the effort to move toward commercialization of agriculture, there has been an emphasis on various areas of the agriculture sector such as intensification agricultural production systems, promotion of farmers' cooperatives, and enhancement of farmers' access to market over the last fifteen years (Ingabire *et al.*, 2017). The sector has made some good achievement from the transformation plan. For instance, the increase of farmers' cooperative has facilitated access to inputs and outputs markets, the improved crop productivity particularly for beans and potatoes as well as agricultural income and commercialization of some staple crops (Verhofstadt & Maertens, 2015).

Despite gender mainstreaming efforts of Rwanda, the farming system remains subsistence oriented, and findings showed that women are more engaged in food crop production rather than cash crop production (Ingabire *et al.*, 2017; MINECOFIN, 2013). In addition, it has been observed that there is gender competition between more commercialized crops and food crops. Women are traditionally considered to be engaged in food crop production. Hence, the reason that keeps them in subsistence agriculture and persistence of this system (MINAGRI, 2010). Furthermore, empirical evidences from studies conducted in Northern Province of the country have revealed that women were more engaged in beans transactions than men, while men highly participated in transactions of potatoes. In Northern Province, potatoes are more commercialized than beans (Ingabire, 2017). Men tend to take control of crops when an opportunity for their commercialization emerges (Fischer & Qaim, 2012; Quisumbing & Pandolfelli, 2010). Moreover, gender bias remains an issue in agriculture sector, both in terms of quantities of assets, agricultural inputs and resources that women control (Sraboni, 2014).

Therefore, women's ability to generate income in agriculture sector is severely constrained. They have limited access to natural and physical capital and limited decision making to the use of agricultural income as compared to men. This gender gap is often rooted from social norms specific to certain geographic area and culture (Gupta, 2017).

Women's empowerment in agriculture reflects the ability of women to access, control and utilize productive resources such as land, livestock, labour, education, extension and financial services, and technology (Quisumbing *et al.*, 2013). It is a great emphasis to government, non-governmental organizations and development agencies in the design of effective food security strategies (Sharaunga *et al.*, 2015). In the African continent, countries in West Africa have the lowest WEAI scores, followed by southern Africa, and then East Africa, with the highest scores. The countries are ranked according to their WEAI scores and divided into low, middle, and high groups. High score ranges (WEAI = 0.85 or higher); medium score (WEAI = 0.73–0.84) low score (WEAI = 0.72 or lower). For instance, in Eastern Africa, Rwanda has 0.9, Ghana (0.71) in West Africa and in South Africa and Malawi has 0.84.

Across the majority of countries and regions, the greatest constraints of empowerment among women in agriculture are a lack of access to credit and the power to make credit-related decisions, excessive workloads, and a low prevalence of group membership. Comparing to men's and women's empowerment scores across countries, on average women are twice as disempowered as men. Women are almost twice as disempowered as men in their ability to access and make decisions regarding credit, and over one and a half times as disempowered with respect to workload and group membership. In East Africa women empowerment in agriculture is more severe constrained on access to and decisions on credit and workload. In Rwanda women are more disempowered than men. The greatest gap between men's and women's disempowerment are workload, speaking in public, and control over use of income (Malapit *et al.*, 2014).

Women's Empowerment in Agriculture Index (WEAI) was designed to measure the empowerment, agency, and inclusion of women in the agricultural sector. WEAI is also used more generally to assess the state of empowerment and gender parity in agriculture, to identify key areas in which empowerment needs to be strengthened, and to track progress over time. It is comprised of two sub-indices. The first sub index assesses the degree to which women are empowered in five domains of empowerment (5DE) of WEAI. It shows the percentage of

women who are empowered among those who are not, and the percentage of domains in which women have adequate achievements (Alkire *et al.*, 2013).

The five domains are production, resources, income, leadership and time. The domains of production are concerned with decisions about agricultural production, resources refer to ownership of, access to, and decision-making power about productive resources such as land, livestock, agricultural equipment, consumer durables, and credit. The domain of income involves sole or joint control over the use of income and expenditures between males and females. Leadership deals with leadership participation in the community, measured by membership in economic or social groups and comfort speaking in public. Time refers to the allocation of time into productive and domestic tasks and satisfaction with the time available for leisure activities. The second sub index is the Gender Parity Index (GPI). It reflects the percentage of women who are empowered or whose achievements are at least as high as men in their households (Alkire *et al.*, 2013).

Despite less consideration women receive, they are the principal actors in food security (Quisumbing *et al.*, 2015). Increasing women's control over the use of assets and allocation of income has a positive relationship. It is more likely that if women have decision power on the use of household's income great portion of budget will be allocated to food (Alkire *et al.*, 2013).

The research conducted in India revealed that there is a positive relationship between women's empowerment and market oriented farming. (Gupta, 2017). However, the study has not shown that whether empowered women have higher commercialization. Therefore, there is necessity to understand if women empowerment in agriculture can influence agricultural commercialization and food access in Rwanda.

## **1.2 Statement of the problem**

Women make great contribution in agriculture and household dietary diversity in Rwanda. However, the level of empowerment of women in agriculture varies at different degrees across the five domains (5DE) of WEAI. Some women are not yet empowered while others have good achievement in a number of the domains. Given this situation, it has not been clearly evaluated whether the women who have been empowered in agriculture through the 5DE have commercialized their agriculture through development of agribusinesses and consequently improving household dietary diversity. The study filled up these knowledge gap by showing

the domains of women empowerment in agriculture under which if women have adequate achievement have influenced them to participate in agribusiness through farm commercialization and furthermore, it has shown how women's empowerment in agriculture is related to household dietary diversification in Rwanda.

### **1.3 Objectives**

#### **1.3.1 General objective**

This study aims to contribute toward agribusiness development through agricultural commercialization and household nutrition in Northern Province of Rwanda.

#### **1.3.2 Specific objectives**

- i. To determine the level of women's empowerment in agriculture in Northern province of Rwanda
- ii. To determine the effect of women's empowerment in agriculture on farm commercialization in Northern province of Rwanda.
- iii. To assess the effect of women's empowerment in agriculture on household dietary diversity in Northern Province of Rwanda.

### **1.4 Research questions**

- i. What is the level of women's empowerment in agriculture in Northern Province of Rwanda?
- ii. How women's empowerment in agriculture affect household farm commercialization in Northern Province of Rwanda?
- iii. How women's empowerment in agriculture affect household dietary diversity in Northern Province of Rwanda?

### **1.5 Justification of the study**

Gender equality, women's empowerment and food security are important pillars of sustainable development goals (Quisumbing *et al.*, 2015). Many studies have been done on women empowerment in agriculture and agricultural commercialization. However, linking women's empowerment in agriculture with commercialization has been given little attention. Therefore, understanding the influence of women's empowerment in agriculture on farm commercialization was an additional input to the literature.

Determining the level of women's empowerment in agriculture informed policy makers and researchers in Rwanda the areas that need more focus to enhance capability of women who are not empowered in agriculture considering WEAI's domains. Since, Farm commercialization is the key toward agricultural transformation in Rwanda. Knowing the effect that women empowerment in agriculture may have on commercialization enabled policy makers and the government to use women empowerment in agriculture as a tool in the development of policies and strategies toward agricultural commercialization. Furthermore, as women are the principal actors to food access, understanding the linkage between women empowerment in agriculture and household dietary diversity was an additional input for the development of food security policies by taking into consideration of the identified role of women in agriculture. Outcomes from the study contributed to the improved farm commercialization, food access and improved livelihoods through women empowerment in agriculture.

#### **1.6 Scope and limitation**

The study carried out in sampled households from two districts which are Musanze and Burera in the Northern Province of Rwanda. The data collected was limited to cross sectional data. It was also taken into consideration only households which have both primary female and male. In addition, the study was limited to smallholder farmers who grow potatoes, beans and maize.

## 1.7 Definition of terms

**Agricultural commercialization** is the process of shifting from consumption oriented to market oriented farming system.

**Commercialization:** is the process of bringing new products or services to market.

**Dietary diversity:** refers to the diversification of household food consumption considering twelve different food groups

**Empowerment:** It is a process that fosters power in people for use in their own lives, their communities and in their society, by acting on issues they define as important.

**Food security:** is the condition in which all people at all-time 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.

**Gender equality:** is when women and men enjoy the same rights and opportunities across all sectors of society.

**Women empowerment:** is the ability to make decisions and have control over their incomes and their families' incomes.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Women in agriculture

Agriculture is the key to food security as a source of food, nutrients, source of income and directly dictates the price of food (Arimond *et al.*, 2010). Women play important roles in agriculture as food producers, natural resources managers, income earners, and caretakers of household food and nutrition security (Quisumbing & Minzen-Dick, 2001). They make essential contributions to the agricultural and rural economies in all developing countries. Their roles vary considerably between and within regions and are changing rapidly in many parts of the world, where economic and social forces are transforming the agricultural sector. Rural women often manage complex households and pursue multiple livelihood strategies. Their activities typically include producing agricultural crops, tending animals, processing and preparing food, working for wages in agricultural or other rural enterprises, collecting fuel and water, engaging in trade and marketing, caring for family members and maintaining their homes. Many of these activities are not defined as economically active employment in national accounts but they are essential to the wellbeing of rural households (Doss *et al.*, 2011).

As seen above, women play a significant role in the agricultural labour force and in agricultural activities. They contribute 40 percent as agricultural labor force and 50 percent in world's production (FAO, 2011). They contribute to a varying degree. Consequently, their contribution to agricultural output is undoubtedly extremely significant, although difficult to quantify with any accuracy. It has often been claimed that women produce 60-80 percent of food. However, assigning contributions to agricultural outputs by gender is problematic because in most agricultural households both men and women are involved in crop production. It can be attempted to allocate output by gender by assuming that specific crops are grown by women and others by men and then aggregating the value of women's and men's crops to determine the share grown by women. Researchers have occasionally used this approach especially in West Africa, where there are distinguishable cropping patterns by gender (Duflo & Udry, 2001 ; Hoddinott & Haddad, 1995). Yet, a careful analysis of agriculture in Ghana finds that while there are gendered patterns of cropping, the distinctions between men's and women's crops do not hold up well enough to use them to make inferences about men's and women's relative contribution to production. In addition, gendered patterns of cropping may change over time (Doss, 2002).

Despite great improvements in building women's capabilities, gender bias still exists in agricultural sector. While some women have great achievement in agriculture, others still have limited access to utilization of resources and input, and they have limited decision making to the use of agricultural income as compared to men and sometimes their participation is not recognized (Gupta, 2017).

## **2.2 Women empowerment**

Women empowerment, most often referring to women's ability in decisions making and have control over their incomes and their families' incomes (Malhotra, 2002). Although various empirical evidences demonstrated that women's empowerment is a rationale in economic development of countries, the nature and the extent of gender inequality differ across countries. The condition necessary to ensure women's empowerment also vary with countries, regions and communities. Women in Southeast Asia are relatively empowered when they have higher decision making and control over their earnings compared to other developing regions (Akter *et al.*, 2017).

Gender inequity is a multidimensional concept and dimensions may vary across and within the community. Women may have the power of making decision over production and use of inputs and may be disempowered in asset's ownership, income control or in community leadership (Alkire *et al.*, 2013). In the context of Rwanda women are empowered considering to the dimensions of land ownership and leadership, because they have equal right of ownership on land as men and they significantly participate in leadership activities. However, some women in agriculture are still facing problems due to limited power of making decisions over the use of agricultural resources such as land and limited income control (Shirley, 2014).

It is important to capture cross cultural variation in gender specific needs and constraints in the study of women empowerment in different context because empowerment is a multidimensional, diversify and has complex gender system (Akte *et al.*, 2017).

### **2.2.1 Women empowerment in agriculture**

The Women's Empowerment in Agriculture Index (WEAI) is a new survey based index designed to measure the empowerment, agency, and inclusion of women in the agricultural sector. The WEAI was initially developed by the United States Government's Feed the Future Initiative, which commissioned the development of the WEAI. The WEAI can also be used

more generally to assess the state of empowerment and gender parity in agriculture, to identify key areas in which empowerment needs to be strengthened, and to track progress over time. The WEAI is an aggregate index, reported at the country or regional level, based on individual-level data collected by interviewing men and women within the same households. The WEAI comprises two sub-indices. The first assesses the degree to which women are empowered in five domains of empowerment (5DE) in agriculture. It reflects the percentage of women who are empowered and, among those who are not, the percentage of domains in which women enjoy adequate achievements. These domains are (1) decisions about agricultural production, (2) access to and decision-making power about productive resources, (3) control of use of income, (4) leadership in the community, and (5) time allocation. The second sub index (the Gender Parity Index [GPI]) measures gender parity. The GPI reflects the percentage of women who are empowered or whose achievements are at least as high as the men in their households (Alkire, 2013).

The rationale of paying attention to gender inequality in agriculture comes from studies which showed how much women play great roles in agricultural production, food security and household nutrition security (Quisumbing *et al.*, 2001). Empowering women and reducing gender inequalities are two key objectives of development policy. They are not only goals of MDGs (Millennium Development Goals) in themselves but have been shown to contribute to improving productivity and increasing efficiency (Quisumbing *et al.*, 2013). Women empowerment through increase of access and control over productive resources, can not only increase their productivity but it also increases their self-esteem. Empowered women in making decisions regarding what to plant and what input and quantity to apply on their plots, empirical evidences have shown makes them to be more productive in the increase of agricultural productivity, their household's health, nutrition and well-being (Smith *et al.*, 2003).

## **2.2.2 Measuring women empowerment in agriculture**

### **The Five Domains of Empowerment in Agriculture**

The complexity and multidimensional of empowerment makes it difficult to measure. This is especially true in the context of agriculture; empowerment is relatively new. Therefore, researchers, practitioners, donors do not yet have an acceptable instrument of measuring empowerment on their disposal. Women empowerment in agriculture index (WEAI) is the first and standardized measure of women empowerment in agriculture which has been introduced

by the United State of America for International Development (USAID), IFPRI and the Oxford Poverty and Human Development Initiative (OPHI) (Alkire *et al.*, 2013).

The WEAI can also be used more generally to assess the state of empowerment and gender parity in agriculture, to identify key areas in which empowerment needs to be strengthened, and to track progress over time. The WEAI is an aggregate index, reported at the country or regional level, based on individual-level data collected by interviewing men and women within the same households. It comprises of two sub-indices: the first assesses the degree to which women are empowered in five domains of empowerment (5DE) in agriculture as measured by ten indicators with their corresponding weights as described in (Table 1). It reflects the percentage of women who are empowered among those who are not and the percentage of domains in which women enjoy adequate achievements. These domains are (1) decisions about agricultural production, (2) access to and decision making power about productive resources, (3) control of use of income, (4) leadership in the community, and (5) time allocation. The second sub index (the Gender Parity Index [GPI]) measures gender parity. The GPI reflects the percentage of women who are empowered or whose achievements are at least as high as the men in their households. The weights of the 5DE and GPI sub-indexes are 90 percent and 10 percent, respectively. The choice of weights for the two sub-indexes is somewhat arbitrary but reflects the emphasis on 5DE while still recognizing the importance of gender equality as an aspect of empowerment and the different magnitudes of the indices. The total WEAI score is the weighted sum of the country- or regional-level 5DE and GPI. Improvements in either 5DE or the GPI will increase the WEAI (Alkire *et al.*, 2013).

**Table 1: Domains and indicators of women empowerment in agriculture index (5DE)**

Domains	Indicators	Definitions of indicators	Weight
---------	------------	---------------------------	--------

Production	Input in Production decisions	Sole or joint decision making over food and cash-crop farming, livestock, and fisheries	1/10
	Autonomy in production	Autonomy in agricultural production, decision making on what input to buy, crops to grow, and what livestock to raise. It reflect the extent to which the respondent's motivation for decision making has values rather than a desire to please others or avoid harm.	1/10
Resources	Ownership of assets	Sole or joint ownership of major households asset	1/15
	Purchase, sale or transfer of assets	Whether respondent participates in decisions to buy, sell or transfer his/her owned assets	1/15
	Access and decisions on credit	Access to and participation in decision making concerning credit	1/15
Income	Control over use of income	Sole or joint control over income and expenditures	1/5
Leadership	Group member	Whether respondent is an active member in at least one economic or social groups such as agricultural marketing, credit, and water user's groups.	1/10
	Speaking in public	Whether the respondent is comfortable speaking in public concerning various issues such as intervening in a family dispute, ensure proper payment of wages for public work programs.	1/10
Time	Work load	Allocation of time to productive and domestic tasks	1/10
	Leisure	Satisfaction with the available time for leisure activities	1/10

---

Source: Alkire (2013)

### **Agricultural Production**

Two indicators are used in this domain. The first, input in productive decisions, is constructed from answers regarding participation in decision-making: (1) whether the individual had sole

or joint input into making decisions about (a) food crop farming, (b) cash crop farming, (c) livestock raising, and (d) fish culture, and (2) the extent to which the individual feels he or she can make his or her own personal decisions about the following aspects of household life if he or she wanted to: (a) agricultural production, (b) which inputs to buy, (c) which types of crops to grow for agricultural production, (d) when to take or who would take crops to market, and (e) whether to engage in livestock raising. An individual has adequacy in this indicator if he or she participates and has at least some input in decisions or if someone else makes the decisions but the individual feels he or she could (Alkire, 2013).

The second is a measure of autonomy that reflects a person's ability to act on what he or she values. This indicator probes the person's own understanding of the situation and how he or she balances different motivations to avoid punishment or social disapproval and to act on his or her own values (Alkire, 2007). The indicator adapts the measure of autonomy developed by psychologists Richard Ryan, E. L. Deci, Valery Chirkov, and others working in Self-determination Theory (Chirkov *et al*, 2011). A sub-index is constructed from answers to the following: (1) My actions in [area of decision-making] are partly because I will get in trouble with someone if I act differently, (2) Regarding [area of decision-making] I do what I do so others don't think poorly of me, and (3) Regarding [area of decision-making] I do what I do because I personally think it is the right thing to do. The areas of decision-making refer to (1) agricultural production, (2) which inputs to buy, (3) which types of crops to grow, (4) when to take or who would take crops to market, and (5) livestock production. An individual is adequate on autonomy if his or her actions are relatively more motivated by his or her own values than by coercion or fear of others' disapproval. Note that this autonomy indicator, unlike decision-making indicators, captures the situation of women living in female-only households, who may indeed be empowered as sole decision makers but whose autonomy may still be deeply constrained by social norms or force of circumstance. It also reflects the situation in joint households, a joint decision may be more or less autonomous, depending on circumstances (Alkire, 2013).

## **Access to and Control of Productive Resources**

Three indicators comprise this domain: (1) ownership of land and assets; (2) decisions regarding the purchase, sale, or transfer of land and assets; and (3) access to and decisions about credit.

The first indicator examines whether an individual reports having sole or joint ownership of land and assets such as agricultural land, large and small livestock, fishponds, farm equipment, house, household durables, cell phone, nonagricultural land, and means of transportation. A person is considered to have adequate achievements if he or she reports having sole or joint ownership of at least one major asset (that is, not including poultry, non-mechanized equipment, or small consumer durables). Although it might be arguable that sole ownership is more indicative of empowerment than is joint ownership, recent qualitative work in Uganda (Bomuhangi & Meinzen, 2011) indicates that land is often held jointly; women can be more empowered if they have joint ownership of a valuable asset (such as land) than if they have sole ownership of a minor asset.

The second indicator, defined with similar assets, asks the person who can make decisions regarding the purchase, sale, or transfer of land and assets. This recognizes that in many societies, full ownership of assets may not apply, but holding other bundles of rights especially rights of control over purchase and disposal of assets can also be empowering. As with the first indicator, a person has adequacy in this area if he or she participates (or can participate) in decisions to buy, sell, or transfer the asset, conditional on the household's owning it (Alkire, 2013).

The third indicator examines decision-making about whether to obtain credit and how to use the proceeds from credit from various sources (nongovernmental organizations, formal and informal lenders, friends or relatives, rotating savings and credit associations). To have adequacy on this indicator, a person must belong to a household that has access to credit (even if they did not use credit), and if the household used a source of credit, the person participated in at least one decision about it (Alkire, 2013).

### **Control over the use of income**

This domain has single indicator for measuring the degree of input into decisions about the use of income generated from (1) food crops, (2) cash crops, (3) livestock production, (4) nonfarm activities, (5) wage and salary work, and (6) fish culture, as well as the extent to which

the individual feels he or she can make his or her own personal decisions regarding wage or salary employment and major and minor household expenditures. A person is considered adequate on this indicator if he or she has input into decisions about income generated, conditional on participation in the activity (Alkire, 2013).

### **Leadership in the Community**

The fourth domain comprises two indicators: (1) whether the person belongs to an economic or social group and (2) whether the person feels comfortable speaking out in public. Recognizing the value of social capital as a resource, the group member indicator shows whether the person is a member of at least one group, encompassing a wide range of social and economic groups. It is possible that a person may not want to join a group because of social and cultural norms that discourage participation in activities outside the household, as demonstrated by the quote in the box below from a 23-year-old Bangladeshi woman or because family members do not approve.

Whether the person is comfortable speaking up in public consists of responses to questions about the person's ease in speaking up in public to help decide on infrastructure (like small wells, roads) to be built, to ensure proper payment of wages for public work or other similar programs, and to protest the misbehavior of authorities or elected officials. Although it does not cover the entire range of possibilities for public engagement, this variable presents some indication of the respondent's empowerment on exerting voice and engaging in collective action.

### **Time Allocation**

The final domain consists of two indicators measuring the allocation of time to productive and domestic tasks and satisfaction with the time available for leisure activities. The first indicator, productive and domestic workload, is derived from a detailed 24-hour time allocation module based on the Lesotho Time Budget Study (Alkire, 2013). Ten Respondents are asked to recall the time spent on primary and secondary activities during the previous 24 hours. The individual is considered inadequate (have an excessive workload) if he or she worked more than 10.5 hours in the previous 24 hours, with hours worked defined as the sum of the time in work-related tasks as the primary activity plus 50 percent of the time in work-related tasks as the secondary activity.

The last indicator asks whether the individual is subjectively satisfied with his or her available time for leisure activities such as visiting neighbors, watching TV, listening to the radio, seeing movies, or doing sports. A person is adequate on this indicator if he or she is satisfied with the time available for leisure.

### **2.2.3 Women empowerment and Gender Parity**

The WEAI was originally intended to measure women's empowerment alone but it became clear that by focusing only on women in isolation from the men in their households, the index would be missing an important piece that contributes to disempowerment or conversely to empowerment.

To Measure gender inequality at the society, level a number of indexes have developed (Hausmann *et al.*,2011), yet many evidences demonstrated that failing to pay attention to intra-household gender inequality which has costs for attaining development objectives (Quisumbing *et al.*,2012). A number of studies have demonstrated that failing to pay attention to intrahousehold gender inequality has costs for attaining development objectives (Alderman *et al.*, 1995; Haddad *et al.*, 1997; Quisumbing, 2003). Studies on child nutritional status (Smith *et al.* 2003) and child schooling by (Quisumbing & Maluccio, 2003) used indicators of differences in age, education, and assets at marriage between the husband and wife within the same household as indicators of intra-household bargaining. Husband's age and educational seniority have also been used to predicate male control over women. Educational differences can be viewed as a proxy for differences in earning power, which influences bargaining power (Quisumbing & Hallman, 2005).

The study conducted by Smith *et al.* (2003) based their measure of women's decision-making power relative to their male partners (usually their husbands) on four underlying indicators: whether a woman works for cash, her age at first marriage, the age difference between her and her husband, and the educational difference between her and her husband.

Intra-household inequality has specifically been shown to have effect on agricultural productivity. Yields on female-managed plots are less than those on male-managed plots within the same household, owing to lower input application on female managed plots (Udry, 1996). Using headship as a proxy for gender differences within households may also lead to underestimation of gender differences in agricultural productivity. Efforts to increase women's

assets may succeed, but without measuring changes in men's assets, gender asset inequality cannot be known (Peterman *et al.*, 2011).

The GPI (Gender Parity Inequality) is a relative inequality measure. It reflects the inequality in 5DE profiles between the primary adult male and female in each dual-adult household. In most but not all cases, the primary and secondary male and female are husband and wife; however, men and women can be classified as the primary male and female decision makers regardless of their relationship to each other. Households without a primary adult male and female pair are excluded from this measure, and thus the aggregate WEAI uses the mean value of dual-adult households for the GPI. The GPI shows the percentage of women who achieve parity with their male relatively to their 5DE score (Alkire, 2013).

### **2.3 Agricultural commercialization**

Farm commercialization's definitions differ in focus, which has also influenced its measurement (Okezie *et al.*, 2008) view it narrowly as increasing of the proportion of marketed outputs. According to Kennedy and Cogill (1987), it is increase of cash crop production. Others authors has broadly defined agricultural commercialization as an agricultural transformation process in which farmers shift from mainly consumption-oriented subsistence production towards market- and profit-oriented production systems. The process involves progressive substitution of subsistence with commercial practices (Pingali & Rosegrant, 1995).

Agricultural commercialization and diversification involve the gradual replacement of integrated farming systems by specialized enterprises for crop, livestock, poultry and aquaculture products. Changes in product mix and input uses are determined largely by the market forces during this transition. Commercialization of agricultural production is an endogenous process and is accompanied by economic growth, urbanization and withdrawal of labor from the agricultural sector (Pingali *et al.*, 1995). Agricultural technology and commercialization are complementary stimulators of the rural economic growth process. Specialization and commercialization of farming households within a more diversified economy is part of the development process (Von, 1995).

Smallholder agricultural commercialization is a cornerstone of rural development and poverty reduction strategies of developing countries (Pender & Alemu, 2007). It is viewed by policymakers as an essential part of the process of agricultural modernization, specialization,

and structural transformation of the economy toward more rapid and sustainable growth (Pender & Alemu, 2007). In Africa and other developing countries found that commercialization increases household incomes emanating from labor and land productivity and also provides opportunities for off-farm employment with an ultimate effect of improved household welfare (Von Braun, 1994). Given that smallholder farmers constitute the majority of people living in absolute poverty, commercialization is seen as a means to bring the welfare benefits of market-based exchanges to this group and is therefore central to an inclusive development process (Gebremedhin & Tegegne, 2012).

In Rwanda the effort to move toward commercialization of agriculture, there has been an emphasis on various areas of the agriculture sector such as intensification agricultural production systems, promotion of farmers' cooperatives, and enhancement of farmers' access to market over the last fifteen years (Ingabire *et al.*, 2017). The sector has made some good achievement from the transformation plan. For instance, the increase of farmers' cooperative has facilitated access to inputs and outputs markets, the improved crop productivity particularly for beans and potatoes as well as agricultural income and commercialization of some staple crops (Verhofstadt & Maertens, 2015).

### **2.3.1 Gender and agricultural commercialization**

Women's participation in agriculture which referred as well as feminization in agriculture, happens because of two main reasons, on one hand, it is caused by number of different non-farm opportunities in the rural areas as well as the out migration that benefits men and causes them leave their agricultural tasks to women. Therefore, the feminization of agriculture can be interpreted as a consequence of gender inequality in terms of access to economic opportunities outside the sector. On the other hand, feminization of agriculture can be explained as a consequence of agricultural transformation. In the process of transformation, women increase their time on agricultural activities by working with men (husband or partner) on cash crops at the same time by keeping their role in subsistence agriculture (Lastarria, 2008). Women make essential contributions to agriculture and rural livelihoods. However, in agricultural commercialization, they are increasingly disadvantaged because of persistent gender disparities in access to productive resources (Fischer *et al.*, 2012). In sub-Saharan Africa, women tend to control subsistence and semi subsistence crops. However, gender relations changes with changing conditions, Agricultural commercialization mostly is associated with a decline in women's control, because cash crops usually fall into the male domain (Negin *et al.*, 2009).

Gender and commercialization are farm-based constraints related to technology uptake, extension services, and insecurity of tenure, tied explicitly or implicitly to lower productivity and the poorer possibilities for the generation of a marketable surplus (Djurfeldt, 2018).

Women's agricultural commercialization in sub-Saharan Africa is still constrained. The male dominate over cash crop production and sales as well as the growing male control over women's crops as they become commercialized is high (Kasente *et al.*, 2012 ; Negin *et al.*, 2009).

According to Manfre (2014), gendered aspects of various value chains as well as the gendered outcomes of different types of marketing arrangements, for instance cooperatives or farmers' groups. The bias against women in terms of their relatively limited access to productive assets, technology, credit, information, and social networks explain their inability to engage in value chains of higher-value or contract farming arrangements.

Gender dynamics of market coordination arrangements that enable access to value chains are limited. A study from Tanzania suggests that farmers' marketing groups dominated by women are less successful in accessing markets than male groups, although the reasons for this, as cautioned by the authors, may well rest with the lack of access to natural resources (Barham & Chitemi, 2009).

Rwanda as in CAADP has agricultural transformation plan by involving women and giving them priority as a particular category. The direct reason for this is that women form the majority of smallholders, supply labour for production of both food and cash crops (NEPAD, 2016).

In Rwanda, the research conducted in Northern Province of the country has revealed that 45% of the households participating in potato markets, only husbands were involved in the transactions while in 27%, only wives have participated to the markets. In the production of bean, the results showed that women have highly participated, as in 52% of the households that sold bean, only wives have participated and engaged the transactions. In contrary, 23% of the households have involved only men and this proportion is significantly (5% level) lower than that of women. This means that the level of women's market participation is higher for beans than potatoes. The commercialization of potatoes is mainly in the hands of husbands. From the same research focus group discussion has also revealed that the role of women in agriculture

is more associated to food crops production than cash crops production. The participants of FGDs, said that beans which mainly produced for consumption purpose in that area is considered as women's crop while potatoes which is more commercialized is for men (Ingabire *et al.*, 2017). It has confirmed the reality from different studies that men tend to take control of crops when an opportunity for their commercialization emerges (Fischer & Qaim, 2012; Meinzen *et al.*, 2014).

### **2.3.2 Measuring agricultural commercialization**

To measure the level of agricultural commercialization at household level three indices have been specified by Randolph (1992) and von Braun *et al.* (1994). The first was output and input side commercialization type indices. It measures the proportion of agricultural output sold to the market and input acquired from market to the total value of agricultural production. The second is the commercialization of the rural economy index defined as the ratio of the value of goods and services acquired through market transactions to total household income. Here, the assumption is that some transactions may take place in-kind such as payments with food commodities for land use. The third is the degree of a household's integration into the cash economy which is measured as the ratio of the value of goods and services acquired by cash transaction to the total household income (Jaleta, *et al.*, 2009). Moreover, to measure the extent of commercialization at household level, household commercialization index (HCI) is mostly used. The HCI is a ratio of the gross value of all crop sales per household per year to the gross value of all crop production. It thus measures the degree to which a household sells its output to market. The index assumes a value of between 0 and 1. If the index is zero, it would imply a totally subsistence oriented household and if the index is closer to 1, it would signify the higher degree of commercialization. The advantage of HCI is that it provides the level commercialization of each household separately and the weakness is that it does not incorporate livestock subsector, which could be more important than crops in some farming systems (Strasberg, 1999). This study will use HCI to measure the extent of household farm commercialization.

Household commercialization index expressed as:

$$HCI = \frac{\text{Gross value of agricultural sales by } i\text{th household in year } j}{\text{Gross value of all agricultural production by } i\text{th household in year } j} \times 100$$

### **2.3.3 Women empowerment in agriculture (WEAI) and agricultural commercialization**

The WEAI has been studied with respect to nutritional outcomes in Nepal (Cunningham *et al.*, 2015; Malapit *et al.*, 2015) and food security outcomes in Bangladesh (Alkire *et al.*, 2014). However, the existing few studies have accounted for the market orientation of farm production or farm commercialization in general. Two households with the same production diversity or the same area of cultivable land can reflect two very different resource-based situations in terms of access to, and decision-making about, productive resources. For instance, although two households may be producing the same number of crops, the market orientation of those crops can differ based on land ownership, area under cultivation, access to irrigation, and other factors. The findings from the study from India has revealed that there is a positive relationship between women empowerment in agriculture and market oriented agriculture. The 5DE scores was higher for women belonging to cash-cropping households, it was more than double the change found for women belonging to food-cropping households (Gupta, 2017).

## **2.4 Food security**

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996). The Summit 1996 also agreed on the four dimensions of food security: availability, access, utilization, and stability.

Food availability: availability of sufficient quantity of food of appropriate quality, supplied from domestic production and import (including food aid). Food access represents the households' ability to regularly acquire sufficient quality and quantity food through a combination of their own stock and home production, purchases, barter, gifts, borrowing or food aid to meet all household members' nutritional requirements for productive lives (Swindale *et al.*, 2006). Food utilization is the households' use of the food to which they have access, intra- household food distribution, and individuals' ability to absorb nutrients, the conversion efficiency of food by the body. This refers to the utilization of food through adequate diet, clear water, sanitation and health care, to reach a state of nutrition well-being in which all physiology need are met. it highlight the non-food in food security. For example, it is insufficient to an individual to receive adequate food if unable to make use of food due to illness (Swindale *et al.*, 2006). Food stability is having the ability to access adequate food at all times, independent of shocks such as economic or climate related crises including seasonal

food insecurity such as the agricultural period before harvest (Carletto, 2013). This study will only be focused on food access.

#### **2.4.1 Women empowerment in agriculture and Food security**

Agriculture is directly linked to food security as source of food, income and nutrient. Moreover, agriculture also directly influencing food price (Arimond *et al.*, 2010). Women empowerment is considered as prerequisite to achieve food security globally. However, gender system is complex, the extent and nature of gender equality and necessary conditions to assure women's empowerment vary across countries, community and regions (Akter, 2017).

Women contribute 50% of the world's food (FAO, 2011). Both globally and in developing countries women contribute 43 % of agriculture labor force (Doss, 2014). Moreover, women invest more of their earning than men in families' expenses such nutrition, education and children's education (Duflo, 2012). However, gender bias still exists in agriculture sector, both in quantities of assets, agricultural inputs and resources that women control (Quisumbing *et al.*, 2003). In addition, the mechanisms through which women's empowerment in agriculture affects household nutrition and food security are complex and not fully understood. A study in Ghana found that women's empowerment in agriculture was positively associated with the quality of child feeding practices, but only weakly positively associated with child nutrition status (Malapit & Quisumbing, 2015). Despite these difficulties of relating women empowerment to food security, there is evidences that disempowerment is one of the cause of vulnerabilities to food insecurity and poor nutrition (Ziaei *et al.*, 2012).

After many years of progress, the absolute number of undernourished people has increased in recent years, from 784 million in 2015 to 820 million in 2018. More than 2 billion people lack the micronutrients needed for growth, development and disease prevention And, over 2 billion people suffer from the adverse health effects of being overweight or obese (world Bank, 2020). In sub-Saharan Africa the prevalence of undernourishment in all regions of the continent has remained flat since 2010 and then, from 2015 to 2016, rose from 20.8 to 22.7 percent. In 2016, there were about 224 million undernourished people in sub-Saharan Africa, up from 200 million in 2015.

The government of Rwanda ha recorded significant achievement in poverty reduction, gender equality, environmental sustainability, food production, education and public health, in line

with the millennium development goals. the government of Rwanda, along with a number of donors, have enacted policy and implemented programs to reduce poverty and malnutrition with the intention of reducing the prevalence of stunting and wasting (Weatherspoon *et al*, 2019).

However, 38.2 percent of the population continues to live the poverty line and almost one fifth is food insecure. Levels of stunting among young children remain very high, at 35 percent (WFP, 2019).

#### **2.4.2 Household Dietary Diversity**

Dietary diversity which is defined as an increase in the variety of foods within and across food groups capable of ensuring adequate intake of essential nutrients that can promote good health, physical as well as mental development (Arimond *et al.*, 2004). The more food groups included in daily diet the greater the likelihood of meeting nutrient requirements. Dietary diversity is an outcome measure of food security at the individual or household level (Labadarios *et al.*, 2011). Household dietary diversity Refers to the number of food groups consumed by household members over a 24-hour period (Mekuria *et al.*, 2017).

The household dietary diversity score (HDDS) is meant to reflect, in a snapshot form of the economic ability of a household to access a variety of foods. Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (Taruvinga, 2013). HDDS measures have gained importance as measures of household food security (Hoddonott & yohannes, 2002).

To calculate HDDS, the number of different food groups consumed should be calculated, rather than the number of different foods consumed to better reflect a quality diet. Knowing that households consume, for example, an average of four different food groups implies that their diets offer some diversity in both macro- and micronutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals. To calculate the HDDS foods must be grouped into 12 categories, cereals, root and tubers, vegetables, fruits, meat, eggs, fish and sea food, pulse/legumes/nuts, milk and milk products, Oil and fats, Sugar and honey, other food such as condiments, coffee and tea (Swindale & Bilinsky, 2006). Information on household food consumption should be collected using the previous 24hours as a reference period (24-hour recall). because longer reference

periods result in less accurate information due to imperfect recall. The recall period of 24 hours was chosen by FAO as it is less subject to recall error, less difficult for the respondent to handle and also conforms to the recall time period used in many dietary diversity studies (Arimond *et al.*, 2010).

The tabulation of HDDS can be done by hand or with the use of software such as a database or spreadsheet. First, the HDDS variable is calculated for each household. The value of this variable range from 0 to 12. Total number of food groups consumed by members of the household. Values for each group named “A” to “L” consecutively, cereals, root and tubers, vegetables, fruits, meat, eggs, fish and sea food, pulse/legumes/nuts, milk and milk products, Oil and fats, Sugar and honey, other food such as condiments, coffee and tea. It is either “0” if it is not consumed or “1” if it is consumed (Swindale *et al.*, 2006).

$$\text{HDDS (0 to 12)} = (A+B+C+D+E+F+G+H+I+J+K+L)$$

$$\text{Average HDDS} = \text{Sum (HDDS)} / \text{Total Number of Households}$$

To interpret the HDDS, there is no established cut-off points in terms of number of food groups to indicate adequate or inadequate dietary diversity for the HDDS, therefore it recommended to use the mean score or distribution of scores for analytical purposes and to set programme targets or goals (Kennedy *et al.*, 2010).

Two options are available to determine appropriate targets. Both of these options have the advantage that the target set represents a level of dietary diversity that is demonstrably achievable by the sample population. First, the dietary diversity patterns of wealthier households can be used as a target, under the assumption that poorer households will diversify their food expenditures as incomes rise, and thereby mirror the consumption patterns of wealthier households. If income data are available, the sample could be divided into three income groups (terciles of income), and the average dietary diversity calculated for the richest income tercile. The average HDDS in the richest 33 percent of households can then serve as a guide for setting the target level of HDDS for the purpose of performance monitoring. Where income data are not available, income groups can be defined using proxies, such as possession of assets or other items found to be highly correlated with income in the project population. Second, in the absence of income or economic data from the baseline survey, a HDDS target can be established by taking the average diversity of the 33 percent of households with the highest diversity (upper tercile of diversity) (Swindale *et al.*, 2006).

This study used the second option for interpretation by taking the average of 33 percent of households with the highest diversity.

### **2.4.3 Women empowerment in agriculture and household dietary diversity**

Intra-household resource allocation has a considerable role to play in nutritional status in developing countries. The extent to which women have access to and control over resources largely determines the kind of care they provide for their children and for the rest of the household. In Ethiopia it has been recognized by the National Nutrition Program, women's lack of control over household resources, time, knowledge, and social support networks constitutes a major barrier to improving poor nutritional outcomes (Yimer *et al.*, 2015).

Agriculture is important to rural households as a source of food for own-consumption and as a source of income; moreover, agricultural policies can affect households' purchasing power through their effects on the prices of food and nonfood crops. However, decisions on how and what to produce are mediated by gender roles, and accumulating evidence shows that men and women within households do not always pool their resources nor have the same preferences (Alderman *et al.*, 1995; Haddad *et al.*, 1997). The non-pooling of agricultural resources within the household creates a gender gap in the control of agricultural inputs, which several empirical studies have identified as a constraint on higher productivity (Kilick *et al.*, 2013; Udry *et al.*, 1995). Unequal control of resources within the household also has implications for the nutritional wellbeing of household members, particularly in societies with well-documented gender gaps, such as Bangladesh. A woman's ability to choose the appropriate amounts of the right types of food for her family, considering household members' different nutritional needs across the life course, may be constrained by her lack of control of resources as well as her lack of knowledge regarding what constitutes a healthy and diverse diet. A large body of literature documents a strong positive association between women's control over household assets and income, and households' investments in child health, nutrition, and education (Ackerson & Shroff, 2011; Allendorf, 2007; Bhagowalia *et al.*, 2012; Cunningham *et al.*, 2015; Quisumbing & Maluccio, 2003; Smith *et al.*, 2003; Subramanian, 2008).

Several studies have used the WEAI in the context of the agriculture-nutrition pathways to examine the association between women's empowerment in agriculture and household and individual welfare. According to Malapit and Quisumbing (2015), women in rural Ghana were

most disempowered in terms of access to and 6 decision making over credit, and that improvement in this domain was associated with greater dietary diversity for women and female children. In Nepal, overall empowerment of women, their membership in collective action groups, their greater control over income, and their hours worked were significantly associated with both maternal dietary diversity and body mass index. According to Sraboni *et al.* (2014), in Bangladeshi women's active membership in collective-action groups, their control over agricultural assets, and a narrowing gap in empowerment between men and women within households were positively associated with calorie availability and dietary diversity at the household level. The Ghana and Nepal studies, which analyzed both maternal and child outcomes, suggested that the domains of empowerment that are significant for women's and children's diet and nutrition outcomes may not always overlap, and pointed to the need to examine the impacts of women's empowerment on individuals across the life course. According to Sraboni and Quisumbing (2018), women empowerment in agriculture has a positive and significant relationship with dietary diversity.

#### **2.4 Empirical studies**

Many studies have conducted on women empowerment in agriculture. This section has reviewed some of them; more attention has put in methodology used, data, the models, findings and limitations of those studies. To analyze the relationship between women empowerment in agriculture and market oriented agriculture, Primary data was collected from two different groups of households based on their farming system, to analyse data multivariate regression model was used. The result has revealed that women's empowerment in agriculture is significantly higher among cash crop production and food-crop production households, relative to the landless households. Further, 5DE scores are higher by 0.086 points for women belonging to cash-cropping households, which is more than double the change found for women belonging to food-cropping households (0.039 points). They also found that indirect measures of empowerment, like age and education, are also significant (Gupta *et al.*, 2017).

The study on the relationship of women empowerment in agriculture and per capita calorie availability, dietary diversity and Adult body mass index in Bangladesh. The study has used the data from the Bangladesh integrated survey, the sample was represented by the representatives of rural households in Bangladesh, instrumental regression module was used to analyze the data. They have included the five domains and their indicators as the key independent variables, per capita calorie, household dietary diverse and adult body mass as

outcome variables. The findings showed that the increase of women's empowerment is positively associated with calorie availability and dietary diverse at household level. Overall, household wealth, education and occupation are important as women's empowerment as determinant of adult nutrition status, although have negative impacts of group membership and Credit on male BMI suggest intra-household tradeoffs may exist. although, the study has pointed the importance of women's empowerment in general, and women's asset ownership in particular for improving household food security but it has not clear demonstrated that prioritizing women's empowerment alone should take precedence over improving other determinants of food security (Sraboni *et al.*, 2014).

The impact of women's empowerment in agriculture on household vulnerability to food insecurity in Kwazulu-Natal province. They have used cross-section data collected from 300 randomly selected primary female heads of households in Msinga rural areas of KwaZulu-Natal. They have used 2-stage least squares regression analysis and binomial logit model, economic and agricultural forms of women empowerment in addition to other household socio-economic characteristics. A household's socio-economic characteristics were used as variables that influence food security. The finding revealed that socio culture and economic characteristics have a positive influence on food security. Therefore, Women empowered more in socio-cultural aspects were less likely to be vulnerable to food insecurity. Although the study was about to know the impact of women's empowerment in agriculture to food security, nevertheless, the domains of women's empowerment and their indicators was not taken into account though they have identified as the main measure of women empowerment in agriculture (Sharaunga *et al.*, 2015).

The study on WEAI and market oriented agriculture was successful however, it has some limitations, the study was strictly conducted on women who are not pregnant, non-lactating women of the reproductive age group. Thus, the results from the group cannot be generalized to conclude the status of WEAI. Moreover, the model used was not able to resolve the problem of endogeneity. The other two studies mentioned was about women's empowerment in agriculture and food security, however, different variable was used to analyze the relationship between those two domains. One has mainly analyzed based on social economic and social-cultural factors and the other one has basically used the domains of women empowerment and their indicators as factors that influence food security. However, food security cannot be

determined by none of both alone. Therefore, this study will combine the domains of women's empowerment in agriculture index and other factors that influence food security in Rwanda.

## **2.5 Theoretical framework**

### **2.5.1 Kabeer's women's empowerment framework**

Empowerment is a process of change where those who have been denied the ability to make choices acquire it. The ability to exercise choice can be thought of in terms of changes in three interrelated dimensions of power, which make up choice: resource, agency and achievement. Resources form the conditions under which choices are made; Agency is at the heart of the process by which choices are made; Achievements reflect the outcomes of choices. Resources are divided into three categories, which are economic, human and social resources. Human resources are embodied in the individual and encompass his or her knowledge, skills, creativity and imagination.

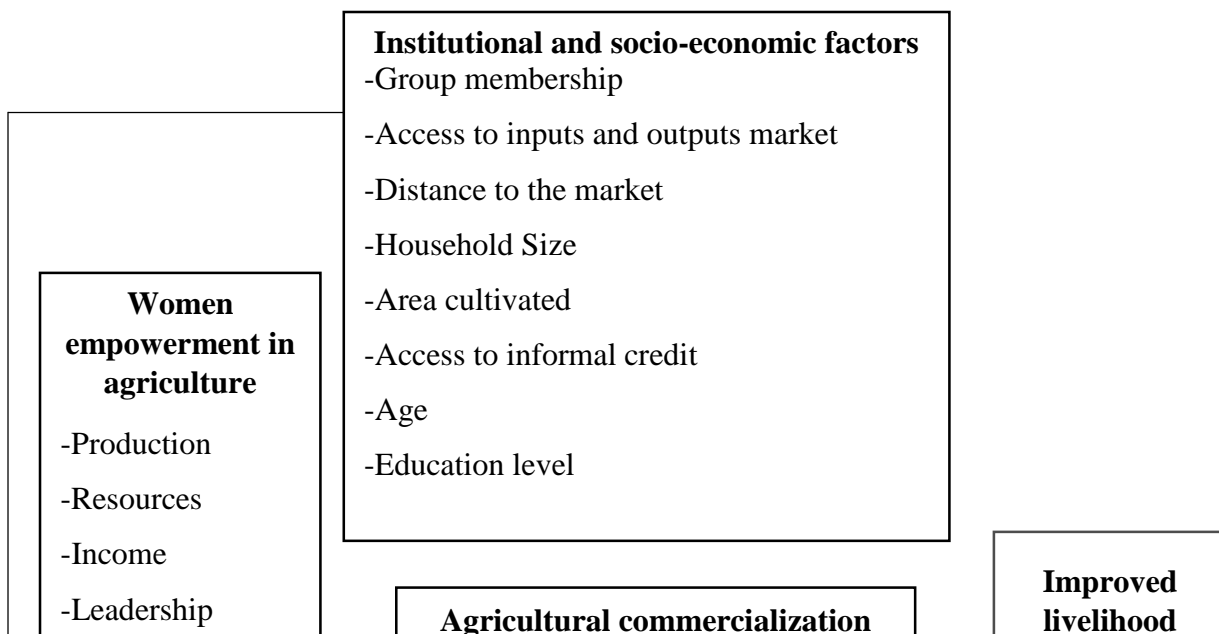
Social resources are made up of the claims, obligations and expectations which inhere in the relationships, networks which enable people to improve their situation and life chances beyond what would be possible through their individual efforts alone. Agency is the ability to define one's goals and act upon them. It is about more than observable action; it also encompasses the meaning, motivation and purpose, which individuals bring to their activity, their sense of agency, or the power within.

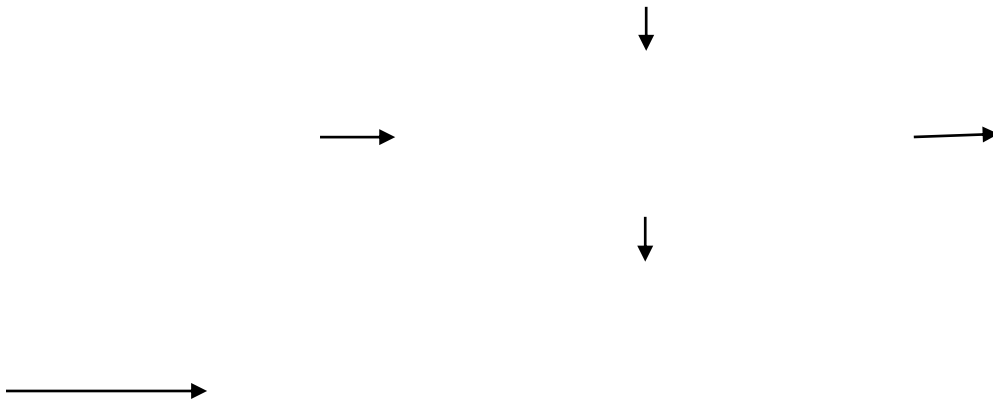
Agency can have both positive and negative meaning as the dimension of power. In the positive sense of power, agency is the capability of people to define the choice of their own life and pursue their own goals. As negative sense of power agency is the capability of actor or category of actors of overriding others' agency, for instance through violence, coercion and threat. Resources and agency together form the potentials that people have for achieving valued ways of being and living (Kabeer, 1999).

Grounding to this framework, this study will explain how women are empowered through the five domains of WEAI which are basically summarized into three dimensions of Kabeer's framework. Through resources, the study will look at the level of women's decision making in economics resources such as land use, decision on assets and their level of decision making on household income as well as credits.

Human and social resources will be covered into two domains among the 5DE, leadership and time. The study will show how women participates into different community groups, which reflects their social network and personal skills through leadership. Through Kabeer’s dimension of achievement the study will look at how women’s empowerment in agriculture affect household farm commercialization as well as how it is related to household dietary diversity.

## 2.6 Conceptual framework





**Figure 1: Conceptual framework**

The conceptual framework of this study, builds on women empowerment in agriculture, farm commercialization and dietary diversity. The framework illustrated in figure 1 present how through the five domains of WEAI and gender parity index affect farm commercialization in Rwanda. It also represents the relationship between women’s empowerment in agriculture and household dietary diversity. In addition, social economic, institutional and individual factors will also be considered to determine their effect on farm commercialization in Rwanda. Agricultural commercialization will be measured using household commercialization index, Household dietary diversity will be determined by household dietary diverse score.

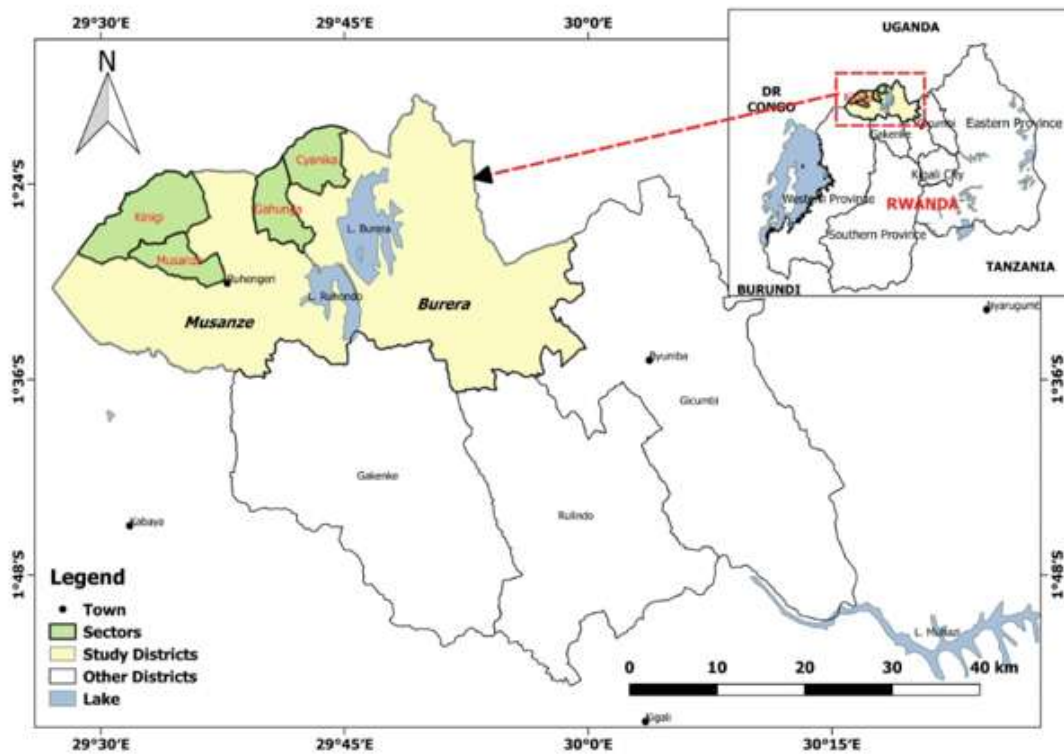
## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Study area**

The study was carried out in Musanze and Burera districts in Northern Province of Rwanda. Rwanda is bordered by Uganda to the north, to the east by Tanzania, to the south by Burundi, and to the west by the Democratic Republic of Congo (DRC). It is 26,338 km<sup>2</sup> of surface area (NISR, 2012). Northern Province has high potentiality in agricultural production. It is the best producer of potatoes, beans and maize which were the crops of interest for this study. In addition to having predominance of farming activity they also have geographic advantage of being close to important local markets closer to Uganda for cross-border trade (Ingabire, 2017).

Musanze district borders with Uganda and Democratic Republic of Congo (DRC) to the North through Virunga National Park, Gakenke District in the South, Burera District to the East, Nyabihu in West and Lake Ruhondo in the South West. The total area of the district is 530.4 km<sup>2</sup>, and located at an altitude of 1,850m above sea level. It is occupied by a total population of 368,563 people and 91% of them are engaged in agriculture. Burera District has a total area estimated at 664.5 km<sup>2</sup>. It borders with the Republic of Uganda in the North and East, Gakenke and Rulindo Districts in the South and by Musanze District in the West. The district is occupied by 336,455 of population. The district is still subsistence farming. It is practiced by more than 80.2% of the total population of the district (NISR, 2013).



**Figure 2: Map of Rwanda**

Source: ICPAC (2015)

### 3.2 Research design

The research design used was a survey through a case study.

### 3.3 Sampling procedure and sample size

The sample size was obtained using multistage sampling techniques. In the first stage, one province was chosen from five provinces, the second stage two districts were chosen purposively, and the last stage was to choose households individuals randomly from the target population of 681 farmers who grow maize, beans and potatoes. The target population was taken from the previous studies done by FATE project 2015 in the same districts.

The respondents were both primary female and male decision makers. It was not necessarily that respondents should be spouse. For this study respondents were anyone above 18 years. However, the priority was given to spouses.

The general formula of Yamane (1967) was used to determine the sample size:

$$n_0 = \frac{N}{1 + N(e)^2} \dots\dots\dots (3.1)$$

Where  $n_0$  was the sample size,  $N$  was the population size and  $e$  was the acceptable error (0.06).

Therefore, the sample size was:

$$n_0 = \frac{681}{1 + 681(0.05)^2} = 252 \text{ households}$$

Both primary female and male from the same households was interviewed.

**Table 2: Sample size distribution in Burera and Musanze districts**

Locality	Population growing maize, beans, potatoes	Sample size
Musanze district	181	43
Kinigi sector	80	32
Musanze sector	90	40
Burera district	140	47
Cyanika sector	98	38
Gahunga sector	92	52
<b>Total</b>	<b>681</b>	<b>252</b>

### 3.4 Method of data collection

The data was collected using semi structured interview to the heads of household (both men and women) as respondents for obtaining quantitative data. Pre-testing of the questionnaire was done to determine the time required to complete each questionnaire and the convenience of getting the data from respondents. The data was collected with the help of enumerators.

### 3.5 Data analysis

STATA version 15 and Microsoft excel were used in data cleaning and analysis

#### 3.5.1 Analytical framework

##### **To determine the level of women empowerment in agriculture in Rwanda**

To measure the level of women empowerment in agriculture, WEAI was computed using individuals' level data collected from male and female respondents within the same households. The WEAI was composed by 5 Domains of Empowerment (5DE) and Gender Parity Index (GPI) sub-indices. A woman was considered empowered if she had achievement in four domains of 5DE or was empowered in some combination of the weighted indicators that reflect 80 percent total adequacy.

Gender parity index was used to know if the woman was empowered or her empowerment score is greater than or equal to that of the male in her household. Thus, the gender parity gap is zero if the household enjoys gender parity. Otherwise, the gap equals the difference in the male and female aggregate empowerment scores.

Both 5DE and GPI was determined using the formulas developed by Alkire (2013). To compute the 5DE, two equivalent notations can be used. One focuses on the percentage of empowered women and adequacies among the disempowered. The other notation focuses on the percentage of disempowered women and the percentage of domains in which they lack adequate achievements. In this study, the second notation was used (Alkire & Foster, 2011).

5DE was computed as;

$$5DE = H_e + H_p \times A_e \dots\dots\dots (3.2)$$

$$H_p = 1 - H_e$$

Where  $H_e$  = the percentage of women who are empowered

$H_p$  = the percentage of women who are not empowered

$A_e$  = the average adequacy score of disempowered individuals

$$A_e = 1 - A_p$$

$$A_p = \frac{\sum_1^n ci(k)}{q}$$

Where  $A_p$ , is the average inadequacy score of disempowered individuals,  $ci(k)$  is the censored inadequacy score of individual  $i$  and  $q$  is the number of disempowered individuals.

**Gender Parity Index determination (GPI):**

The GPI combined two key pieces of information: (1) the percentage of women who had not yet achieved empowerment or gender parity relative to their male counterparts (within a given population) and (2) the extent of the inequality between those women who lacked parity and the men with whom they live.

The GPI will be computed as follows:

$$GPI = 1 - (H_w \times I_{GPI}) \dots\dots\dots (3.3)$$

Where,  $H_w$  is the percentage of women without gender parity.

$I_{GPI}$  the average empowerment gap between women compared with men in their household

$$I_{GPI} = \frac{1}{h} \sum_{j=1}^h \frac{cik^{wW} - cik^M}{1 - cik^M} \dots\dots\dots (3.4)$$

$$WEAI = 0.9(5DE) + 0.1(GPI) \dots\dots\dots (3.5)$$

The extent of women’s empowerment in agriculture was weighted from the average of 5DE sub-index and GPI sub-index (Alkire, 2013).

**To determine the effect of women empowerment in agriculture on farm commercialization in Rwanda**

The household commercialization index (HCI) was used to determine household specific level of commercialization (Govere *et al.*, 1999; Strasberg *et al.*, 1999). The index measures the ratio of the gross value of crop sales by household *i* in year *j* to the gross value of all crops produced by the same household *i* in the same year *j* expressed as a percentage:

$$HCI = \frac{\text{Gross value of agricultural sales by } i\text{th household in year } j}{\text{Gross value of all agricultural production by } i\text{th household in year } j} \times 100$$

To analyse the extent to which women empowerment in agriculture influences farm commercialization in Rwanda, fractional regression model was used.

Papke and Wooldridge (1996) in a seminal paper proposed a fractional regression model (FRM). The FRM is used specifically for situations where the dependent variable is a proportion defined on the unit interval (Ramalho, 2009). It is therefore based on the conditional mean assumption that respects the range of values taken by HCI that FRM was the appropriate model to analyze this objective.

The FRM requires assumption of a functional form for *y* that imposes the desired constraints on the conditional mean of the dependent variable:

$$E (y/x) = Gx^\beta \dots\dots\dots (3.6)$$

Where *y* is dependent variable which is HCI for the context of this study, *x* is a vector of explanatory variable and *G*(·) is a known nonlinear function satisfying 0 ≤ *G*(·) ≤ 1. This approach was first formally proposed by Papke and Wooldridge (1996), which suggested as possible specifications for *G*(·) any cumulative distribution function is the logistic function.

$$E (y/x) = \frac{e^{x\beta}}{1+e^{x\beta}} \dots\dots\dots (3.7)$$

Instead of being first linearized it must be directly estimated using nonlinear techniques. Hence, it was estimated by the quasi-maximum likelihood method (QML) based on the Bernoulli log-likelihood function, which was given by;

$$LL_i (\beta) = y_i \log[G(x_i\beta)] + (1 - y_i)\log[1 - G(x_i\beta)] \dots\dots\dots (3.8)$$

As the Bernoulli distribution is a member of the linear exponential family (LEF), the QML estimator of  $\beta$  was defined by:

$$\widehat{\beta}_0 = \arg \max_{\beta} \sum_1^N LL_i(\beta) \dots\dots\dots (3.9)$$

The equation was empirically presented.

$$E(HCI/x) = G(\beta_1 + \beta_2E + \beta_3HHsize + \beta_4Farmsize + \beta_5Mktaccess + \beta_7 roadacces + \beta_8Agrtech + \beta_9Assetownership + \beta_{10}assetcontrol + \beta_{11} Productiondec + \beta_{12}Group + \beta_{13}GPI) + \varepsilon_i \dots\dots\dots (3.10)$$

**Test for model specification**

Fractional regression model was used for household commercialization analysis. Household commercialization index is a fractional variable. In this study the link test was used for testing model specification. The dependent variable regressed on the predicted values and their squares. Important to note is the non-significance of the squares of the predicted values ( $p > 0.1$ ). It is on this basis that the logit link was used and the model was considered to be correctly specified (Daryl, 1980).

**To evaluate the relationship between women empowerment in agriculture and household dietary diversity in Rwanda.**

To analyze the relationship between household dietary diversity and women empowerment in agriculture, nonlinear instrumental variables regression model or generalized method of moments (GMM) estimation technique was used because it was more likely that women empowerment in agriculture within the household might be affected by the same factors affecting the household dietary diversity or simultaneously cause each other. Therefore, it was more likely to have the problem of endogeneity. The generalized method of moments (GMM) estimation technique is appropriate for count data models with endogenous regressors. Count data models can be specified with additive or multiplicative errors (Mullahy, 1997)

Household dietary diversity score (HDDS) was used to determine the level of household dietary diversity. It ranges between 0 and 12. Therefore it is a count data because it only takes the non-negative integer.

Before describing the estimation of count data model with endogenous regressors by the generalized method of moment (GMM), the standard of Poisson model must be presented as it accommodated the discrete nature of the dependent variable.

Let  $y_i, i = 1, \dots, n$  denote an independently distributed, nonnegative integer-valued variable with conditional mean specified as

$$E[y_i/x_i, \varepsilon_i] = \exp(x_i\beta), \dots\dots\dots (3.11)$$

The condition mean specification was implicitly defining a regression model

$$y_i = \mu_i + u_i = \exp(x_i\beta) + u_i, \dots\dots\dots (3.12)$$

The model was empirically specified as:

$$HDDS = \exp(\beta_0 + \beta_1 empowerment + \beta_2 Groups + \beta_3 Decinc + \beta_4 Resource + \beta_5 Time + \beta_6 Production + \beta_7 Hsize + \beta_8 Farmsize + \beta_9 mktaccess + \beta_{10} differenceAge + \beta_{11} InfCredit) + u_i, \dots\dots\dots (3.13)$$

Where HDDS is the number of food group consumed by household in 24 hours of the previous day,  $\beta_1 \dots \beta_{11}$  are parameters to be estimated. The coefficient  $\beta$  captures the main relationship of interest: the relationship between women's empowerment in agriculture and household dietary diversity. However, there are possibilities of estimates of  $\beta$  to be biased.

The factors influencing women's empowerment in agriculture can also influence household dietary diversity or women's empowerment in agriculture and household dietary diversity can simultaneously cause each other, thus, it results into endogeneity which cause estimate to be biased and inconsistency. Therefore, to diagnose the problem of endogeneity, Instrumental variables approach for count data was used. The difference in ages between the primary male and female decision-makers and information on the number of informal credit source in community village was used as instruments for all of the empowerment indicators.

The differences in ages can reflect the difference in bargaining power, since difference in age between primary female and primary male can reflect the difference of human capital. The study has not considered formal credit because it is collateral which can be correlated with household wealth. NGOs credit will not be considered because it requires membership. The existence of great number of informal credit could explain the presence of greater social capital, which can reflect women's decision making power within the community (Quisumbing & Hallman, 2005).

**Test for endogeneity**

### Durbin-Wu-Hausman test

The Durbin-Wu-Hausman test (Durbin, 1954; Wu, 1973; Hausman, 1978), hereafter derived the name of the DWH test, it is used to test the presence of endogeneity by comparing the ordinary least squares (OLS) estimate of the structural parameters in the IV regression to that of the two-stage least squares (TSLS). In addition, the DWH test used to decide whether to use an IV analysis compared to a standard OLS analysis; the IV analysis has lower bias when the included possibly endogenous variable in the IV regression is truly endogenous whereas the standard OLS analysis has smaller variance (Banerjee, 2007; Mulligan, 1996). The DWH test depends on strong instruments (Baum, 2007). This study has used the DWH test to test the presence of endogeneity in the model, since women empowerment score is endogenous. Hansen's j test was used to test for the validity of instrumental variables.

**Table 3: Model, Variables, Measurement and Expected variables**

Variables	Description	Measurement	Expected sign
Dependent variable			
Household commercialization index ( $Z_t$ )	Ratio of the gross value of all crop sales per household per year to the gross value of all crop production.	Percentage	NA
Household dietary diversity (D)	Number of food group consumed in the household in 24 hours	Value of HDDS	NA
Independent variables			
Empowerment score (E)	Female respondent's achievement in 5DE of WEAI	Female adequacy in 5DE	+
Household size (HHsize)	Number of household members	Number	-
Farm size	Total area of cultivation of the household	Square meter	+
Asset ownership	Women's sole or joint ownership of household's major asset	1=has ownership 0=has no ownership	+
Asset control	If woman has solo or joint decision of buying or selling assets (Dummy variable)	1=participated in decisions 0=not participated	+

Production dec	Having input in Production decisions	1= has input into decision 0= no input	+
Group	Number of groups female respondent is an active participant	Number	+
Decision on income ( <i>Decinc</i> )	decisions woman makes on the use of income and expenditures	1= has at least decision in one activity 0= has no inputs	+
Credit	Access to and participation in decision making concerning credit	1= has input in decision to the of credit 0=has no input into decisions	+
Time	Female workload	In hours	-
GPI	Gender parity gap	Value of GPI	-
Mktaccess	Distance to input and output market access	in hours	-
Roadaccess	State of road to the output market		-
		1.Very bad 2.Bad 3.Moderately 4.Good 5.Very good	
MktPrice	Price of the output per kg in Rwf (continuous)	In Rwfs	-
Agrtech	Having access to extension services (Dummy variable )	Yes=1 No =0	+
Instrumental variables			
Difference in age	Difference in age of primary female and male of the household	In years	+
Informal credit	Source of informal credit	Number	+

## CHAPTER FOUR

### RESULTS AND DISCUSSION

This chapter presents the results from analysis to address the objectives of the study. It is organized in three sections based on the three objectives of this study. The first objective presents the level of women empowerment in agriculture in Northern Province of Rwanda. The second objective determined the effect of women empowerment in agriculture on household farm commercialization in Rwanda. The last section presents the effect of women's empowerment in agriculture on household dietary diversity in Rwanda.

#### 4.1 Level of women empowerment in agriculture in Northern Province of Rwanda

This section addresses the first objective and presents the WEAI, and its sub-indices, the 5DE and the GPI, in Burera and Musanze districts from Northern Province of Rwanda. The WEAI for the Northern Province in Rwanda is 84.2 percent. It is a weighted average of the 5DE sub-index value of 0.83 and the GPI sub-index value of 0.95. The disempowerment index ( $M_0$ ) by domain and indicator was presented for both women and men for comparison purpose.  $M_0$  for women was greater than men's, means women are more disempowered than men. Women's  $M_0$  was 16.8 and men's  $M_0$  was 12. The results are presented in Table 4.

**Table 4: WEAI in the Northern province of Rwanda**

Indices	Women (%)	Men (%)
Disempowered headcount ( $H$ )	30	28
Average inadequacy score ( $A$ )	28	42
Disempowerment Index ( $M_0$ )	16.8	12
5DE Index ( $I - M_0$ )	0.83	88
Number of observation	252	252
Percentage of women without gender parity ( $H_{GPI}$ )	61	
Average Empowerment Gap ( $I_{GPI}$ )*	7.2	
Gender Parity Index	95	
Number of women in dual households	252	
WEAI	84.2	

Note: WEAI = Women's Empowerment in Agriculture Index

The 5DE for Northern Province of Rwanda shows that 70 percent of women are empowered. The 30 percent of women are not yet empowered; on average, inadequate achievement is 28 percent of domains. Thus, women's  $M_0$  is 60 percent  $\times$  28 percent = 0.168

5DE is  $1 - 0.168 = 0.83$  For men 28 percent of men were not yet empowered. The average inadequacy score among these men is 0.42. So men's  $M_0$  is 28 percent  $\times$  42 percent = 0.12 and men's 5DE is  $1 - 0.12 = 0.88$ .

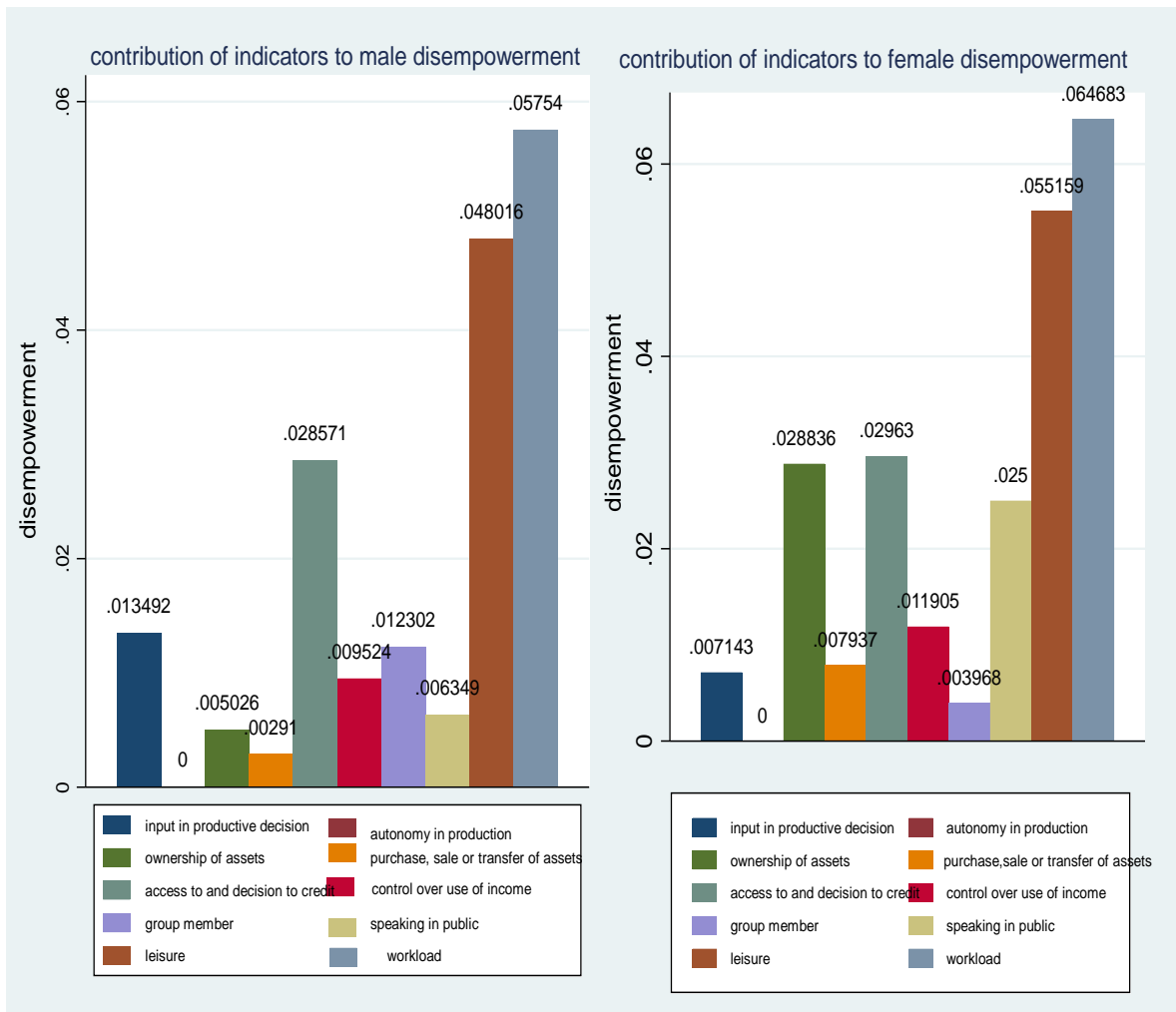
The results revealed that in Northern Province of Rwanda, women are less empowered in the 5DE, they have 83 percent while men have 88 percent. According to Alkire *et al.* (2013), men are more empowered than women in all indicators of women empowerment in agriculture. It was shown using the 5DE. Men's 5DE were 87.1 percent while women's 5DE were 69 percent in Bangladesh.

The number of women without gender parity was 69 percent while the number of women with gender parity was 31 percent and the average empowerment gap between women without gender parity and the adult males in their household ( $I_{GPI}$ ) is 7.2. According to Malapit *et al.* (2014), 70 percent of women in the whole country have achieved adequate empowerment. The average empowerment gap between women without gender parity and the adult males in their household was 0.15. WEAI was 0.91, 5DE index was 0.90, and GPI index was 0.96.

The WEAI from this study was 83.4 percent, however the study conducted by Malapit *et al.* (2014) demonstrated that the WEAI was 91 percent calculated considering all provinces of Rwanda. The 5DE index was 0.90, GPI index was 0.96, and about 70 percent of women have achieved adequate empowerment. The findings from this study have a lower WEAI because it was only based on one province of Rwanda.

#### **4.1.1 Contribution of each indicator to disempowerment of women and men**

Figure 3 compares male and female disempowerment and illustrates the contribution of each indicator to disempowerment.



**Figure 3: contribution of each indicator to disempowerment**

Findings represented in figure show that out of 10 indicators, 7 of them contributed less to men’s disempowerment compared to women. Making decisions on production decisions contributed less to men’s disempowerment with a mean value of 0.013492 of disempowerment compared to 0.007143 for women. Women are more disempowered in asset ownership (0.028836) compared to men (0.005206). Autonomy in production has no contribution to disempowerment for both women and men. For both women and men their mean value of disempowerment on autonomy is 0.

Purchase, sale and transfer of assets women have greater mean value of disempowerment of 0.07937 compared to men with 0.0291. Women are more disempowered in access to and decision on credit compared to men. They have a disempowerment mean value of 0.2963 and men have 0.28571. On control over the use of income, women are disempowered compared to

men. Men have a disempowerment mean value of 0.09524 and women have 0.07937. Women are more empowered in group membership compared to men.

Women's disempowerment mean value was 0.03968 and men's was 0.12302. Men are empowered in speaking in public compared to women with a disempowerment mean value of 0.006349 and 0.025 of women. Leisure time and workload time contribute more to disempowerment of both men and women, however they have contributed more to women's disempowerment (0.064883) compared to men's 0.048016.

Autonomy in production has contributed less to women's and men's disempowerment. The indicators that contribute the most to women's and men's disempowerment are workload and leisure. The indicator that contributed the least to women's in the same factor is group membership. The indicator that contributed the least to men's disempowerment is purchase, sale or transfer of assets. The indicators that show the greatest gap between men's and women's disempowerment are ownership of assets, speaking in public, group member and control over use of income.

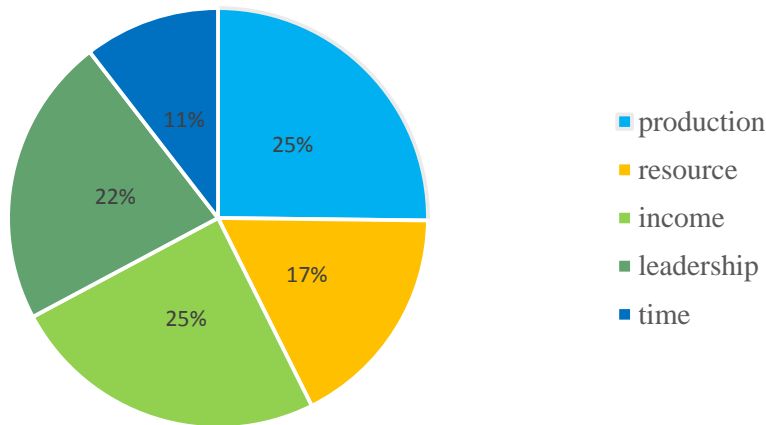
The results concur with the findings from the study conducted by Malapit *et al.* (2014) which showed that in East Africa women empowerment in agriculture is more severe constrained on access to and decisions on credit and workload. In Rwanda women are more disempowered than men. The greatest gap between men's and women's disempowerment are workload, speaking in public, and control over use of income.

The difference was also confirmed by a statistical test run to see the difference between female and male disempowerment. The results showed that at 5 %, the level of empowerment is different. After running the test,  $H_0$ , where there was no difference between male and female was reject. It was concluded considering the P value. Where,  $\Pr(|T| > |t|) = 0.0001$ .

#### **4.1.2 Contribution of 5DE to women empowerment**

Figure 4 presents the results of 5 Domains of Empowerment relating to women in the northern province of Rwanda.

### Contribution of Domains on Women Empowerment in Agriculture



**Figure 4: Contribution of each of domains to empowerment of women**

Figure 4 depicts that Agricultural production and control over use of income have contributed 25 percent of empowerment of women compared to the rest of the domains. This is consistent with the findings from the study conducted by Randell and McCloskey (2014) which revealed that in Rwanda, women are much more likely than men to work in agricultural occupations, and are more likely to depend on their farm work for income.

Women are empowered at 17 percent on the use of resources. The findings show that women's control over the use of agricultural resources is still constrained. Equal access to and control of land by both men and women still challenging gender equality in agriculture. On the domain of leadership women are empowered at 22 percent (MINAGRI,2010). The results are related to the government's policy that guarantee women a representative voice in public policy (Randell & McCloskey, 2014).

Women on the domain of time use are empowered at 11 percent. It is the domain which has the least contribution to empowerment of women in Northern Province of Rwanda. The plausible reason is that women are overwhelmed with household chores together with farm activities. Women's workload in Rwanda is extremely high. They are responsible for unpaid home activities such as fuel-wood and water collection as well as other household tasks, including care for the children and the elderly. In addition, they work on the family's cash crop plot as well as home garden plot and care for small animals kept by the household (USAID,2015).

## **4.2 Effect of women empowerment in agriculture on household commercialization**

Before presenting empirical results, both the categorical and continuous variables are discussed using descriptive approaches like graphs, means and percentages. This addresses the second objective.

### **4.2.1 Household commercialization**

The findings revealed that the mean Household Commercialization Index of maize, beans and potatoes for the entire sample was 0.32. This implies that on average, the farmers sell about 32 % of maize, beans and potatoes production.

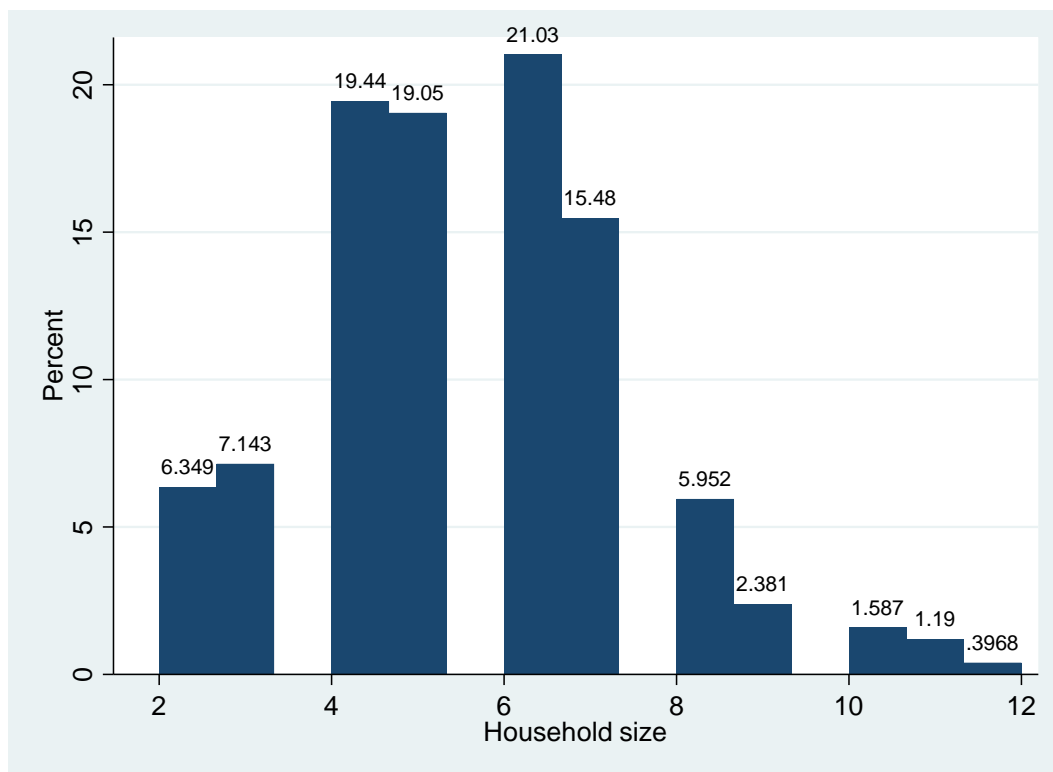
According to Mahaliyanaarachchi (2006), smallholder farmers can be categorized according to their commercialization levels. They can be classified into three groups namely subsistence (HCI Less or equal to 0.5), semi-commercial (HCI between 0.5 and 0.75) and commercial (HCI greater than 0.75). In Northern Province, 70 percent of households are in subsistence agriculture, 24 percent participate in semi-commercial and 6 percent are in commercial.

**Table 5: Farmer grouping by commercialization index**

<b>HCI</b>	<b>Farmer description</b>	<b>Percentage of farmers</b>
0.0-0.5	Subsistence	70
0.51-0.74	Semi-commercial	24
0.75-1.0	Commercial	6

### 4.2.1 Description of categorical variables affecting household commercialization

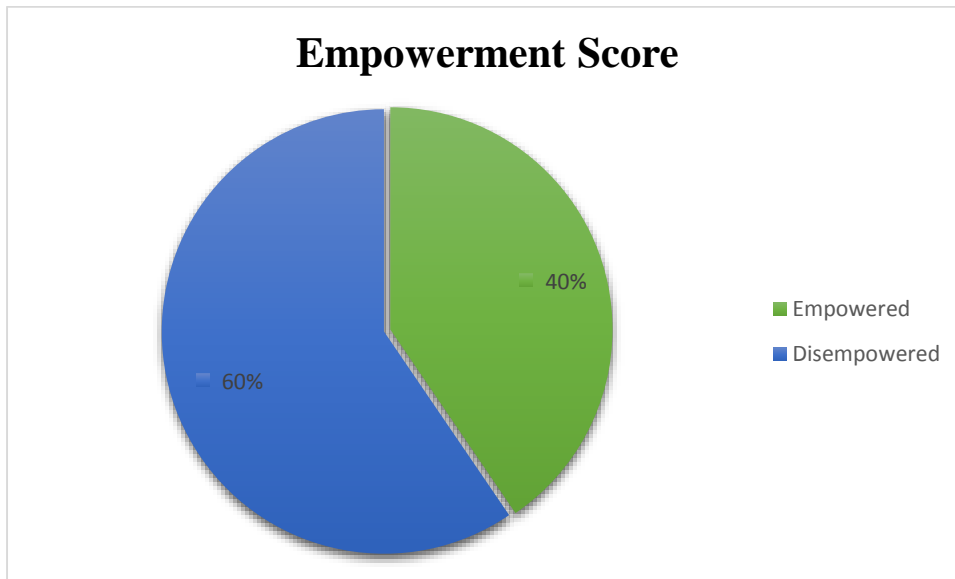
The categorical variables are household size, empowerment score, and gender.



**Figure 5: Size of the households**

Figure 5 depicts the distribution of household size. The largest number (75 percent) of the households had between 4 and 7 members distributed as follows: 4 members (19.44 percent), 5 members (19.05 percent), 6 members (21.03 percent), 7 members (15.48 percent). Only 13.49 percent had less than 4 members while only 11.5 percent had more than 7 members.

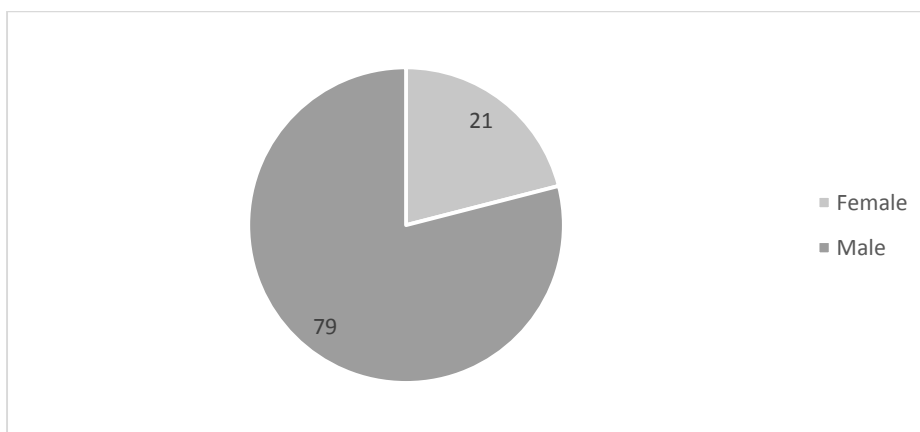
#### 4.2.2 Distribution of empowerment score of women and men



**Figure 6: Empowerment score**

The empowerment score of the households are given in Figure 5. Overall, 40% of the households have achieved empowerment in the five domains of women empowerment in agriculture, while 60% are disempowered. According to Quisumbing & Minzen-Dick (2001), despite improvements in building women’s capabilities, gender gaps in entitlements of the resources that women can command through available legal means continue to persist in Bangladesh.

Results in Figure6 shows that21% of the households in the province were headed by women while79 percent were headed by male. The households headed by women were less than the households headed by men. However, at the national level, 71% of households are headed by males and 29% by females in Rwanda (NISR, 2013).



**Figure 7: Empowerment percentage based on Gender**

#### 4.2.2 Description of continuous variables affecting household commercialization

Table 6, depicts the results of continuous variables that affect household commercialization.

**Table 6: Descriptive statistics of continuous variables affecting household farm commercialization in Northern Province of Rwanda**

Variables	Description	Mean	SD
<b>HCI</b>	<b>Household commercialization index</b>	<b>0.319</b>	<b>0.277</b>
Total farm size	Total area of cultivation in square meters	2991.68	3063.262
Access to input market	Distance to input market in hours	23.88	25.011
Access to output market	Distance to output market in hours	28.08	28.59
Distance to town	Distance to town market in hours	33.58	31.247
Total production of maize, beans and potatoes*	Total production in kg	110.70	162.686
Price of maize	Price of maize in Rfws/Kg	225.57	83.857
Price of potato	Price of potato in Rfws/Kg	220.65	95.532
Price of beans	Price of beans in Rfws/Kg	413.06	154.505

Table 6 depicts that the mean value of household commercialization index was 0.32. This implies that on average, the farmers sell about 32 % of maize, potatoes and beans. This is related to Word bank (2013) which has revealed that Rwanda farm commercialization is still limited.

The average total area of cultivation of the household was 0.3 hectares. Rwanda is one of the most densely populated countries thus fragmentation and small farm sizes are considered key policy issues (MINAGRI, 2012).

The Average time to input market was 23.88 minutes, average time to output market was 28.08 minutes and the average time taken to the nearest town was 33.58 minutes. This is due to the location of the study which was Musanze and Burera Districts. Both districts are near to the town and have easy access to output and input markets (NISR, 2013).

The average price per bag of maize was 225.57 Rfws/Kg (USD 0.23) potatoes was 220.61 Rfws (USD 0.23) while beans was 413.06 Rfws/Kg (USD 0.44). The average weight per bag of

maize, potatoes and beans was 110 kg. The results were consistent with the findings of NISR (2019) which revealed that in 2018/2019 agricultural year the country had relative increase of crop production.

#### **4.2.3 Econometric results of effect of women empowerment in agriculture on household dietary diversity in Northern Province of Rwanda**

First, a test of specification of the model was done. Table 6 shows the link test results of the fractional response model. The dependent variable regressed on the predicted values and their squares. Important to note is the non-significance of the squares of the predicted values ( $p > 0.1$ ). It is on this basis that the logit link was used and the model was considered to be correctly specified.

**Table 7: The link test result**

<b>HCI</b>	<b>Coefficients</b>	<b>P_value</b>
Hat	2.039254	0.13
Hatsq	-.8815519	0.429
Cons	-.2889918	0.454

The econometric results showing the effect of women empowerment in agriculture and other socio-economic factors on household farm commercialization are presented in Table 8.

**Table 8: Econometric results of effect of women empowerment in agriculture on household farm commercialization in Northern Province of Rwanda**

Variables	Coefficients	Robust Standard error	p_values
<b>HCI</b>			
women empowerment score	2.537***	0.8917	0.004
Family size	0.029	0.03371	0.380
Farm size	0.0547**	0.0222	0.014
Distance to market	-0.0006	0.0024	0.798
Input in productive decision	0.2071	0.3444	0.548
Asset ownership	0.0429	0.1653	0.795
Asset control	0.2549	0.2830	0.368
Access to extension services	-0.4325***	0,1726	0.012
Access to road	-0.0010	0.0533	0.984
Price of maize	0,0043***	0.0005	0.000
Price of potatoes	0.0018***	0.0003	0.000
Price of beans	0.00109***	0.0002	0.000
Constant	-3.426	0.5673	0.000
Number of observations	252		
Log pseudolikelihood	-135.353		
Pseudo R <sup>2</sup>	0.1424		

Note: \* p<0.1, \*\* p<0.05, \*\*\*p<0.01

In the Northern Province of Rwanda, the factors that positively and significantly influenced household farm commercialization were: women empowerment score, farm size, and prices of maize, potatoes and beans. On the other hand, access to extension services had a negative relationship.

Women empowerment in agriculture score was positively and statistically significant at 1 %. An increase of 1 unit of women empowerment in agriculture score, increases household farm commercialization by 2.53 units. Since women are main actors in agriculture, when they are empowered they promote market orientated agriculture (Quisumbing *et al.*, 2015). According to Afolabi (2012), women empowerment has a positive relationship with farm commercialization.

Farm size has a positive sign and it was statistically significant at 5 %. Each additional unit of farm size increased household farm commercialization by 0.547 units. When the farm size increases, it also increases with the production which lead to the increase of agricultural commercialization. According to Martey *et al.* (2012), farm size has a positive significant relationship with household agricultural commercialization in Ghana.

All prices of maize, potatoes and beans have positive signs. The price of maize was statistically significant at 1 %. At every increase of 1Rwf on the price of maize increases household farm commercialization by 0.004 units. It implies that if the price of maize increases, farmers are encouraged to sell more because of better returns. The Study conducted by Asante *et al.* (2017) revealed that unit price of maize has a positive relationship with agricultural commercialization in Ghana. They have found that maize's farmers were taking their production to the market when the price was high.

The price of potatoes has a positive sign and statistically significant at 1 %. If the price of potatoes increases at one unit, household agricultural commercialization increases by 0.002 units. The plausible reason is that increase of output price encourages farmers to produce more to the market. According to Kyomugisha *et al.* (2018), the price of potatoes was a positive and statically significant with agricultural commercialization in Uganda.

The price of beans has a positive sign and was statically significant at 1 %. If the price of beans increases of 1 unit it increases 0.001 units of household farm commercialization. The results are consistent with the results from the research done in Rwanda by Ingabire *et al.* (2017) revealed that the price of beans has a positive and statically significant relationship with farm commercialization in Northern Province of Rwanda.

Access to extension services has a negative sign and it is statistically significant at 5 %. Every additional unit of extension service reduces household farm commercialization at 0.432 units. The plausible reason may be attributed to the kind of extension messages given to the farmers which may not be related to commercialization. This is consistent with findings from the study conducted in Ghana by Martey *et al.* (2012) which revealed that the extent of cassava commercialized by households with access to extension services is 4% lower than those without access to extension services. According to Ingabire *et al.* (2017), access to extension

services have a negative relationship with beans commercialization in Northern Province of Rwanda.

### **4.3 Effect of women empowerment in agriculture on household dietary diversity in northern province of Rwanda**

This section presents the results and discussion of effect of women empowerment in agriculture score and other indicators of women empowerment in agriculture index on household dietary diversity. It was estimated by instrumental variable Poisson regression model for count data using generalized method of moment (GMM). Age difference between the primary male and female decision-makers and information on the number of informal credit source in community village was used as instruments for all of the empowerment indicators. All instruments were tested valid using Hansen's J test presented. Endogeneity was tested using Durbin-Wu\_Hausman (DWH) test. It is a hypothesis test. The results of DWH test, shown that the P-value of 0.0464. Therefore, the null hypothesis which was that the variables are exogenous was rejected. This has concluded the presence of endogeneity.

GMM is judged to be the appropriate estimation technique (Braum *et al.*, 2003). The validity of instrumental variables was conducted using Hansen's j test. The test has shown that the model was significant at 10 % with the p-value of 0.0923. Therefore, the model was identified and the instruments were valid.

#### **4.3.2 Household dietary diversity**

The household dietary diversity was calculated using household dietary diversity score (HDDS). It was based on the recall of food group consumed by the household within the 24 hours of the previous day.

The average HDDS was 4.5 in Musanze and Burera districts. On average, households consumed five food groups on the previous day of the survey. The target HDDS was 7. The target HDDS to consider the household adequate in dietary diversity was established by taking the average diversity of the 33 percent of households with the highest diversity (upper tercile of diversity) (Swindale *et al.*, 2006). Only 20% of the households had consumed at least seven food groups among the twelve used to calculate HDDS. According to Paridaens *et al.* (2018), despite a rapid economic growth food access, food consumption, and chronic malnutrition remain issues in Rwanda.

**Table 9: Econometric results of effect women empowerment in agriculture on household dietary diversity in northern Rwanda**

Variables	Robust		
	Coefficient	Standard error	p_value
<b>HDDS</b>			
Female empowerment score	2.594***	0.429	0.000
group membership	1.046	2.121	0.622
Income control	1.950**	0.642	0.002
Asset ownership	0.870	0.854	0.308
Workload	-1.111**	0.483	0.022
Decision making for productive capital	0.089	1.317	0.946
Household size	-0,029***	0.014	0,042
Total farm size	0.00002***	6.230	0.000
Distance to nearest town	-0.0007	0.000	0.277
Gender parity	-0.004**	0.002	0.015
Number of observation	252		
Number of moments	10		
Number of parameters	13		
Initial weight matrix			
GMM weight matrix	Unadjusted		
	Robust		

Note: \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

From the results presented in Table 9, household dietary diversity was positively and statistically significant with women empowerment score, female control of the use of income and total farm size of the household. It was negatively and significantly with female workload, household size and gender parity.

Women empowerment score had a positive sign and it was statistically significant at 1%. An additional one unit of women empowerment score, increases household dietary diversity by 2.594 units. According to Sraboni *et al.* (2014), in Bangladesh female empowerment score was highly significant and positively correlated with household dietary diversity.

Control of income by women was positively significant at 5 % with household dietary diversity. For, every additional control of income, it increases household dietary diversity by 1.950 units. The plausible reason is that if women are given opportunity to participate in household decision making especially the use of household income, greater portion of budget will be allocated to food (Alkire *et al.*, 2013). It has also revealed that in Bangladesh female control over use of income had a positive and significant relationship with household dietary diversity (Sraboni *et al.*, 2014).

The level of workload of women was negatively significant at 5 % with household dietary diversity. Additional one hour to women workload reduced household dietary diversity by 1.111 units. The plausible reason is that if women who are mostly considered to prepare food are overwhelmed with work, they could not find the time to focus on diversifying food. They may also try to make it as simple as possible and do not concentrate to dietary diversification (Swindale & Bilinsky, 2006). In Ghana, the results suggest that lack of time in domestic work and cooking time is likely to negatively impact women and children's dietary diversity (Kkomatsu *et al.*, 2018).

Household size has a negative sign and it is statistically significant at 5 %. Every additional member of household decreases household dietary diversity by 0.029 units. When the number of household members increase, they tend to focus on the quantity of food prepared rather than focusing on the quality and diversification of diet. According to Ochieng *et al.* (2017), household size has a negative relationship with household dietary diversity in Tanzania.

Farm size had a positive sign and it is statistically significant at 1%. the bigger the portion of land owned by a household, the more the production of diversified crops. According to Ochieng *et al.* (2017), revealed that in Tanzania, agricultural land has a positive sign and it is statically significant. Land is an important factor for diet diversity and households owning larger areas of agricultural land had higher HDDS.

Gender parity had a negative sign and statistically significant at 5 %. A unit increase in gender parity makes household dietary diversity to reduce by 0.004 units. The higher men's empowerment compared to their women within the same household lead to the reduction of household dietary diversity. According to Sraboni *et al.* (2014), in Bangladesh gender parity

had a negative sign and is statistically significant. They have revealed that increase of gender gap within the household reduces household dietary diversity.

## **CHAPTER FIVE**

### **CONCLUSIONS AND RECOMMENDATIONS**

This section presents summary of the major findings in the study, conclusions drawn, recommendations and area for further research.

#### **5.1 Summary and Conclusions**

##### **5.1.1 Summary**

The overall objective of this study was to contribute toward agribusiness development through agricultural commercialization and rural women empowerment in agriculture in Rwanda. This study was therefore guided by three specific objectives. To determine the level of women empowerment in agriculture in Northern province of Rwanda, to determine the effect of women empowerment in agriculture on farm commercialization in Rwanda, to assess the effect of women empowerment in agriculture on household dietary diversity in Rwanda. The study was done on the sample size of 252 households from Musanze and Burera districts in Northern Province of Rwanda. It was obtained using multistage and random sampling techniques. The study has considered both primary female and male decision makers as respondents.

The results showed that in Northern Province women empowerment in agriculture was 84.2 % but women were less empowered than men in the 5DE. Women's 5DE was 83 % and men's 5DE was 88%. To meet this objective WEAI was calculated and descriptive statistics were used for analysis.

The effect of women empowerment in agriculture of household farm commercialization in Rwanda was estimated using fractional regression model. It was analyzed using female empowerment score and other social economic factors with the help of STATA and excel. Household farm commercialization was positively and significantly influenced by women empowerment in agriculture score, farm size and prices of maize, potatoes and beans. On the other hand, it has a negative relationship with access to extension services. Both descriptive and analytical statistics was used. Household farm commercialization was determined using household commercialization index which was the ratio of gross value of agricultural sales by gross value of all agricultural production of maize, potato and beans.

The effect of women empowerment in agriculture on household dietary diversity was assessed using instrumental variable Poisson regression model for count data. The data was analyzed

using STATA and excel. Both descriptive and analytical statistics was used. Household dietary diversity was positively and statically significant with women empowerment score, female control over the use of income and total farm size of the household. Household dietary diversity was negatively and significantly influenced by female workload, household size and gender parity. Household dietary diversity was determined using household dietary diversity score. It was calculated based on the recall of food group consumed by the household in the previous day.

### **5.1.2 Conclusions**

The study demonstrated the level of women empowerment in agriculture in Northern province of Rwanda. It has been developed using individual detailed data from both primary female and male respondents from the same household. Women were more empowered in the domains of production and use of income, they are less empowered in the domain of time. It has been concluded that women are less empower compared to men in northern province of Rwanda.

The second objective was to determine the effect of women empowerment in agriculture on household farm commercialization in Rwanda. Household farm commercialization in Rwanda was positively and significantly influenced by women empowerment in agriculture score, farm size and prices of maize, potatoes and beans. Therefore, it has been concluded that farmers should consider gender equality in agricultural decision making.

The third objective was to determine the effect of women empowerment in agriculture on household dietary diversity in Rwanda. Increasing women's empowerment scores, control over use income for women and narrowing gender inequality and women's workload are significantly associated with household dietary diversity. Other social economic factors were also used. Increasing total farm size, reducing the number of household and the distance to the town have significant relationship with household dietary diversity. It has been concluded that HDDS can be achieved by empowering women in Northern province of Rwanda.

Based on this study women's empowerment in all indicators of WEAI is not the only factor which can influence household dietary diversity in Rwanda. The finding revealed that not only women empowerment in agriculture contributes to absolute empowerment, but the relative empowerment of women within households, also positively affects nutritional well-being and provides additional support for policies to narrow the gender gap in Rwanda.

## **5.2 Recommendations**

Based on the findings from these study women are still less empowered in agriculture compared to men in Northern Province of Rwanda. The government should set policies emphasizing to the gender equality in agriculture.

Women empowerment in most of indicators of women empowerment in agriculture index has a positive and significant effect to both household farm commercialization. Government should encourage farmers to consider empowering women in agricultural decision making.

Women empowerment has a positive relationship with household dietary diversity in Northern province of Rwanda, thus the government and policy makers should consider taking women empowerment in agriculture as an important tool toward development of food security.

### **5.2.1 Areas for further research**

This study was based on cross sectional data, it does not supported an examination of the dynamic impacts associated with women's empowerment in agriculture on household farm commercialization as well on household dietary diversity. Hence the effect of women empowerment in agriculture on both farm commercialization and dietary diversity should be checked using time series data. Furthermore, since women empowerment in agriculture has shown to be a multidimensional concept, its effect should be analyzed on different aspect such agricultural production. This study has used 24 hours recall on household dietary diversity. Further research should be done using a 7 days recall of food groups consumed by the household for capturing more information of dietary diversity within several days. In addition, the study was mainly based on women empowerment score and other women empowerment in agriculture indicators and few of social economic factors. Others researches should be done by adding some more social economic variables. This study has used women empowerment in agriculture as an independent variable. Further, research should be done by considering women empowerment in agriculture as dependent variable and associate it with other social economic variables.

## **REFERENCES**

- Allendorf, K. (2007). Do Women's Land Rights Promote Empowerment and Child Health in Nepal? *World Development*, 35 (11): 1975–1988.  
<https://dx.doi.org/10.1016%2Fj.worlddev.2006.12.005>

- Ackerson, L. K., & Subramanian, S. V. (2008). Domestic violence and chronic malnutrition among women and children in India. *American journal of epidemiology*, 167(10), 1188–1196. <https://doi.org/10.1093/aje/kwn049>
- Afolabi, M. (2012). Shifting Gender Power Dynamics: Agricultural Commercialization and Its Impacts on Gender Relations. *Mojirayo University*, 40 (2012) 1-17. <https://doi.org/10.1080/00220388.2016.1139693>
- Akter, S., Rutsaert, P., Luis, J., Htwe, M., San, S., Raharjo, B. & Pustaka, A. (2017). Women’s empowerment and gender equity in agriculture: A different perspective from Southeast Asia”. *Food Policy*, 69 (2017) 270–279. <https://dx.doi.org/10.1016/j.foodpol.2017.05.003>
- Alderman, H., P. A. Chiappori, L. Haddad, J. Hoddinott, & R. Kanbur. (1995). Unitary versus Collective Models of the Household: Is It Time to Shift the Burden of Proof? *World Bank Research Observer* 10 (1): 1–19. <https://econpapers.repec.org/RePEc:oup:wbrobs:v:10:y:1995:i:1:p:1-19>
- Alkire, S. (2005). Subjective Quantitative Studies of Human Agency. *Soc Indic Res*, 74, 217–260. <https://doi.org/10.1007/s11205-005-6525->
- Alkire, S. (2007). Measuring Agency: Issues and Possibilities. *Indian Journal of Human Development* 1 (1): 169–178. <https://doi.org/10.1177%2F0973703020070110>
- Alkire, S. & Foster, J. (2011). Counting and multidimensional poverty measurement. *Journal of Public Economics*, 95(7-8), 476-487. <https://econpapers.repec.org/scripts/showcites.pf?h=repec:eee:pubeco:v:95:y:2011:i:7-8:p:476-487>
- Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The women’s empowerment in agriculture index. *World development*, 52, 71-91. <https://www.ophi.org.uk/wp-content/uploads/ophi-wp-58.pdf>.
- Alsop, R. & Heinsohn, N. (2005). Measuring Empowerment in Practice: Structuring Analysis and Framing Indicators”. *World Bank Policy*, 12(1):1-17. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3657746/>
- Andersen, P. (2009). Food security: Definition and measurement”. *Food Security*, 1(1), 5-7. <https://doi.org/10.1007/s12571-008-0002-y>
- Andersson, D. Agnes (Ed.); Dzanku, Mawunyo F., Isinika, A. (2018) : Agriculture, Diversification, and Gender in Rural Africa: *Longitudinal Perspectives from Six Countries*, <http://dx.doi.org/10.1093/oso/9780198799283.001.0001>

- Anju M., Schulte, J. & Payal Patel Patti Petesch., (2009). "Innovation for women empowerment and gender equality. *International Center for women research*, 10(3): 30-45. <https://www.icrw.org/wp-content/uploads/2016/10/Innovation-for-Womens-Empowerment.pdf>
- Arimond, M., Hawkes, C., Ruel, M. T., Sifri, Z., Berti, P. R., Leroy, J. L. & Frongillo, E. A. (2011). Agricultural interventions and nutrition: lessons from the past and new evidence. *Eds B. Thompson and L. Amoroso*, 41-75. <https://hdl.handle.net/10568/66342>
- Asante, S. B., Osei-Asare, Y. B., & Kuwornu, J. K. (2016). Smallholder maize farmers' food consumption expenditures in Ghana: The mediating role of commercialization. *AGRIS on-line Papers in Economics and Informatics*, 8(3):13-27. <http://dx.doi.org/10.7160/aol.2016.080302>
- Babatunde, R., Omotesho, O., Olorunsanya, E. & Owotoki, G. (2007). Determinants of Vulnerability to Food Insecurity: A gender-based analysis of farming households in Nigeria. *Indian Journal of Agricultural Economics*, 63(1): 116–25. <https://econpapers.repec.org/RePEc:ags:inijae:204567>
- Banerjee, S. B., Martin, S. W., Roberts, R. K., Larson, J. A., Hogan Jr, R. J., Johnson, J. L., & Reeves, J. M. (2007). Adoption of conservation-tillage practices in cotton production (No.1367-2016-108357). <https://econpapers.repec.org/software/bocbocode/s429401.htm>.
- Barham, J., & Chitemi, C. (2009). Collective action initiatives to improve marketing performance: Lessons from farmer groups in Tanzania. *Food policy*, 34(1), 53-59. <http://dx.doi.org/10.1016/j.foodpol.2008.10.002>
- Bashir M. & Schilizzi, S. (2012). Measuring food security: Definitional sensitivity and implications, 56th AARES annual conference, Fremantle, Western Australia, February 7-10, 2012. <https://doi.org/10.22004/AG.ECON.124227>
- Bashir, M., Schilizzi, S., Khalid Bashir, M. & Schilizzi, S. (2012). Measuring food security: Definitional sensitivity and implications, Conference (56th), *Australian Agricultural and Resource Economics Society (AARES)* Fremantle, Australia. <https://doi.org/10.22004/ag.econ.124227>
- Baum C., Schaffer M., & Stillman S. (2003). Instrumental variables and GMM: Estimation and testing. *The Stata Journal*, 3(1), 1-31. <https://econpapers.repec.org/RePEc:tsj:stataj:v:3:y:2003:i:1:p:1-31>

- Baum, C., Schaffer, M., & Stillman, S. (2007). Instrumenta variable for endogeneity: Stata module to calculate Durbin-Wu-Hausman endogeneity test after instrumental variable regression. *The Stata journal*, 5(7), 310-330.  
<https://ideas.repec.org/c/boc/bocode/s429401.html>
- Bhagowalia, P., P. Menon, A. R. Quisumbing, & V. Soundararajan. (2012). What Dimensions of Women's Empowerment Matter Most for Child Nutrition: Evidence Using Nationally Representative Data from Bangladesh? *International Food Policy Research Institute*. <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/127005>
- Bogale, A. & Shimelis, A. (2009). Household Level Determinants of Food Insecurity in Rural Areas of Dire Dawa, Eastern Ethiopia. *African Journal of Food, Agriculture, Nutrition and Development*, 9(9), 14–26.  
<http://ajfand.net/AJFAND/copyrightstatement.html>
- Bomuhangi, A., C. Doss, & R. Meinzen-Dick. (2011). Who Owns the Land? Perspectives from Rural Ugandans and Implications for Land Acquisitions. IFPRI Discussion Paper 1136. Washington, DC: *International Food Policy Research Institute*.  
[www.ifpri.org/sites/default/files/publications/ifpridp01136.pdf](http://www.ifpri.org/sites/default/files/publications/ifpridp01136.pdf).
- Braun, V., Kennedy, E. & Tickner, V. (1995). Agricultural Commercialization, Economic Development, and Nutrition. *Food Policy-Economics Planning and Politics of Food and Agriculture*, 20(3), 161- 202.  
<http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129374>
- Carletto C., Zezza A. & Raka B. (2012). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security*, 2 (2013) 30–40. <http://dx.doi.org/10.1016/j.gfs.2012.11.006>
- Chirkov, V., R. M. Ryan, & E. L. Deci. (2011). Human Autonomy in Cross-cultural Context: Perspectives on the Psychology of Agency, Freedom, and Well-being (Cross-Cultural Advancements in Positive Psychology). Dordrecht, the Netherlands: *Springer science and business media*. 1(5)20-40. <https://link.springer.com/content/pdf/bfm%3A978-90-481-9667-8%2F1.pdf>
- Cunningham, K., M. Ruel, E. Ferguson, & R. Uauy. (2015). Women's Empowerment and Child Nutritional Status in South Asia: A Synthesis of the Literature. *Maternal and Child Nutrition* 11 (1): 1–19. <http://dx.doi.org/10.1111/mcn.12125>
- Daryl P. (1980). Goodness of Link Tests for Generalized Linear Models. *the Royal Statistical Society. Series C (Applied Statistics)*. 29(1), 15-24. <https://doi.org/10.2307/2346405>

- Djurfeldt, A. A. (2018). Gender and rural livelihoods: Agricultural commercialization, and farm/non-farm diversification. Agriculture, diversification, and gender in rural Africa: Longitudinal perspectives from six countries, *Oxford University Press, Oxford*, 81-112 <http://dx.doi.org/10.1093/oso/9780198799283.001.0001>
- Doss, C., Raney, T., Anríquez, G., Croppenstedt, A., Gerosa, S., Lowder, S., & Skoet, J. (2011). The role of women in agriculture. *Food and Agriculture Organization of the United Nations*. <https://www.fao.org/3/am307e/am307e00.pdf>
- Duflo, E. (2012). Women empowerment and economic development. *Journal of Economic Literature*, 50(4), 1051-79. DOI: 10.1257/jel.50.4.1051
- Duflo, E. & Udry, C. (2004). Intrahousehold resource allocation in Cote d'Ivoire: Social norms, separate accounts and consumption choices. *National Bureau of Economic Research*, 1-60. <https://ideas.repec.org/p/nbr/nberwo/10498.html>
- FAO. (2011). Women in agriculture: closing the gender gap for development. *Electronic Publishing Policy and Support Branch*. <https://www.fao.org/publications/sofa/2010-11/en/>.
- FAO. (2017). Regional overview of food security and nutrition. 2015-2016. *Regional Office for Africa*. <https://www.fao.org/3/i7967e/i7967e.pdf>
- Fischer, E. & Qaim, M. (2012). Gender, agricultural commercialization, and collective action in Kenya. *Food Security*, 4(3), 441-453. <https://doi.org/10.1007/s12571-012-0199-7>
- Gebbers, R. and Adamchuk, V. I. (2010). Precision agriculture and food security. *Science*, 327(5967), 828-831. <http://dx.doi.org/10.1126/science.1183899>
- Gebremedhin, B., & Tegegne, A. (2012). Market orientation and market participation of smallholders in Ethiopia: Implications for commercial transformation. (No. 1007-2016-79528). <https://hdl.handle.net/10568/21782>
- GMO. (2017). Gender and agriculture. Retrieved from [http://gmo.gov.rw/rw/fileadmin/user\\_upload/profiles/Gender\\_Profile\\_in\\_Agriculture\\_GMO](http://gmo.gov.rw/rw/fileadmin/user_upload/profiles/Gender_Profile_in_Agriculture_GMO). On 9<sup>th</sup> May 2020.
- Gupta, K. (2017). Globalization and Women Empowerment. *Journal of Social Sciences and Multidisciplinary Management Studies*, 1(1), 1-4. <https://mpa.ub.uni-muenchen.de/82895/>
- Haddad, L., Hoddinott, J. & Alderman, H. (1997). Intrahousehold Resource Allocation in Developing Countries. *International Food Policy Research Institute*. 21218-4319. <http://www.pep-net.org/sites/pep-net.org/files/typo3doc/pdf/intrahhres1.pdf>

- Hoddinott, J. Yohannes, Y. (2002). Dietary Diversity as food security indicator. *Food consumption and nutrition division paper no.136. International of Food Policy Research Institute*, Washington, DC Retrieved from:  
<http://www.nber.org/papers/w16555>. On 15<sup>th</sup> May, 2019
- Ibnouf, F. O. (2011). Challenges and possibilities for achieving household food security in the Western Sudan region: the role of female farmers. *Food Security*, 3(2), 215-231.  
<https://doi.org/10.1007/s12571-011-0118-3>
- Ingabire C., Mshenga, P., Langat, K, Bigler, C, Musoni, A., Butare L. & Birachi E. (2017) Towards commercial agriculture in Rwanda: understanding the determinants of market participation among smallholder bean farmers. *African Journal of Food Agriculture. Nutrition*, 17(4), 12492-12508.  
<http://dx.doi.org/10.18697/ajfand.80.16825>
- Ingabire, C., Mshenga, P. M., Amacker, M., Langat, J. K., Bigler, C., & Birachi, E. A. (2018). Agricultural transformation in Rwanda : Can Gendered Market Participation Explain the Persistence of Subsistence Farming? *Gender and Women's Studies*, 2(1), 1–18.  
<http://dx.doi.org/10.31532/GendWomensStud.2.1.004>
- Jaleta, M., Gebremedhin, B. & Hoekstra, D. (2009). Smallholder commercialization: Processes, determinants and impact. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project, *ILRI (International Livestock Research Institute)*.  
[https://cgspace.cgiar.org/bitstream/handle/10568/27/SmallholderCommercializationProcesses\\_DiscPaper18.pdf?sequence=1&isAllowed=y](https://cgspace.cgiar.org/bitstream/handle/10568/27/SmallholderCommercializationProcesses_DiscPaper18.pdf?sequence=1&isAllowed=y)
- Jensen, R. T. & Miller, N. H. (2010). A revealed preference approach to measuring hunger and undernutrition. *National Bureau of Economic Research*.  
<https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.nber.org%2Fpapers%2Fw16555.pdf;h=repec:nbr:nberwo:16555>
- Kabeer, N. (2001). Resources, agency, achievements: Reflections on the measurement of women's empowerment, in A. Sisask, ed, *Discussing Women's Empowerment Theory and Practice*, Stockholm: *Swedish International Development Cooperation Agency*, 17–59,  
<https://gsdrc.org/document-library/resources-agency-achievements-reflections-on-the-measurement-of-womens-empowerment/>
- Kabeer, N. (2005). Gender equality and women's empowerment: A critical analysis of the third millennium development goal. *Gender and Development*, 13(1), 13-24.  
<http://dx.doi.org/10.1080/13552070512331332273>

- Kasente, D. (2012). Fair trade and organic certification in value chains: Lessons from a gender analysis from coffee exporting in Uganda. *Gender & Development*, 20(1), 111-127. <https://doi.org/10.1080/13552074.2012.663627>
- Kennedy, G., Ballard, T. & Dop, M. C. (2011). Guidelines for measuring household and individual dietary diversity. Rome. *Food and Agriculture Organization of the United Nations*, Rome.
- Kennedy, G., Razes, M., Ballard, T. & Dop, M. (2010). Measurement of dietary diversity for monitoring the impact of food based approaches. In *International symposium on food and nutrition security*, Rome.
- Kilic, T., A. Palacios-Lopez, & M. Goldstein. (2013). Caught in a Productivity Trap: A Distributional Perspective on Gender Differences in Malawian Agriculture. Policy Research Working Paper 6381. Washington, DC: *World Bank*. <http://hdl.handle.net/10986/13182>
- KKomatsu, H., Malapit, H. J. L., and Theis, S. (2018). Does women's time in domestic work and agriculture affect women's and children's dietary diversity? Evidence from Bangladesh, Nepal, Cambodia, Ghana, and Mozambique. *Food Policy*, 79(2), 256–270. <https://doi.org/10.1016/j.foodpol.2018.07.002>
- Kyomugisha, H., Sebatta, C., & Mugisha, J. (2018). Potato market access, marketing efficiency and on-farm value addition in Uganda. *Scientific African*. 1, 1-13. <https://doi.org/10.1016/j.sciaf.2018.e00013>
- Labadarios, D., Steyn, N. P. & Nel, J. (2011). How diverse is the diet of adult South Africans? *Nutrition Journal*, 10, (33), 1-11. <https://doi.org/10.1186/1475-2891-10-3>
- Lastarria-Cornhiel, Susana. 2008. *Feminization of Agriculture : Trends and Driving Forces*. Washington, DC: *World Bank*. <https://openknowledge.worldbank.org/handle/10986/9104> License: CC BY 3.0 IGO.
- Mahaliyanaarachchi, R. P. & Bandara, R. M. A. S. (2006). Commercialization of agriculture and role of agricultural extension. *Sabaragamuwa University Journal*, 6(1), 13-22. <http://doi.org/10.4038/suslj.v6i1.1686>
- Mahmud, S., Shah, N. M. & Becker, S. (2012). Measurement of women's empowerment in rural Bangladesh. *World development*, 40(3), 610-619. <https://dx.doi.org/10.1016%2Fj.worlddev.2011.08.003>
- Malapit, H. J. L., & A. R. Quisumbing. (2015). What Dimensions of Women's Empowerment in Agriculture Matter for Nutrition in Ghana? *Food Policy*, 52:54–63. <http://dx.doi.org/10.1016/j.foodpol.2015.02.003>

- Malapit, H. J. L., S. Kadiyala, A. R. Quisumbing, K. Cunningham, & P. Tyagi. (2015). Women's Empowerment Mitigates the Negative Effects of Low Production Diversity on Maternal and Child Nutrition in Nepal." *Journal of Development Studies* 51 (8): 1097–1123.  
<https://doi.org/10.1080/00220388.2015.1018904>
- Malapit, H. J., Sproule, K., Kovarik, C., Meinzen, R., Quisumbing, A., Ramzan, F. & Alkire, S. (2014). Measuring progress toward empowerment: Women's empowerment in agriculture index: Baseline report. *International Food Policy Research Institute*, 52, 54-63.  
<http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/128190>
- Malhotra, A., Schuler, S. R., & Boender, C. (2002). Measuring women's empowerment as a variable in international development. In background paper prepared for the World Bank Workshop on Poverty and Gender, *New Perspectives*, 1-59.  
<https://doi.org/10.1037/e597202012-004>
- Martey, E., Al-Hassan, R. M., & Kuwornu, J. K. (2012). Commercialization of smallholder agriculture in Ghana: A Tobit regression analysis. *African Journal of Agricultural Research*, 7(14), 2131-2141.  
<http://dx.doi.org/10.5897/AJAR11.1743>
- Meinzen, R., Behrman, J., Pandolfelli, L., Peterman, A. and Quisumbing, A. (2014). Gender and social capital for agricultural development. *Springer, Dordrecht*, 235-266.  
[https://doi.org/10.1007/978-94-017-8616-4\\_10](https://doi.org/10.1007/978-94-017-8616-4_10)
- Mekuria, G., Wubneh, Y., & Tewabe, T. (2017). Household dietary diversity and associated factors among residents of finote selam town, North West Ethiopia: a cross sectional study. *BMC Nutrition*, 3(1), 28.  
<https://bmcnutr.biomedcentral.com/articles/10.1186/s40795-017-0148-0>
- MINAGRI. (2010). *Agriculture Gender Strategy. Government of Rwanda*.  
[https://www.minagri.gov.rw/fileadmin/user\\_upload/documents/Publications/Agriculture%20Gender%20Strategy%20Final.pdf](https://www.minagri.gov.rw/fileadmin/user_upload/documents/Publications/Agriculture%20Gender%20Strategy%20Final.pdf)
- MINECOFIN. (2013). *Economic Development and Poverty Reduction Strategy II (2013-2018). Government of Rwanda*. <http://www.minecofin.gov.rw/index.php?id=149>
- Mullahy, J. (1997). Instrumental-variable estimation of count data models: Applications to models of cigarette smoking behavior. *Review of Economics and Statistics*, 79(4), 586-593. <https://doi.org/10.1162/003465397557169>

- Mulligan, R. F. (1996). Export-import endogeneity in the context of the Thirlwall–Hussain model: an application of the Durbin–Wu–Hausman test incorporating a Monte Carlo experiment. *Applied Economics Letters*, 3(4), 275-279.  
<https://doi.org/10.1080/758520879>
- National Institute of Statistics of Rwanda (NISR), Ministry of Finance and Economic Planning (MINECOFIN). (2012). *Population size, structure and distribution. Rwanda Fourth Population and Housing Census*.  
<http://www.statistics.gov.rw/> .
- Negin, J., Remans, R., Karuti, S., & Fanzo, J. (2009). Integrating a broader notion of food security and gender empowerment into the African Green Revolution. *Food Security*, 1(3)351-360. DOI : [10.1007/s12571-009-0025-z](https://doi.org/10.1007/s12571-009-0025-z)
- NEPAD. (2016). Guidelines CAADP Country Implementation under the Malabo Declaration. *New Partnership for Africa's Development*, Malabo.  
<https://www.nepad.org/publication/country-caadp-implementation-guidelines-under-malabo-declaration>
- Njuki, J., Kaaria, S., Chamunorwa, A., & Chiuri, W. (2011). Linking smallholder farmers to markets, gender and intra-household dynamics: does the choice of commodity matter?. *The European Journal of Development Research*, 23(3), 426-443.  
<https://doi.org/10.1057/ejdr.2011.8>
- Ochieng J, Afari-Sefa V, Lukumay PJ, Dubois T (2017) Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. *PLoS ONE* 12(12),1-18. <https://doi.org/10.1371/journal.pone.0189022>
- Okezie, C. A., Nwosu, A. C., & Okezie, C. R. (2008). An assessment of the extent of the commercialization of agriculture in Abia State. *Nigeria. Agricultural Journal*, 3(2), 129-133. <http://www.iosrjournals.org/iosr-javs/papers/vol4-issue2/J0424955.pdf?id=4031>
- Papke, L. E., & Wooldridge, J. M. (1996). Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. *Journal of applied econometrics*, 11(6), 619-632. [https://doi.org/10.1002/\(SICI\)1099-1255\(199611\)11:6%3C619::AID-JAE418%3E3.0.CO;2-1](https://doi.org/10.1002/(SICI)1099-1255(199611)11:6%3C619::AID-JAE418%3E3.0.CO;2-1)
- Paridaens, A. & Jayasinghe, S. (2018). Rwanda 2018 Comprehensive food security and vulnerability analysis. *NISR, National institute of Rwanda*, 5(20)1-152.  
<http://www.wfp.org/food-security>

- Pender, J. L., & Alemu, D. (2007). Determinants of smallholder commercialization of food crops: Theory and evidence from Ethiopia. *International Food Policy Research Institute*, 1(4)250-230
- Pérez-Escamilla, R., & Segall-Corrêa, A. M. (2008). Food insecurity measurement and indicators. *Revista de Nutrição*, 21, 15-26.
- Peterman, A., Quisumbing, A., Behrman, J. & Nkonya, E. (2011). Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda. *Journal of Development Studies*, 47(10), 1482-1509.  
<https://doi.org/10.1080/00220388.2010.536222>
- Pingali P. & Rosegrant M. (1995). Agricultural commercialization and diversification: Process and policies. *Food Policy*. 20(3), 171-185.  
<https://econpapers.repec.org/RePEc:eee:jfpoli:v:20:y:1995:i:3:p:171-185>
- Pingali, P., Khwaja, Y. & Meijer, M. (2005). Commercializing small farms: Reducing transaction costs. *The Future of Small Farms*, 61, 5-8.  
<https://ideas.repec.org/p/fao/wpaper/0508.html>
- Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food security*, 1(1), 5-7. <http://dx.doi.org/10.1007/s12571-008-0002-y>
- Quisumbing, A. (2013). Generating evidence on individuals' experience of food insecurity and vulnerability. *Global food security*, 2(1), 50-55.  
<http://dx.doi.org/10.1016/j.gfs.2012.11.004>
- Quisumbing, A. & Hallman, K. (2005). Marriage in transition: Evidence on age, education, and assets from six developing countries. *The changing transitions to adulthood in developing countries: Selected studies*, Washington DC, 200-269.  
<https://doi.org/10.17226/11524>
- Quisumbing, A. & Minzen-Dick, R. (2001). Empowering women to achieve food security. *International Food Policy Research Institute*, Washington D.C.  
<https://www.ifpri.org/publication/empowering-women-achieve-food-security>
- Quisumbing, A. & Smith, L. (2012). Intrahousehold Allocation, Gender Relations, and Food Security in Developing Countries (4-5). *Case Studies in Food Policy for Developing Countries*, 195-208. <http://dx.doi.org/10.7591/9780801466366-021>
- Quisumbing, A. R. (1995). Gender differences in agricultural productivity: a survey of empirical evidence, (No. 583-2016-39541). <http://dx.doi.org/10.22004/ag.econ.42675>

- Quisumbing, A. R., & Maluccio, J. A. (2003). Resources at marriage and intrahousehold allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa. *Oxford Bulletin of Economics and Statistics*, 65(3), 283-327.  
<https://onlinelibrary.wiley.com/journal/14680084>
- Quisumbing, A. R., & Pandolfelli, L. (2010). Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions. *World development*, 38(4), 581-592.  
<https://econpapers.repec.org/RePEc:eee:wdevel:v:38:y:2010:i:4:p:581-592>
- Quisumbing, A., Rubin, D., Manfre, C., Waithanji, E., Van den Bold, M., Olney, D. & Meinzen-Dick, R. (2015). Gender, assets, and market-oriented agriculture: learning from high-value crop and livestock projects in Africa and Asia. *Agriculture and Human Values*, 32(4), 705-725. <https://doi.org/10.1007/s10460-015-9587-x>
- Rahman, S. (2010). Women's labour contribution to productivity and efficiency in agriculture: empirical evidence from Bangladesh. *Journal of Agricultural Economics*, 61(2), 318-342. <https://doi.org/10.1111/j.1477-9552.2010.00243.x>
- Ramalho, E., Ramalho, J. & Murteira, J. M. (2011). Alternative estimating and testing empirical strategies for fractional regression models. *Journal of Economic Surveys*, 25(1), 19-68. <https://doi.org/10.1111/j.1467-6419.2009.00602.x>
- Randell, S. & McCloskey, M. (2014). Sustainable rural development in Rwanda: the importance of a focus on Women in agriculture. *International Journal of Agricultural Extension*, 6116(01), 107-119.  
<https://esciencepress.net/journals/index.php/IJAE/article/view/662>
- Sajid K. (2013). Women's empowerment through poverty alleviation: a sociocultural and politico-economic assessment of conditions in Pakistan. *International Journal of Academic Research and Reflection*, 1(1), 16-40
- Sen, A. (1981). Poverty and Famine: an Essay on Entitlement and Deprivation, *Oxford University Press*, New York
- Sharaunga, S., Mudhara, M., & Bogale, A. (2016). Effects of 'women empowerment' on household food security in rural KwaZulu-Natal province. *Development Policy Review*, 34(2), 223–252. <https://doi.org/10.1111/dpr.12151>
- Shroff, M. R., Griffiths, P. L., Suchindran, C., Nagalla, B., Vazir, S., & Bentley, M. E. (2011). Does maternal autonomy influence feeding practices and infant growth in rural India? *Social Science & Medicine*, 73(3), 447–455.  
<https://doi.org/10.1016/j.socscimed.2011.05.040>

- Smith, L., Ramakrishnan, U., Ndiaye, A., Haddad, L. & Martorell, R. (2003). The Importance of Women's Status for Child Nutrition in Developing Countries. Research Report (131). *International Food Policy Research Institute*, Washington, DC.
- Smith, L. C., Ramakrishnan, U., Ndiaye, A., Haddad, L., & Martorell, R. (2003). The Importance of Women's Status for Child Nutrition in Developing Countries. *Food and Nutrition Bulletin*, 24(3), 287–288. <https://doi.org/10.1177/156482650302400309>
- Sraboni, E., A. R. Quisumbing, & A. U. Ahmed. (2014). How Empowered Are Bangladeshi Women in the Agricultural Setting? Empirical Evidence Using a New Index. *The Bangladesh Development Studies*, 37 (3), 1– 25. <https://www.jstor.org/stable/26538638>
- Sraboni, E., Malapit, H. J., Quisumbing, A. R., & Ahmed, A. U. (2014). Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development*, 61, 11–52. <https://doi.org/10.1016/j.worlddev.2014.03.025>
- Strasberg, P. J., Jayne, T. S., Yamano, T., Nyoro, J. K., Karanja, D. D. & Strauss, J. (1999). Effects of agricultural commercialization on food crop input use and productivity in Kenya. <https://doi.org/10.22004/ag.econ.54675>
- Swindale, A. & Bilinsky, P. (2006). Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: *Indicator Guide (v.2)*, Washington, D.C. [https://www.fantaproject.org/sites/default/files/resources/HDDS\\_v2\\_Sep06\\_0.pdf](https://www.fantaproject.org/sites/default/files/resources/HDDS_v2_Sep06_0.pdf)
- Taruvunga, A., Muchenje, V. & Mushunje, A. (2013). Determinants of rural household dietary diversity: The case of Amatole and Nyandeni districts, South Africa. *International Journal of Development Sustainability*, 2 (4): 2233-2247. <https://isdsnet.com/ijds-v2n4-4.pdf>
- Tawodzera, G. (2011). Vulnerability in crisis: urban household food insecurity in Epworth, Harare, Zimbabwe. *Food Security*, 3(4), 503–520. <https://doi.org/10.1007/s12571-011-0152-1>
- Udry, C., Hoddinott, J., Alderman, H., & Haddad, L. (1995). Gender differentials in farm productivity: implications for household efficiency and agricultural policy. *Food Policy*, 20(5), 407–423. [https://doi.org/10.1016/0306-9192\(95\)00035-d](https://doi.org/10.1016/0306-9192(95)00035-d)
- Verhofstadt, E., & Maertens, M. (2014). Smallholder cooperatives and agricultural performance in Rwanda: do organizational differences matter? *Agricultural Economics*, 45(S1), 39–52. <https://doi.org/10.1111/agec.12128>
- Verhofstadt, E., & Maertens, M. (2014a). Can Agricultural Cooperatives Reduce Poverty? Heterogeneous Impact of Cooperative Membership on Farmers' Welfare in



Ziaei, S., Naved, R. T., & Ekström, E. C. (2012). Women's exposure to intimate partner violence and child malnutrition: findings from demographic and health surveys in Bangladesh. *Maternal & Child Nutrition*, 10(3), 347–359.  
<https://doi.org/10.1111/j.1740-8709.2012.00432.x>

## APPENDICES

### APPENDIX A: QUESTIONNAIRE

Dear respondent,

I am Olive UWINEZA, Masters' student at Egerton University.

This questionnaire is prepared to collect data for the study on; Effect of women empowerment in agriculture on farm commercialization and household dietary diversity in Rwanda. This study aims to provide an understanding of the five domains of women empowerment in agriculture and their relation to agricultural commercialization and household dietary diversification in Rwanda. Your most valuable contribution to the questions will be highly appreciated as this will inform policy makers toward improvement of agricultural commercialization, women empowerment in agriculture and food security. You are promised confidentiality with the information you give since it will be used only for purposes of this study.

#### MODULE A: HOUSEHOD IDENTIFICATION & LOCATION

**A00:** Name of Enumerator: .....

**A01:** Household code: .....

**A02:** District .....

**A03:** Sector: .....

**A04:** Cell: .....

**A05:** Type of household (1. Male-headed, 2. Female-headed, 3. Child-headed)

**A06:** Name of the respondent: ..... Sex: .....

**A07:** Name of the primary decision maker: ..... Sex: .....

**A08:** Name of the secondary decision maker: ..... Sex: .....

**A09:** Phone number:

**PART ONE: The respondent in this part is one of the two main decision makers in the household.**

**MODULE Ba: HOUSEHOLD LISTING, DEMOGRAPHICS AND EMPLOYMENT (REQUIRED).**

**Enumerator:** Ask these questions about all household members. Ask about each member in household. Please list the names of all member of the household, starting with the primary respondent.

Name of household member? [start with primary respondent, continue with the secondary respondent, and other members in descending order of age]	What is [NAME's] sex? 1 = M 2 = F	What is [NAME's] relationship to the primary respondent? CODE 1	What is [NAME's] age? (in complete years)	What is [NAME's] marital status? CODE 2	Is [NAME] currently attending school this year? 1 = Yes 0 = No	Can [NAME] read and write? CODE 4	How many years of education were completed by [NAME]? CODE 5	Does [Name] have any occupation or paid activities, outside of your own farm (self-employment included)
B01	B02	B03	B04	B05	B06	B07	B08	B09
Code 1: Codes for respondent (relation with hh heads)		Code 2: (B05)	Code 4 (B07): Literacy		Code 5: (B09) Education level			
[1] HH Head [2] Spouse [3] Child [4] None	1. Single/never married 2. Divorced 3. Separated 4. Widowed		1. Cannot read nor write 2. Can sign (write) only 3. Can read only 4. Can read and write		[0] None [1] Primary 1 [2] Primary 2 [3] Primary 3			

<p>[5] Other (specify):  .....</p>	<p>5. Religious marriage  6. Civil marriage  7. Cohabiting  8. Offical marriage (civil and religiose)</p>		<p>[4] Primary 4  [5] Primary 5  [6] Primary 6  [7] Ordinary level 1  [8] Ordinary level 2  [9] Ordinary level 3  [10] Secodary 4  [11] Secodary 5  [12] Secodary 6  [13] Teritiary-CERAI-Familial (post primary)  [14]Teritiary- (post-secondary)  [15] University</p>
--	---	--	---

**MODULE B. SOCIAL ECONOMIC AND INSTITUTIONAL CHARACTERISTICS**

Number of household members	.....
Female members	
Male members	
Owning livestock	Yes=1 No=0
Input and output market access	a. Distance to nearest input market (hours) b. Distance to nearest output market (hours)
Distance to market	a. Access to guaranteed output market (have/not have contract) Proximity to town (km)
Land size	Total size of household own
Group membership	Being active member in at least one group
Road access	State of the road to nearest output market 1. Very bad 2. Bad 3. Moderately good 4. Good 5. Very good
Area cultivated	
Do you or anybody in this household receive any Agri-extension services?	

## Module C. PRODUCTION AND MARKETING

Three crops cultivated by the household in season A of 2019 and B of 2018	Who was in charge of this crop?	Area cultivated (indicate in hectare, if other measure, specify	Total production in ( kgs)	Production oriented for consumption in (kgs)	Production kept for seeds and donation in (kgs)	Production sold in (kgs)	What was the price per (kg)	What was the negotiated price per (kg)	Where was product ion sold? (more than 1 answer is possible)	To whom was it sold ?	Who sold it from the household
Code 1	Code 2							Code 3	Code 4	Code 5	Code 2
Code 1 1. Maize 2. Beans 3. Potatoes 4. Cassava 5. Pyrethrum 6. Vegetables 7. Sweet potatoes 8. Others (specify)	Code 2 1.Male household head 2.Female household head (wife) 3.Both spouse 4.Other male's household members 5.Other female's household members			Code 3 1.Price negotiated before the harvest (contract farming) 2.Price negotiated after the harvest 3.Price fixed yearly (eg; By cooperative) Current market price of this crop		Code 4 1.At farm/field 2.Local market 3.Regional market 4.Export 5.Cooperative 6.Other specify		Code 5 1.local market 2.Cooperative 3.State-Regional authority 4.Other intermediaries (local dealers) 5.Family or friends 6.Cross boarding trade 7.Other specify			

**MODULE D: WOMEN EMPOWERMENT IN AGRICULTURE**

<b>MODULE E1: ROLE IN HH IN DECISION MAKING AROUND PRODUCTION &amp; INCOME GENERATION: Input in productive decisions</b>				
Activity		Did you (singular) participate in [ACTIVITY] in the past 12 months (that is during the last [one/two] cropping seasons)? Yes 1 No 2 >> next activity	How much input did you have in making decisions about [ACTIVITY]?	How much input did you have in decisions on the use of income generated from [ACTIVITY]
Activity code	Activities' description			
A	Food crop farming			
B	Cash crop farming			
C	Livestock raising			
D	Purchase of agricultural inputs			
E	Non-farm economic activities			
F	Food processing and marketing			
G	Employment outside agriculture			
H	Wage and salary employment			
E1.02/E1.03: Input into decision making				
1 no input .....			1	
2 Input into very few decisions .....			2	
3 Input into some decisions .....			3	
4 Input into most decisions .....			4	
5 Input into all decisions .....			5	
6 No decision made .....			6	
7 not applicable .....			7	
8 I don't know .....			8	

<b>MODULE E3: ACCESS TO PRODUCTIVE CAPITAL: Purchase, Sale or Transfer of assets</b>						
Productive capital		Does anyone in your household currently have any [ITEM]? Yes.....1 No.....2>>>next item	Who would you say can decide whether to sell [ITEM] most of the time?	Who would you say can decide whether to give away [ITEM] most of the time?	Who would you say can decide to mortgage or rent out [ITEM] most of the time?	Who contributes most to decisions regarding a new purchase of [ITEM]?
Activity code	Productive capital	E5.01a	E3.03	E3.04	E3.05	E3.06
A	Agricultural land (Plots)					
B	Large livestock (cattle)					
C	Small livestock (goats, pigs, cheep)					
D	Chickens, Ducks, Turkeys, Pigeons					
E	Fish pond or fishing equipment					
F	Farm equipment (non-mechanized)					
G	Farm equipment (mechanized)		E3.02-E3.06: Decision-making and control over productive capital: Self.....1 Partner/Spouse .....2 Self and partner/spouse jointly.....3 Other household member .....4 Self and other household member(s).....5 Partner/Spouse and other household member(s).....6 Someone (or group of people) outside the household.....7 Self and other outside poeple.....8 Partner/Spouse and other outside people.....9 Self, partner/spouse and other family members.....10			
H	Nonfarm business equipment					
I	House (and other structures)					
J	Large consumer durables (fridge, TV, sofa)					
K	Small consumer durables (radio, cookware)					
L	Cell phone					
M	Other land not used for agricultural purposes (pieces, residential or commercial land)					
N	Means of transportation (bicycle, motorcycle, car)					

<b>MODULE E3: ACCESS TO CREDIT</b>				
Lending source		Has anyone in your household taken any loans or borrowed cash/in-kind from [SOURCE] in the past 12 months?	Who made the decision to borrow from [SOURCE]?	Who makes the decision about what to do with the money/item borrow from [SOURCE]?
Activity code	Productive capital	E3.07	E3.08	E3.09
A	Non-governmental organization (NGO)			
B	Informal lender			
C	Formal lender (bank/financial institution)			
D	Friends or relatives			
E	Group based micro-finance or lending including SACCOs/ merry-go-rounds			
		E3.07 Taken loans: Yes, cash 1 Yes, in-kind 2 Yes, cash and in-kind 3 No 4 >> G3.11A Don't know...5 >> G3.11A	E3.08-E3.09: Decision-making and control over credit: Self.....1 Partner/Spouse .....2 Self and partner/spouse jointly.....3 Other household member.....4 Self and other household member(s).....5 Partner/Spouse and other household member(s).....6 Someone (or group of people) outside the household.....7 Self and other outside people.....8 Partner/Spouse and other outside people....9 Self, partner/spouse and other family members.....10	

**MODULE E3: DECISION MAKING: Control over use of income**

<b>ENUMERATOR:</b> Ask E5.01 for all categories of activities before asking E5.02. Do not ask E5.02 if E5.01 response is 1 and respondent is male OR E5.01 response is 2 and respondent is female. If household does not engage in that particular activity, enter 8 and proceed to next activity.		When decisions are made regarding the following aspects of household life, who is it that normally takes the decision?	To what extent do you feel you can make your own personal decisions regarding these aspects of household life if you want(ed) to? Ask only if E5.01 is 1 and respondent is female, E5.01 is
Activity code	Activity description	E5.01	E5.02
A	Getting inputs for agricultural production		
B	The types of crops to grow for agricultural production		
C	Taking crops to the market (or not)		
D	Livestock raising		
E	Your own (singular) wage or salary employment		
F	Major household expenditures (such as a large appliance for the house like refrigerator)		
G	Minor household expenditures (such as food for daily consumption or other household needs)		
H	Non-farm economic activities		
I	Food processing and marketing		
J	Employment outside agriculture		

E5.01:Who makes decision	E5.02: Extent of participation in decision making
Main male or husband.....1 (if MALE)	Not at all .....1
Main female or wife.....2 (if FEMALE)	Small extent.....2
Husband and wife jointly.....3	Medium extent.....3
Someone else in the household.....4	To a high extent.....4
Jointly with someone else inside the household.....5	
Jointly with someone else outside the household.....6	
Someone outside the household/other.....7	
Household does not engage in activity/Decision not made.....8	

<b>MODULE E4: GROUP MEMBERSHIP AND INFLUENCE IN THE GROUP</b>			
Group Membership		Is there a [GROUP] in your community?	Are you an active member of this [GROUP]?
		Yes 1	Yes 1
		No 0 >> next group	No 0
Activity code	Group categories	E4.01	E4.02
A	Agricultural / livestock/ fisheries producer's group (including marketing groups)		
B	Water users' group		
C	Forest users' group		
D	Community based natural resources management group		
E	Credit or microfinance group (including SACCOs/merry-go-rounds/ VSLAs)		
F	Mutual help or insurance group (including burial societies)		
G	Trade and business association		
H	Civic groups (improving community) or charitable group (helping others)		
I	Local government		
J	Religious group (choir, prayer groups, church action groups)		
K	Other women's group (only if it does not fit into one of the other categories)		
L	Other (specify)		

<b>MODULE E4: INDIVIDUAL LEADERSHIP AND INFLUENCE IN THE COMMUNITY: Speaking in public</b>			
Q <sup>no</sup>	Question	Response	Response code
E4.03	Do you feel comfortable speaking up in public to help decide on infrastructure (like small wells, roads, water supplies) to be built in your community?		No, not at all comfortable .....1 Yes, but with a great deal of difficulty.....2 Yes, but with a little difficulty.....3 Yes, fairly comfortable.....4
E4.04	Do you feel comfortable speaking up in public to ensure proper payment of wages for public works or other similar programs?		Yes, very comfortable.....5
E4.05	Do you feel comfortable speaking up in public regarding the crop to cultivate in the consolidated land		
E4.06	Do you feel comfortable speaking up in public giving your ideas in local meeting?		
E4.07	Do you feel comfortable speaking up in public to protest the misbehavior of local authorities or elected officials in this cell?		

**Module E5: Time allocation**

**Enumerator:** Please record a log of the activities for the individual in the last complete 24 hours (starting in the morning at 4 am, finishing at 3:59 am of the next day) of the last working day. The time intervals are marked in 30 min. intervals and one to two activities can be marked for each time period by drawing a line through that activity. If two activities are marked, they should be distinguished with a P for the primary activity and S for the secondary activity written next to the lines.

**Enumerator:** “Now I’d like to ask you about how you spent your time during the past 24 hours of your last working day. We’ll begin from the morning and continue through to the next morning. This will be a detailed accounting. I’m interested in everything you do (resting, eating, personal care, work inside and outside the home, caring for children, cooking, shopping, socializing.), even if it doesn’t take you much time.

Activity	24-hour time diary																																				
	1			2			3			4			5			6			7			8			9			10			11			12			
A Sleeping and resting																																					
B Eating and drinking																																					
C Personal care																																					
D School (also homework)																																					
E Work as employed																																					
F Own business work																																					
G Farming/livestock/fishing																																					
J Shopping/getting service (in																																					
K Weaving, sewing, textile car																																					
L Cooking																																					
M Domestic work (incl fetching																																					
N Care for children/adults/elderly																																					
P Travelling and communiting																																					
Q Watching TV/listening to rad																																					
T Exercising																																					
U Social activities and hobbies																																					
W Religious activities																																					
X Other, specify...																																					

## E. MEASURING FOOD ACCESS USING HDDS

The respondent (household's food preparer) should be interviewed about what they have consumed in his/her household yesterday (in last 24 hours) during the day and night.

Enumerator: Read the list of foods. Enter one in if anyone in the household ate the food, enter zero if no one in the household ate the food.

<b>Food group</b>	<b>Example</b>	Did anyone from your household consume the following food in the last 24 hours? Enter 1 if it is yes or 0 if it is no.
1. Cereals	maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, umutsima, porridge or paste	
2. White roots and tubers	Any potatoes, yams, manioc, cassava or any other foods made from roots or tubers?	
3. Any vegetables	Pumpkin, carrot, tomato, onion, eggplant and other locally available vegetables 6	
4. Any fruits	Mango, orange, passion fruits, strawberry, papaya, tree tomatoes any other local fruits and juices made from fruits	
5. Meats	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	
6. Any eggs	eggs from chicken, duck, omelette or any other egg	
7. Fish	Any fresh or dried fish or shellfish	
8. Legumes, nuts and seeds	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)	
9. Milk and milk products	Any cheese, yogurt, milk or other milk products	
10. Oils and fats	oil, fats or butter added to food or used for cooking	
11. Sweets	sugar, honey, sweetened drinks, sugary foods such as chocolates, candies, cookies and cakes	
12. Any other foods, such as condiments, coffee, tea?		

**APPANDIX B: Five domains of empowerment indicator definitions**

Dimension	Indicator name	Survey questions	Aggregation method	Inadequacy cut-off	weight
	Input in productive decisions	How much input did you have in making decisions about food crop farming, cash crop farming, livestock raising, and fish culture? To what extent do you feel you can make your own personal decisions regarding these aspects of household life if you want(ed) to: agriculture production, which inputs to buy, which types of crops to grow for agricultural production, when to take or who should take crops to market, and livestock raising?	Achievement in two	Inadequate if individual participates but does not/has not at least some input in decisions or does not make decisions nor feels he or she could	0.10
	Autonomy in production	My actions in domain of production are partly because I will get in trouble with someone if I act differently. Regarding [domain] I do what I do so others don't think poorly of me. Regarding [domain] I do what I do because I personally think it is the right thing to do. Agricultural production, inputs to buy, crops to grow, take to market, livestock.	Achievement in any	Inadequate if Relative Autonomy Indicator is less than 1	0.10
Resources	Ownership of assets	Who would you say can use the [item] most of the time? Agricultural land, large livestock, small livestock, chickens and so on;	Achievement in any if not only one small asset (chickens, nonmechanized	Inadequate if household does not own any asset or if household owns the type of	0.07

		fishpond/equipment; farm equipment (nonmechanized); farm equipment (mechanized); nonfarm business equipment, house; large durables; small durables; cell phone; nonagricultural land (any); transport.	equipment and no small consumer durables)	asset but she or he does not own most of it alone	
	Purchase, sale, or transfer of assets	Who would you say can decide whether to sell, give away, rent/mortgage [item] most of the time? Who contributes most to decisions regarding a new purchase of [item]? Agricultural land, large livestock, small livestock, chickens and so on, fishpond, farm equipment (nonmechanized), farm equipment (mechanized).	Achievement in any if not only chickens and nonmechanized farming equipment	Inadequate if household does not own any asset or household owns the type of asset but he or she does not participate in decisions (exchange or buy) about it	0.07
	Access to and decisions about credit	Who made the decision to borrow/what to do with money/item borrowed from [source]? Nongovernmental organization, informal lender, formal lender (bank), friends or relatives, rotating savings and credit associations (savings/credit group).	Achievement in any	Inadequate if household has no credit or used a source of credit but she or he did not participate in any decisions about it	
Income	Control over use of income	How much input did you have in decisions about the use of income generated from food crop, cash crop, livestock, nonfarm activities, wages and salary, and fish culture? To what extent do you feel you can make your own personal decisions regarding these aspects of household	Achievement in any if not only minor household expenditures	Inadequate if individual participates in activity but has no input or little input in decisions about income generated	0.2

		life if you want(ed) to: your own wage or salary employment? Minor household expenditures?			
Leadership	Group member	Are you a member of any agricultural/livestock/fisheries producer/market group; water, forest users', credit, or microfinance group; mutual help or insurance group (including burial societies); trade and business association; civic/charitable group; local government; religious group; other women's group; other group?	Achievement in any	Inadequate if not part of at least one group	0.10
	Speaking in public	Do you feel comfortable speaking up in public to help decide on infrastructure (like small wells, roads) to be built, to ensure proper payment of wages for public work or other similar programs, to protest the misbehaviour of authorities or elected officials, or to intervene in a family dispute?	Achievement in any	Inadequate if not comfortable speaking in public	0.1
Time	Workload	How did you spent your 24 hour of previous day	Worked less than 10.5 hours in the previous 24 hours.	Inadequate if individual works more than 11 hours per day	0.10
	Leisure	How would you rate your satisfaction with your time available for leisure activities such as visiting neighbours, watching TV, listening to the radio, seeing movies, or doing sports?		Inadequate if not satisfied (<5)	0.10

**APPENDIX C: Results of fractional regression model**

<b>VARIABLES</b>	<b>Coefficients</b>	<b>Robust Standard error</b>	<b>Z</b>	<b>P_values</b>	<b>[95% Conf.</b>	<b>Interval]</b>
<b>HCI</b>						
women empowerment score	2.537***	0.8917	2.84	0.004	0.788	4.283
Family size	0.029	0.03371	0.88	0.380	-0.036	0.095
Farm size	0.0547**	0.0222	2.47	0.014	0.011	0.098
Distance to market	-0.0006	0.0024	-0.26	0.798	-0.004	0.005
Input in productive decision	0.2071	0.3444	0.60	0.548	0.882	0.468
Asset ownership	0.0429	0.1653	0.26	0.795	0.281	0.366
Asset control	0.2549	0.2830	0.90	0.368	0.809	0.299
Female group membership	0.0307	0.338	0.09	0.928	0.694	0.633
Access to extension services	-0.4325***	0,1726	-2.51	0.012	-0.771	-0.094
Access to road	-0.0010	0.0533	-0.02	0.984	-0.105	0.103
Price of maize	0,0043***	0.0005	7.62	0.000	0.003	0.005
Price of potatoes	0.0018***	0.0003	5.15	0.000	0.001	0.002
Price of beans	0.00109***	0.0002	3.94	0.000	0.000	0.001
Constant	-3.426	0.5673	-6.04	0.000	-4.538	-2.314
Number of observations	252					
Log pseudolikelihood	-135.353					

Pseudo R <sup>2</sup>	0.1424
-----------------------	--------

**APPENDIX 4: Results of instrumental variable Poisson regression model for count data**

<b>VARIABLES</b>	<b>Coefficient</b>	<b>Robust Standard error</b>	<b>Z</b>	<b>P_value</b>		
HHDS						
Female empowerment score	2.594***	0.429	3.04	0.000	0.802	3.705
group membership	1.046	2.121	0.70	0.622	-3.708	7.845
Income control	1.950**	0.642	1.80	0.002	3.332	0.139
Asset ownership	0.870	0.854	0.63	0.308	2.498	1.283
Workload	-1.111**	0.483	1.95	0.022	2.001	0.003
Decision making for productive capital	0.089	1.317	0.43	0.946	2.662	4.153
Household size	-0,029***	0.014	-1.77	0,042	-0.057	0.002
Total farm size	0.00002***	6.230	3.64	0.000	0.000	0.000
Distance to nearest town	-0.0007	0.000	-1.16	0.277	-0.002	0.000
Gender parity	-0.004**	0.002	1.71	0.015	-0.000	0.008
Number of observation	252					
Number of moments	10					
Number of parameters	13					
Initial weight matrix	Unadjusted					
GMM weight matrix	Robust					



# APPENDIX D: RESEARCH PERMIT





**NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY (NCST)**  
 Grand Pension Plaza, 13th Floor, KN 2 Roundabout, Kigali  
 PO Box: 2289 Kigali – Rwanda  
 E-MAIL: info@ncst.gov.rw WEBSITE: www.ncst.gov.rw

**PERMISSION TO CONDUCT RESEARCH IN RWANDA**  
**N° NCST/482/150/2019**

I, the undersigned, hereby grant the researcher (s) in Section I permission to conduct research in Rwanda. This permission only covers research activities related to the provided research title, during the specified period and at specified location (s) in Section II of this form.

**Section I: Personal Information**

- Family Name: Iddephonse      Other Names: Musafiri
- Academic Qualification (Highest degree): MS, MA
- Home Institution: Egerton University      Occupation: PhD Student
- Phone Number (in Rwanda): 0788624422
- Email: musafiri@gmail.com
- Primary Research Supervisor:
  - Names: Dr. Eliud Abuheli Birachi
  - Institution: CIAT      Occupation: Country Director
  - Phone Number: +250 783808149
  - Email: e.birachi@cglar.org
- Research Collaborators:
 

Names	Institution
1 Justin Dodd Mullikin	Rutgers University, US
2 Christine Bigler	University of Bern, Switzerland
3 Marie Louise Matthys	University of Bern, Switzerland
4 Illien Patrick	University of Bern, Switzerland
5 Olive Uwineza	Egerton University




**Section II: Research Information**

- Research Area: Agriculture
- Research Title: Feminization, Agricultural Transition and Rural Employment
- Affiliating Rwandan Institution: International Center for Tropical Agriculture (CIAT)
- Rwandan Supervisor:
  - Names: Dr. Eliud Abuheli Birachi
  - Occupation: Country Director
  - Phone Number: +250 783808149      d. Email: e.birachi@cglar.org
- Fieldwork Location:
 

**Burera, Musanze, Nyamasheke, Nyanza and Gatsibo Districts**
- Research Period:
  - From: October 08, 2019
  - To: October 07, 2020


**Section III: Other Important Notes**


This research permit is the second extension of research permit number MINEDUC/S&T/283/2015 issued by MINEDUC. The first extension was issued by NCST on September 28, 2018.

**Section IV: Signature**

This permission to conduct research in Rwanda is issued in accordance with Ministerial Instructions 003/2010 of 09/12/2010 regulating research activities in Rwanda.

Kigali, on October 03, 2019      NCST Ref: .. /NCST.2018

  
**KALISA M. Felly**  
 Ag. Executive Secretary



## THE ROLE OF WOMEN EMPOWERMENT IN AGRICULTURE ON HOUSEHOLD FARM COMMERCIALIZATION OF MAIZE, POTATOES AND BEANS IN NORTHERN PROVINCE OF RWANDA

Olive Uwineza<sup>1</sup>, Job Kibiwot Lagat<sup>1</sup>, Risper M. Berem<sup>1</sup>

<sup>1</sup>Egerton University, Njoro, Kenya

**Abstract.** In Sub-Saharan Africa, agricultural commercialization is a major factor in household food diversification and household income. To move to agricultural transformation, Rwanda has focused on shifting from subsistence-based farming to market-oriented agriculture. Various studies have been conducted on agricultural commercialization, however, women's role in the commercialization of agriculture has received little attention and none of the studies have associated it with women's empowerment in agriculture. In Rwanda, women are principal players in agriculture and food security, therefore, it is important to understand the influence of their empowerment in agriculture on its commercialization. To investigate the relationship between women's empowerment in agriculture and agricultural commercialization, the Women's Empowerment in Agriculture Index (WEAI) was used to measure women's empowerment in agriculture. A sample size of 252 households from Musanze and Burera districts in the Northern Province of Rwanda was used. It was obtained using the multistage and random sampling techniques. To analyze data, a fractional regression model was used. The results revealed that farm commercialization in Rwanda was positively and significantly influenced by WEAI score, farm size and the prices of maize, potatoes and beans. On the other hand, the index has a negative relationship with access to extension services. It is recommended that the government should strengthen policies of empowering women in agriculture.

**Keywords:** maize, beans, potatoes, fractional regression model, household commercialization index, women's empowerment in agriculture index

### INTRODUCTION

Agriculture is the backbone of the developing economy (World Bank, 2008). As countries develop, the share of their population working in agriculture is declining. While in poor countries more than two-thirds of the population work in agriculture, this group accounts for less than 5% of the population of rich countries (Roser, 2013). The transition from subsistence (or semi-subsistence) agriculture to commercialized agriculture is important for the development of low-income countries. It is one of the major pathways to economic growth and welfare improvement at the national level. Furthermore, it is expected to increase household income, improve food consumption, food security and nutritional outcomes in rural households (Carletto, 2013). Women participate significantly in agricultural labor force and in agricultural activities, they account for 40% of agricultural labor force and 50% of the world's food production (FAO, 2011). Women contribute to agriculture at varying degrees, consequently, their contribution to agricultural output is noteworthy, although difficult to quantify with accuracy; it is claimed that 60 to 80 percent of food is produced by women (Alderman et al., 1995; Dufló and Udry, 2001). Despite their extensive participation in agriculture, women still have low access to productive resources (such as land and livestock),

<sup>1</sup>Department of Agricultural Economics and Agribusiness Management, Egerton University, Along Nakuru-Mau Narok Road, P.O. Box 536-20115, Egerton-Njoro, Kenya, e-mail: ollivianhs@gmail.com, <https://orcid.org/0000-0003-4960-7842>