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

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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; Duflo and Udry, 2001). Despite their extensive participation in agriculture, women still have low access to productive resources (such as land and livestock),

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inputs (fertilizers and improved seeds), and services (credit, extension) for agriculture. This reflects a considerable gender gap that most often is related to social norms specific to a particular region and culture. It is in the same context that women have many responsibilities within households, in addition to agricultural labor (e.g., care of children and the elderly, fetching water and fuel, and tending to domestic chores) (FAO, 2011). There is very little research that has systematically examined the connection between agricultural commercialization and women's empowerment in agriculture (Gupta, 2017).

Women's empowerment in agriculture reflects the ability of women to access, control and utilize productive resources such as land, livestock, labor, education, extension, financial services, and technology (Quisumbing et al., 2015). It is measured by the Women's Empowerment in Agriculture Index (WEAI) which is a new survey-based index designed to measure empowerment, agency, and inclusion of women in the agricultural sector. The WEAI is an aggregate index, reported at a 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 sub-index 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 those who are not. It also illustrates 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 the 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 those of men in their households (Alkire et al., 2013).

Despite the gender mainstreaming efforts of Rwanda, the farming system remains subsistence-oriented, additionally, research findings showed that women are more engaged in the production of consumption-oriented crops rather than the production of market-oriented crops (MINECOFIN, 2013; Ingabire et al., 2017). Furthermore, 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. Therefore, women remain in subsistence agriculture and hence the continued

persistence of subsistence farming (MINAGRI, 2010). Empirical evidence from the Northern Province of Rwanda has revealed that women were more engaged in beans transactions than men, while men highly participated in transactions of potatoes. Ironically, potatoes are more commercialized than beans in northern Rwanda (Ingabire et al., 2017). It highlighted the fact that men tend to take control of crops when an opportunity for their commercialization emerges (Fischer and Qaim, 2012; Quisumbing and Pandolfelli, 2010). However, only a few studies have been conducted on the relationship between agricultural commercialization and women's empowerment in agriculture (Gupta, 2017).

This study investigated the relationship between women's empowerment in agriculture and agricultural commercialization in Rwanda across 252 households from Musanze and Burera districts in the Northern Province of Rwanda. In the same household, both female and male primary decision-makers were interviewed. A survey based on the Women's Empowerment in Agriculture Index (WEAI) was used (Alkire et al., 2013). The primary objective of this research was to assess the relationship between women's empowerment in agriculture and agricultural commercialization in Rwanda. This body of work helps to fill the knowledge gap around the issues of women's empowerment and agricultural commercialization, especially for Rwanda.

THEORETICAL FRAMEWORK

The study was underpinned by the women's empowerment framework developed by Naila Kabeer (2001). Such empowerment is a process of change where those who have been denied the ability to make choices acquire such an ability. The ability to exercise choice can be thought of in terms of changes in three interrelated dimensions of power, which make up a 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 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 such goals. 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 lives and pursue their own goals. A negative sense of power agency is the capability of an actor or a category of actors of overriding the agency of others, 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, 2001).

Based on this framework, women are empowered through the five domains of the WEAI which are summarized into three dimensions of Kabeer's framework. Through resources, the study looked at the level of women's decision-making in economic resources such as land use, the decision on assets and the impact of their decision making on household income as well as credits. Human and social resources were covered in two domains among the 5 Domains of Empowerment (5DE), leadership and time. The study showed how women participate in different community groups, which reflects their social network and personal skills through leadership. Through Kabeer's dimension of achievement, the study looked at how women's empowerment in agriculture affects household farm commercialization.

MATERIAL AND METHODS

Study area

The study was carried out in Musanze and Burera districts in the 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 has an area of 26,338 km² (NISR, 2013). The 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 a predominance of farming activity, these districts also have geographic advantage of being close to important local markets closer to Uganda for cross-border trade (Ingabire et al., 2017).

Musanze district borders with Uganda and the Democratic Republic of Congo (DRC) to the North through Virunga National Park, Gakenke District in the South, Burera District to the East, Nyabihu in the West and Lake Ruhondo in the South West. The total area of the district is 530.4 km², and it is located at an altitude of 1,850 m 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 km². It borders with the Republic of Uganda in the North and East, Gakenke and Rulindo Districts in the South and Musanze District in the West. The district is occupied by a population of 336,455. The district is still subsistence farming; more than 80.2% of the total population of the district is engaged in subsistence agriculture (NISR, 2013).

Sampling techniques

The sample size was obtained using multistage sampling techniques. In the first stage, one province was chosen from five provinces, in the second stage, two districts were chosen purposively since they have predominance in farming activities, and the last stage was to choose 252 individuals randomly from the target population of 681 farmers who grow maize, beans and potatoes. The target population was taken from the previous studies conducted under the Feminization, Agricultural Transition and Rural Employment (FATE) project 2015 in the same districts.

Table 1. 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
Total	681	252

Source: own elaboration.

Yamane's general formula (1967) was used to determine the sample size:

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

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 respondents from the same households were interviewed. The respondents were not necessarily spouses, they were decision-makers in a household.

Data collection

The data were collected using a semi-structured questionnaire for the heads of household (both men and women) as respondents for obtaining quantitative data. Pre-testing of the questionnaire was carried out to determine the time required to complete each questionnaire and the convenience of obtaining the data from respondents. The data was collected with the help of 20 trained enumerators.

Analytical framework

The household commercialization index (HCI) was used to determine the household-specific level of commercialization (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:

$$HCI = \frac{\text{Gross value of agricultural sales by } i^{\text{th}} \text{ household in year } j}{\text{Gross value of all agricultural production by } i^{\text{th}} \text{ household in year } j} \times 100 \quad (2)$$

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

Papke and Wooldridge (1996) in their 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 et al., 2011). 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 the assumption of a functional form for y that imposes the desired constraints on the conditional mean of the dependent variable:

$$E(y/x) = Gx^\beta \quad (3)$$

Where y is the dependent variable, which is HCI for the context of this study, x is a vector of explanatory variable and $G(\cdot)$ is a known nonlinear function satisfying $0 \leq G(\cdot) \leq 1$. This approach was first formally proposed by Papke and Wooldridge (1996).

$$E(y/x) = \frac{e^{x^\beta}}{1 + e^{x^\beta}} \quad (4)$$

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

$$LL_i(\beta) = y_i \log[G(x_i\beta)] + (1 - y_i) \log[1 - G(x_i\beta)] \quad (5)$$

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

$$\widehat{\beta}_0 = \arg \max_{\beta} \sum_1^N LL_i(\beta) \quad (6)$$

The equation was empirically presented as:

$$E(HCI/x) = G(\beta_1 + \beta_2 E + \beta_3 HHsize + \beta_4 Farmsize + \beta_5 Mktaccess + \beta_7 roadaccess + \beta_8 Agrtech + \beta_9 Assetownership + \beta_{10} assetcontrol + \beta_{11} Productiondec + \beta_{12} Group + \beta_{13} GPI) + \varepsilon_i \quad (7)$$

Test for model specification

A fractional regression model was used for household commercialization analysis. The 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 (Pregibon, 1980).

RESULTS AND DISCUSSION

Effect of women’s empowerment in agriculture on household commercialization

Before presenting empirical results, both the categorical and continuous variables are discussed using descriptive approaches such as graphs, means and percentages.

Household commercialization

The findings revealed that the mean Household Commercialization Index of maize, beans and potatoes for the entire sample was 0.33 (Table 2). This implies that on average, farmers sell about 33% of maize, beans and potatoe production. Based on a study by Mahaliyanaarachchi and Bandara (2006), smallholder farmers can be categorized according to their commercialization levels into three groups, namely subsistence (HCI less or equal to 0.5), semi-commercial (HCI between 0.5 and 0.75) and commercial (HCI higher than 0.75). In the Northern Province, 70% of households are in subsistence agriculture, 24% participate in semi-commercial and 6% are in commercial agriculture.

Table 2. Farmer grouping by commercialization index

HCI	Farmer description	Percentage of farmers
0.0-0.5	Subsistence	70
0.51-0.74	Semi-commercial	24
0.75-1.0	Commercial	6
Mean		33

Source: own elaboration.

Description of categorical variables affecting household commercialization

The categorical variables are household sizes presented in Fig. 1.

Figure 1 depicts the distribution of household size. The largest number (75%) of the households had between 4 and 7 members distributed as follows: 4 members (19.44%), 5 members (19.05%), 6 members (21.03%), 7 members (15.48%). Only 13.49% had less than 4 members while only 11.5% had more than 7 members.

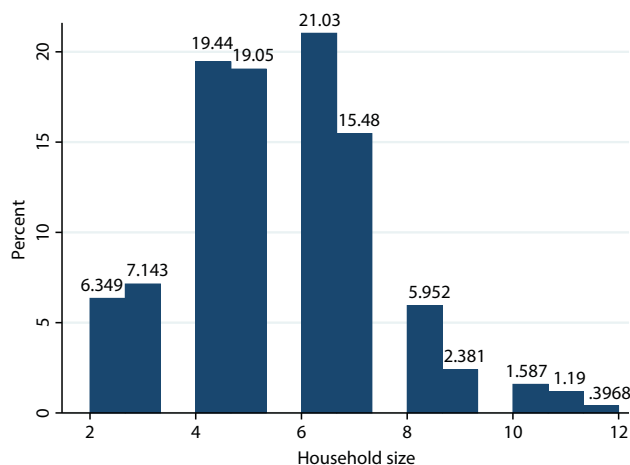


Fig. 1. Size of households

Source: own elaboration.

Description of continuous variables affecting household commercialization

Table 3 depicts the results of continuous variables that affected household agricultural commercialization in this research.

Table 3 demonstrates that the mean value of the household commercialization index was 0.32. This implies that on average, farmers sell about 32% of maize, potatoes and beans. This concurs with the research by World Bank (2008) which has revealed that Rwanda’s farm commercialization is still limited.

The average total area of cultivation of a household was 2991.68 square meters (0.3 hectares). Rwanda is one of the most densely populated countries, thus fragmentation and small farm sizes are considered key policy issues (MINAGRI, 2010). The average time to input market was 23.88 minutes, the average time to output market was 28.08 minutes and the average distance 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 a town and have easy access to output and input markets (NISR, 2013).

The average price per kg of maize was 225.57 Rwfs (USD 0.23), for potatoes it was 220.61 Rwfs (USD 0.23), while for beans it was 413.06 Rwfs (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 the 2018/2019 agricultural year the country had a relative increase in crop production.

Table 3. Descriptive statistics of continuous variables affecting household farm commercialization in the Northern Province of Rwanda

Variables	Description	Mean	SD
HCI	Household commercialization index	0.319	0.277
Total farm size	The total area of cultivation in square meters	2 991.68	3 063.262
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 per kg	Price of maize in Rwanda Francs (Rwfs)	225.57	83.857
Price of potato per kg	Price of potato in Rwfs	220.65	95.532
Price of beans per kg	Price of beans in Rwfs	413.06	154.505

Source: own elaboration.

Econometric results of the effect of women's empowerment in agriculture on household dietary diversity in the Northern Province of Rwanda

First, a test of the specification of the model was conducted. Table 4 demonstrates 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 4. The link test result

Hci	Coefficients	<i>p</i> -value
Hat	2.039254	0.13
Hatsq	-0.8815519	0.429
Cons	-0.2889918	0.454

Source: own elaboration.

The econometric results showing the effect of women's empowerment in agriculture and other socio-economic factors on household farm commercialization are presented in Table 5.

Table 5. Econometric results of the effect of women's empowerment in agriculture on household farm commercialization in the Northern Province of Rwanda

Variables	Coefficients	Robust Standard error	<i>p</i> -values
HCI			
Women's 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 ²	0.1424		

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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

Women's empowerment in agriculture score positively and statistically significantly influenced household commercialization at 1%. This means that an increase of 1 unit of women's empowerment in agriculture score increases household farm commercialization by 2.53 units. Since women are the main actors in agriculture, they promote market-orientated agriculture when they are empowered (Quisumbing et al., 2015). Afolabi (2012) also revealed that women's empowerment has a positive relationship with farm commercialization in Nigeria.

Farm size was significantly associated with agricultural commercialization at 5%. It implies that each additional unit of farm size increased household farm commercialization by 0.547 units. When farm size increases, production also increases, which leads to the increase of agricultural commercialization. Martey et al. (2012) also revealed that 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%. Every increase of 1 Rwf in 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. Asante et al. (2016) revealed that the unit price of maize has a positive relationship with agricultural commercialization in Ghana. They have found that maize farmers were taking their produce to the market when the price was high.

The price of potatoes has a positive sign and is statistically significant at 1%. If the price of potatoes increases by one unit, household agricultural commercialization increases by 0.002 units. The plausible reason is that an increase in output price encourages farmers to produce more to the market. Kyomugisha et al. (2018) found that the price of potatoes was 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 by 1 unit, it increases household farm commercialization by 0.001 units. The results are consistent with the

research conducted by Ingabire et al. (2017) in Rwanda which revealed that the price of beans has a positive and statically significant relationship with farm commercialization in the Northern Province of Rwanda.

Access to extension services negatively influenced agricultural commercialization at 5%. Every additional unit of extension service reduces household agricultural commercialization by 0.432 units. The plausible reason may be the kind of extension messages provided to farmers which may not be related to commercialization. This is consistent with findings 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 by those without access to extension services. Ingabire et al. (2017) also showed that access to extension services has a negative relationship with the commercialization of beans in the Northern Province of Rwanda.

CONCLUSION AND POLICY IMPLICATIONS

This work contributes to the existing literature on women's empowerment in agriculture by examining the relationship of women's empowerment in agriculture and household agricultural commercialization in the Northern Province of Rwanda. The results revealed that household agricultural commercialization in the Northern Province of Rwanda was positively and significantly influenced by the women's empowerment in agriculture score. Furthermore, social-economic factors other than WEAI indicators were considered. Farm size, price of maize, price of potatoes and price of beans significantly influenced household agricultural commercialization. On the other hand, farm commercialization had a negative relationship with access to extension services.

The used WEAI is based on household individual-level data set, enabling a more detailed analysis of component indicators. In particular, these component indicators can be used to identify concrete areas for policy interventions to increase the contribution of women's empowerment to agricultural commercialization.

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