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An Analysis of Female Farmers' Contribution to Agricultural Production in Tanzania

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Abstract

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The purpose of this study is to estimate the contribution of Tanzania female farmers to farm production and analyze the effects of household and farm characteristics on their contribution to agricultural production. First, we estimated the contribution of each member group on the farm such as male adults, female adults, teenagers, and children to agricultural contributions at the individual farm level. Second, we investigated the factors affecting the contribution of female farmers to agricultural production in the farm household. A shadow wage estimation method based on the input distance function approach is used for estimating the agricultural contribution of family members.

The main findings of this study are as follows. First, the average agricultural contribution of each household member group was significantly lower than that of the hired workers. Second, female farmers' contribution was higher than that of men. Third, age and schooling years of women were found to have a significant influence on the contribution to agricultural production. Fourth, female farmers in the farm growing cash crops such as tobacco, coffee and tea show less contribution to agricultural production. Fifth, a higher proportion of male households participating in family farming leads to lower female contributions. Finally, the number of children aged 0 to 6 years old in the household was found not to lower the female members' agricultural contribution.

The findings from this study show that the actual value of the female farmers' contribution to agricultural production, whose status as a major producer of agricultural production is not well recognized. In addition, it can be used as useful data in planning and implementing agricultural policy and rural development policy in Tanzania focused on gender inequality problems and female farmers.

Keywords: Contribution of women to agricultural production, Family farm labor, Input distance function, Stochastic frontier analysis, Shadow wage estimation, Tanzania

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Chapter 1. Introduction

1.1. Statement of the problem

Sub-Saharan African (SSA) countries have been facing drastic economic changes, with their production slowly shifting from agriculture to manufacturing and industries over the last 20 years (Woldemichael et al., 2017). Male labor forces have been redirected from the former to the latter and as a result, female labor importance in agriculture in SSA countries has risen: the ratio of female farmers in this sector has reached over 70% (UNCTAD, 2018). Consequently, donors, researchers and activists have focused on the change of status of females regarding farming contribution.

After lengthy study and observation to SSA, global society agrees that women in SSA's agriculture play a major role in farming. Though women are regarded as a crucial labor force in agriculture, they struggle with a number of constraints in accessing agricultural inputs, services and markets (OECD/FAO, 2016) and face barriers to their economic involvement as real economic agents and producers in agriculture (Idris, 2018).

Furthermore, restrictions on women's land rights, gender gap in agricultural productivity, limited time allocation with unpaid care work/household chores and their economic activities are the main problems which make it difficult to promote and help women in Africa join economic activities and to reduce economic exclusion from them

(SIDA, 2015; OECD/FAO, 2016; Idris, 2018; UN Women, 2019).

Especially, in agricultural sector, recognizing women's critical role as agricultural producers and remunerating them is the priority. And hence, it is required to provide them with equal opportunities to get equal returns for their work in the agricultural sector with men (SIDA, 2015). For this first step, it is required to evaluate the female farmers' agricultural contribution properly and find out the factors that affect their contribution to agricultural production at the individual farm level.

1.2. Purpose of research

The main goal of this study is to investigate to what extent Tanzanian women contribute to farm production, and to compare with other family members who also participate in family farming. Furthermore, we analyze the main driving factors of female farmers' contribution including individual characteristic and farm type.

For this research, a shadow price approach is used to estimate the value of the contribution of each family member using the input distance function. An input distance function is estimated by using the Stochastic Frontier Analysis model and Maximum Likelihood. For the second step regression analysis investigating the determinant of female farmer's contribution to agricultural production, quantile regression is employed to take into account the left−skewed estimates of agricultural contribution which has a long right−tailed distribution.

1.3. Study scope and explanations of terms

Among many developing countries in SSA, the poverty in Tanzania is more widespread among women than men (Lyimo-Macha and Mdoe, 2002) and their participation in agriculture is easily underestimated as unpaid family workers (Alemu and Alebachew, 2018), while Tanzanian women' roles are important in their economy as the main producers and providers of food. Nevertheless, the economic approach based on farm level data on the gender gap issues regarding Tanzania's agricultural sector is sparse. So, the study will add an empirical analysis on Tanzania to this research area investigating the value of female farmers' labor in farm production

This study will estimate the contribution of family member groups (i.e. male adults, female adults, teenagers, and children)[①] to agricultural production at the individual farm level by using a shadow wage approach.

All the samples used for the analysis for this research are farm

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[①] The detailed description of family groups is shown in table 3 in chapter 4.

households of family farming. Family farming is farming managed and operated by a family and predominantly reliant on family labor (Garner and de la O Campos, 2014). In this regard, each group includes only family members who participated in family farming. For instance, female farmers defined as female adults who are over 18 years old and under 65 years old and have participated more than at least once in farming on the farmland which their families own or rent. This study also includes paid workers that farm hires as a group of farm employees.

Following Kang and Kwon (2005)②, this study estimate the shadow wages for each family member. The shadow wage in this study means the estimate of agricultural productivity in monetary terms for each farm labor. That is, it is normally interpreted as an implicit hourly (or daily) wage per person.

However, the shadow wage estimates from this study is an average shadow wage for each family member groups which are categorized into female adults, male adults, teenagers, and children to consider the different context of farm households in Tanzania. In Tanzania, the average number of workers in family farming is about 5.32 based on our data. Even, teenagers and children are frequently

② Kang and Kwon (2005) estimated the individuals' shadow wages by farm house in Korea where most of farm houses manage their farms by two adult household member, husband and wife, and hire employees seasonally.

employed frequently in agricultural production. That is why we determine that the shadow wages from each farm family stand for an aggregated contribution of member groups in a household, not a wage of each individual.

1.4. Literature review

First, earlier studies have investigated female farmers' agricultural participation and also analyzed their contribution to agricultural production. Shapiro (1990), Ezumah and Domenico (1995), Auta et al (2000), Barry and Yoder (2002), and Damisa et al (2007) have studied women's contribution in agricultural production in developing countries such as Zaire[3] and Nigeria.

Shapiro (1990) explores the relationship between household composition and farm size with an emphasis on women's contribution to agricultural production by using determinants analysis. This paper finds driving factors on crop areas by households, gender composition of the household work force, and household size. In this paper, women's contribution to farm size at the margin is larger than that of men, which is seen as the division of labor in Zaire agriculture results in women specializing in agriculture and men being more actively involved in other non−agricultural activities such as hunting and gathering (Shapiro, 1990, p. 17).

In Ezumah and Domenico (1995), their basic quantitative analysis with small−scale farm data shows that female farmers' participation in agricultural production gets influenced by location and marital status, education level of women, and people ' s conception of

[3] Zaire was the name of a country which is now called the Democratic Republic of the Congo.

activities required for specific gender. Specially, Igbo female farmers in Nigeria are found in this study to undertake some of the conventional male agricultural tasks in addition to those in the female domain due to greater male participation in nonfarm activities. Barry and Yoder (2002) conducts the multiple regression analysis on women's contribution to agricultural production with microdata in 119 agricultural societies over the world including America and South–Saharan Africa. As a dependent variable in their study, contribution by women to agriculture is made as a score by the researchers from four agricultural activities[④]. According to their empirical result, agricultural contribution by women is positively associated with bonding by women in a house.

Next, one of our goals in this study is to find the average wage gap by gender group by estimating to what degree female family members of a farm house participate in agricultural work. With regards to the studies about the gender wage gap and productivity gap, Jung (2005) analyzes the gender wage gap and its trend in the Korean labor market for the years 1985 – 2004 by following Oaxaca

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④ Barry and Yoder (2002) sets the four agricultural activities to soil preparation with hoe or plow, crop planting and/or transplanting, crop tending such as weeding and irrigation, and harvesting including preparation for storage. The contribution by women to agriculture ranges from 0 (exclusively men) to 100 (exclusively women) (Barry and Yoder, 2002, p. 290).

and Ransom (1994) to decompose the gender wage gap into the gap of productivity and non-productivity-related gap such as unobserved productivity gap and discrimination. This paper estimates wage function by gender and uses wage data of full-time workers from National Wage Structure Basic Survey in Korea.

Lastly, this paper introduces a stochastic frontier model of a production function and an estimation method for unobserved wages of family members who contribute to the agricultural production. Jacoby (1993), Skoufias (1994) are pioneering papers which have estimated shadow wage. As recent studies, Kang and Kwon (2005) and Nepal and Nelson (2015) derive agricultural productivity by gender for farm households by using shadow wage estimation.

Jacoby (1993) studies the time-allocation models for self-employed peasants in Peruvian Sierra. In this study, he estimates the shadow wage of the household workers in Peruvian Sierra in order to model the implicit working values for different workers, which are not determined by the market. This research utilizes the Cobb-Douglass production function to get shadow wages of family laborers and they put different types of family labor into the agricultural production function for shadow wage estimation such as adult male labor, adult female labor, teenage labor, and child labor.

Skoufias (1994) has produced one of the most important existing pieces of literature regarding shadow wage method. It applies to data of rural India in estimating labor supply of agricultural households and gets direct estimates of the marginal productivity of male and female labor in households derived from a Cobb-Douglas production function. Afterwards, it uses the estimated shadow wages as repressors in a structural model of labor supply. It is assumed that male labor, female labor in houses and hired labor are specified as heterogeneous inputs. Our research also follows this assumption, motivated by the success of researchers who came after Skoufias (1994) (Manon et al., 2005; Barrett at al., 2008; Nepal and Nelson, 2015).

Kang and Kwon (2005) and Nepal and Nelson (2015) estimate input distance functions to get shadow wages by gender in households in South Korea and Nepal respectively. Kang and Kwon (2005) researches the shadow wages of two main family laborers (a man and a woman) in each farm house and finds that the estimated shadow wages of family laborers are lower than the hired workers' wages and interprets that the hired workers are required to conduct hard tasks by being paid and likely to be more productive than family workers. Nepal and Nelson (2015) estimates shadow wages by gender based on a standard time-allocation model by using the Nepal Living Standard Survey. Their findings suggest that females have higher productivity than males and that they are underpaid in the labor market in regard to their marginal productivity in Nepal. However, It is unclear whether this study estimates individual shadow wages of female farmers in houses or not.

Table 1. Previous studies about farmers' agricultural contribution with a method of shadow wage estimation

Study	Research topic	Sample Area	Model / Estimation method
Jacoby (1993)	Shadow wage and labor supply	Peruvian Sierra	Cobb–Douglas production function / OLS, Instrument Variable (IV) regression
Skoufias (1994)	Shadow wages of small-scale farmers	India	Time allocation model based on Cobb-Douglass production function / OLS, Two-Stage Least Squares (2SLS)
Kang and Kwon (2005)	Shadow wages of a male member and a female member in a house	South Korea	Translog input distance function / Frontier Estimation
Nepal and Nelson (2015)	Shadow wages of male and female family members	Nepal	General Production function / Generalized Method of Moment (GMM)

1.5. Significance of study

The main contributions of this study can be summarized as follows. First, it is pioneering by measuring aggregated agricultural contribution of female family members to family farming by household in the monetary term, while the previous studies usually conducted quantitative research about the female farmers' contribution or their productivities only with samples of female farmers who are household heads.

Next, this study add an empirical evidence to the African women study, especially for the rural and agricultural sector, by using more sophisticated economic theory and econometric model. The existing literature on women in Africa had rarely focused on it because of lack of data.

Finally, analyzing agricultural contribution by gender and studying female farmers has not made much progress in Tanzania. This study aims to investigate the agricultural features by gender in Tanzania and discover the keys in agricultural contribution of women using the 2014-2015 Tanzania National Panel Survey (NPS). The results from this analysis will provide basic information to develop policy measures for lessen gender gap in rural and agricultural sector in SSA countries.

1.6. Contents of study

The upcoming chapter includes background studies about agriculture and farmers in Tanzania with a sociocultural approach. Chapter 3 presents the explanation about Input distance function and shadow price estimation which we use in our research. In addition, the methodology in details and variables are provided. Chapter 4 shows the empirical results about the estimated contribution of female farmers to their family farming and also determinants analysis. Finally, Chapter 5 concludes with a discussion on the implications of our findings. Also, some limitations we faced and suggestions are given for further potential studies.

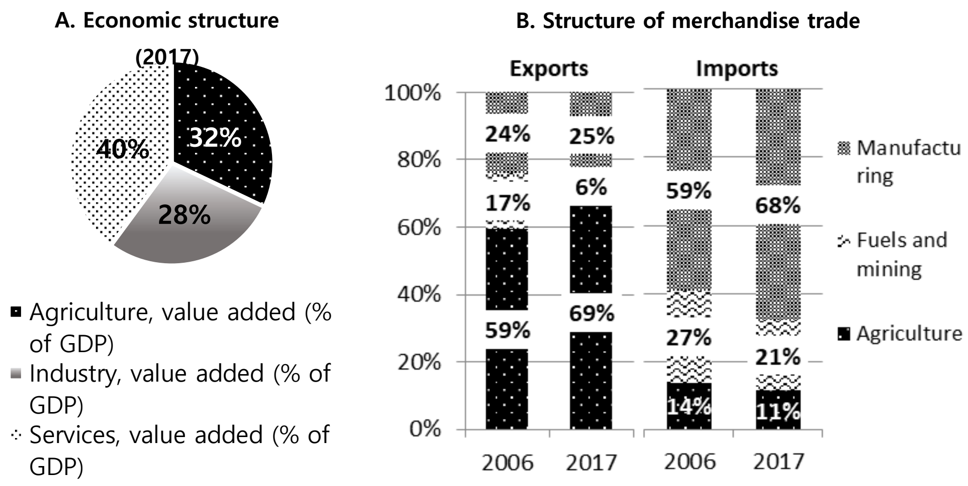
Chapter 2. Background of Study Area

2.1. Economy and agriculture in Tanzania

Tanzania is among the least developed countries in the world with a gross national income per capita of about $2,683 USD (constant 2011) in 2017 (OECD/WTO, 2019a). According to the Tanzania National Bureau of Statistics, Tanzania has maintained high growth rate over recent years and reports real gross domestic product (GDP) growth in 2018 was 7.0%, which was higher than 6.8% in 2017. In spite of rapid economic growth in Tanzania, their economy has still been driven by agriculture, which generates 32 percent of value added in GDP and 69 percent of total exports in 2017 (Figure 1).

Despite sustaining a relatively higher growth rate over the last decade, trade balance has deteriorated due to a constantly higher volume of import. Exports in 2018 were contracting by 3.9% in gross value while imports were increasing by 7.8% because of increased capital spending on development projects (WB, 2019).

Figure 1. Economic indicators in Tanzania



Source: OECD/WTO (2019a), p. 427.

Due to efforts to enhance economic development and reducing poverty for decades, poverty rates estimated by institutes have declined from 59.9 to 49.1 percent between 2007 and 2011, as estimated by OECD⑤, or from 36.0 to 22.8 percent from 2007 to 2015 as estimated by CIA⑥ as shown in Figure 2. However, WB (2019)

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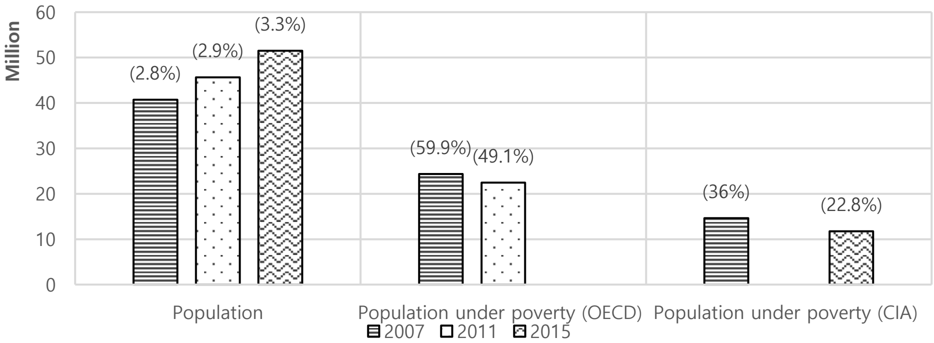
⑤ Percentage of population living at $1.90 a day (2011 PPP)

⑥ National estimates of the percentage of the population falling below the poverty line are based on surveys of sub-groups conducted by CIA, with the results weighted by the number of people in each group.

notes that the overall number of poor people has still held at a high level because of a high growth rate of the population. According to their research, 5 out of 6 people in extreme poverty dwell in the rural sectors (WB, 2015).

Figure 2. Population and population under poverty in Tanzania



Source: by author using OECD/WTO (2019a) and CIA (2019).

As shown in Figure 1, agriculture plays a significant role in the economy of Tanzania. Most people have engaged in agriculture, which constituted 80 percent of Tanzania's work force in 2003 (Thurlow and Wobst, 2003), and now accounts for approximately 68 percent (FAO, 2018). The main staple crop is maize and Tanzania is highly self−sufficient in maize with regards to this specific crop. Maize production accounts for more than 70 percent of the cultivated cereal.[7] Cassava, paddy, sorghum and bananas are the second most widely grown staple crops by farmers in Tanzania. Most crops are grown during wet seasons – a long rainy season regarded as a period ranging from March to May and a short rainy season regarded as a period ranging from October to December (Figure 3). June to September is called ‘dry season’ when a few farmers plant permanent crops or fruits (NBS, 2017).

Figure 3. Rainy seasons and dry season in Tanzania

WET SEASON					DRY SEASON				WET SEASON		
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		LONG RAINY SEASON							SHORT RAINY SEASON		

[7] Match Maker Group (2019.10.01) ‘Maize sector in Tanzania: challenges and opportunities’, http://www.matchmakergroup.com/news/maize−sector−in−tanzania−challenges−and−portunities.aspx#.XbhUnegzZPY

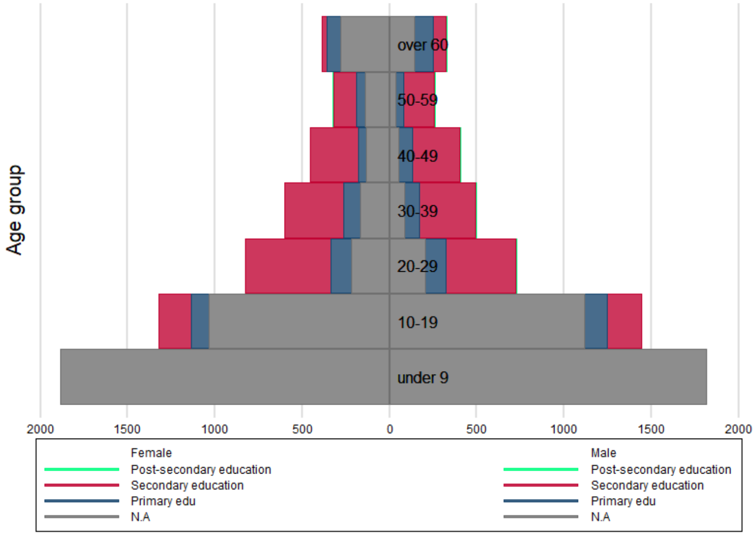
2.2. Farm houses and female farmers in Tanzania

The agricultural sector in Tanzania is dominated by small-scale subsistence farmers. 83 percent of all holding areas are run by small-scale farmers and they substantially contribute to the agricultural sector with around 75 percent of the total agricultural output in Tanzania (FAO, 2018). With this characteristic of farming, problems such as low productivity, inadequate skills and lack of capabilities to utilize the natural resources have arisen, preventing an efficient development in agriculture and rural economy (OECD/WTO, 2019b).

Based on the original data of NPS 2014/15 we used in this study, it shows characteristics of farm houses in Tanzania. According to this, almost 69 percent of households were cultivating land whether the land is owned or rented. Farmers cultivate farm plots of 3 hectares on average and 84 percent of the farmers own less than 4 hectares of land. Most of them are engaged in subsistence farming as we already mentioned but one-third of the farmers sell some of the crops they cultivated (NBS, 2017).

As figure 4 shows, the population structure in farm houses forms a pyramid shape which is frequently observed among low developed countries. Men are outnumbered by women in all age groups except teenagers (ten to nineteen years old). The population of children who are under 10 years old is 3,709 and teenagers are 2,768. Thus, the population of children and teenagers in farms is totally 6,477, which represents 57% of the total farm population. Populations decrease with age groups because Tanzania has a high birth rate as well as high mortality. According to KEXIM (2018), the life expectancy in Tanzania is 65 years.

Figure 4. Population and distribution of educational background in farm households



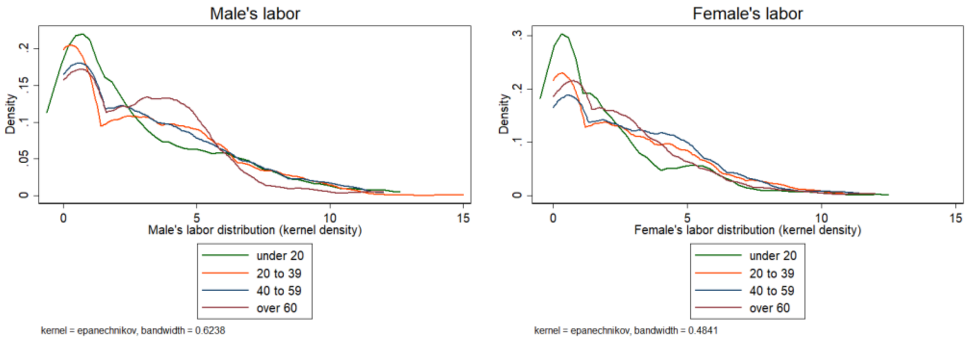
Source: by author using NPS 2014/15.

Note: We count them as N.A., when a respondent answered nothing on the question of education level. The other education groups show that the highest level of schooling they received.

Gender inequalities in education are seen minor by age group in this data. However, researchers argue that the rate of illiteracy is still high in Tanzania. In particular, 39 percent of women and 23 percent of men in rural areas are illiterate, and the ratio gap of the percentage of secondary school enrollment between rural area and urban area is even bigger (Osorio et al., 2014).

Figure 5 shows that distributions of labor in farming are generally similar by age and gender except the distributions for people over 60. Here we can see that the contribution of children in farming takes an important portion of the labor input on intra-household farming and female members over 20 years old participate in farming perform. Here we can observe the involvement of children in farming is more significant regarding labor input on intra-household farming. Women over 20 years old contribute as main human resources similarly to men, given the similar labor between the two genders.

Figure 5. Distribution of working hours spent on farming by gender (2014-2015)



Source: by author using NPS 2014/15 survey

As we focus on characteristics of female farmers in Tanzania, WB (2015) explains that they are less educated than male farmers and female heads in agricultural households are likely to have less household members and also cultivate smaller land than male heads do. In addition, 67% of them are widowed, divorced or separated while only 9% of male household heads are, which shows that households with female heads are prone to have difficulties using male laborers in farming (WB, 2015).

From a sociocultural perspective, Fletcher and Kubik (2016) and Parkin and Nyamwaya (2018) point out that most rural communities in Tanzania are patrilocal and follow patrilineal customary practice, especially regarding land and property. Around 20 percent of communities follow matrilineal customs, but still acquisition of ownership such as land registration practices and inheritance of land is conducted between male family members. As usually observed in patrilineal societies, Tanzanian female farmers generally take charge of diverse tasks and responsibilities, such as childcare, food preparation, collecting water and firewood, even though they were found to work longer in a day compared to men (Shayo and Martin, 2009).

Under these circumstances, female farmers in Tanzania have difficulties to access and possess land as well as key agricultural inputs such as machinery and modern tools (UN Women et al., 2015). Furthermore, Tanzanian women in agricultural areas tend to be undervalued and defined as unskilled laborers, even though they engage in complex actions and dominantly carry the variety of housework processes (Shayo and Martin, 2009).

Chapter 3. Data and Methodology

3.1. Data

This study used nationally representative survey data from the World Bank's Living Standard Measurement Study (LSMS) – ISA (Integrated Survey on Agriculture) program. We considered the recent household survey in Tanzania called Tanzania National Panel Survey 2014-2015 (NPS 2014/15). Using the most recent round survey among four rounds surveys in order to maximize the statistical power and grasp the recent social and economic phenomena in Tanzania.

The LSMS-ISA program of World Bank assists Sub-Saharan African countries to implement multi-topic household survey with technical assistance to national statistical offices in these countries. The main objective of this program is to provide high-quality household-level data to governments of Sub-Saharan countries and other stakeholders for monitoring poverty dynamics, tracking the progress of their poverty reduction strategy over years and evaluating the impact of their policy initiatives (WB, 2019).

The data used this paper is drawn from Tanzania National Panel Survey (NPS) of World Bank's LSMS-ISA. The NPS is a household panel survey that has been conducted over 4 waves with 2 year interval since 2008 (NBS, 2017). The latest wave, NPS 2014/15, is used in this paper. This survey generated 2,872 household survey across 359 EA (Enumeration area) in Dar es Salaam and other urban areas on Mainland and 1,776 samples in 222 EA which belong to rural area in Mainland. 480 household surveys were produced in Zanzibar which is semi-autonomous region in Tanzania. The resulting sample consists of 3,352 households across 419 EAs as shown in Table 2.

Table 2. Number of Clusters and Households in Samples of NPS 2014/15 by Area

Area	Cluster	Household	Percentage
Tanzania	419	3,352	100%
Tanzania Mainland	359	2,872	85.7% (100%)
Dar es Salaam	69	552	16.5% (19%)
Other Urban Mainland	68	544	16.2% (19%)
Rural	222	1,776	53% (62%)
Tanzania Zanzibar	60	480	14.3%

Source: World Bank Living Standard Measurement Survey (LSMS) – Tanzania National Panel Survey 2014-2015 (NPS 2014/2015)

Note: The weights in parentheses refer to the weights in the parent item, Tanzania Mainland. Each parenthesis under the parent item sums up to 100%.

3.2. Input distance function and Shadow wage estimation

The production technology of crops can be described as using input requirement sets, $V(y)$, representing the set of all (M×1) input vectors, x, which are required to produce the (N×1) output vector, y which is given. That is,

$$V(y) = \{x:\ x\ can\ produce\ y\} \quad (1)$$

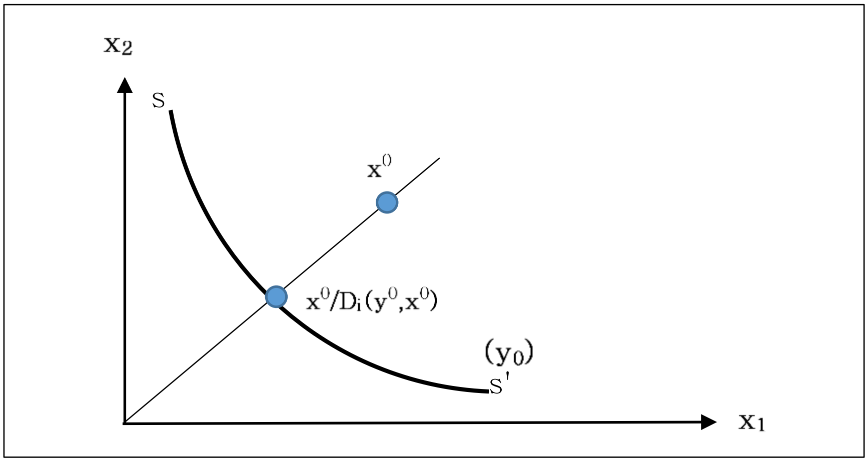
The production technology described by $V(y)$ can explain its properties with the equation (2) which shows the input distance function. The input distance function indicates how far each input vector is from the frontier of the input sets when the output vector is given.

$$D_i(y,x) = sup_{\lambda}\{\lambda > 0: (\chi/\lambda) \in V(y)\} \quad (2)$$

, where λ is a positive scalar. The Input distance function is illustrated in figure 6 where two inputs, x_1 and x_2, are used to produce output, y^0. The isoquant, SS', is the boundary of the input set and reflects the minimum input combinations to produce a given output vector, y^0. In this case, the value of the distance function for a farm house producing output, y^0, using the input vector defined by point x^0.

The value of $D_i(y^0,x^0)$ puts $x^0/ D_i(y^0,x^0)$ on the boundary of $V(y^0)$. If an input vector is located inside $V(y^0)$, this input vector can produce y^0 and the input distance function, $D_i(y^0,x)$, is greater than one. If it is located on the frontier of $V(y^0)$, the input distance function has a value of one, which means that it produces y^0 technically at the most efficient point where the minimum level of input sets produces y^0 as already mentioned. Instead, the value would be less than one when the input vector is outside of $V(y^0)$. Since being outside $V(y^0)$ does not satisfy the minimum input(the frontier level) for y^0, it cannot produce y^0. Thus, the range of $D_i(y^0,x)$ is theoretically bigger than one or one (Färe & Primont, 1995 ; Kwon, 2019).

Figure 6. The input set and the input distance function



Source: Färe & Primont (1995), p. 20.

The input distance function, D_i (x,y), has several properties. D_i (x,y) is non−decreasing, positively linearly homogeneous in degree one in *x*, and non−increasing and quasiconcave in y (see Equation (3), equation (4), and equation (5), respectively). Additionally, the input set, {x : D_i (x,y) ≥ α } is closed and bounded for any $\alpha > 0$. (Sherphard, 1970; Färe & Grosskopf, 1990; Hailu and Veeman, 2000, Kang & Kwon, 2005).

$$\frac{\partial \ln \mathrm{D_i}(\mathrm{y},\mathrm{x})}{\partial \ln \mathrm{x}_n} \geq 0 , \qquad \mathrm{n} = 1, \dots, \mathrm{N} \tag{3}$$

$$\mathrm{D_i}(\mathrm{y}, k\mathrm{x}) = k\mathrm{D_i}(\mathrm{y},\mathrm{x}) \text{ for all } (\mathrm{x},\mathrm{y}) \ in \ R_+^{N+M} \tag{4}$$

$$\frac{\partial \ln \mathrm{D_i}(\mathrm{y},\mathrm{x})}{\partial \ln \mathrm{y_m}} \leq 0 , \qquad \mathrm{m} = 1, \dots, \mathrm{M} \tag{5}$$

It is well−known that a duality theorem is established as below between the input distance function, D_i, and the cost function, *C* (Sherphard, 1970; Färe, 1988; Kwon, 2019).

$$\mathrm{C}(y,p) = \min_x\{px : D_i(y,x) \geq 1\}, \tag{6}$$

$$D_i(y,x) = \inf_p\{px : C(y,p) \geq 1\} \tag{7}$$

, where $x \in R_{+}^{N}$ is a vector of inputs and $\mathrm{p} \in R_{+}^{N}$ is a vector of input prices. Jacobsen (1972) mentioned that the relationship between the two equations above is important when it comes to analyzing production models using the duality and this relationship can be used to derive the shadow price for each input. To explain this briefly, the equation (8) holds by solving the cost minimization problem of the equation (6) in applying the property of the input distance function which is homogeneous of degree one. In the equation (8), △ is the partial differential operator (Hailu and Veeman, 2000; Kang and Kwon, 2005).

$$\mathrm{p} = \mathrm{C}(y, p) \triangle_{x} D_{i}(y, x) \tag{8}$$

$$\frac{P_2}{P_1} = \frac{\mathrm{C}(y,p) \cdot \partial D_i(y,x)/\partial x_2}{\mathrm{C}(y,p) \cdot \partial D_i(y,x)/\partial x_1} = \frac{\partial D_i(y,x)/\partial x_2}{\partial D_i(y,x)/\partial x_1} \tag{9}$$

Here, we assume p_1 is a price of a good or service, x_1, which is traded in market and p_2 is an invisible price of a good or service, x_2, which is not dealt in market. When we obtain the shadow price of x_2 from the equation (8), we need to know the cost function, *C.* However, it is impossible to get the value of C(x,y) since several input prices do not exist in market such as p_2. The equation (8) can be written again as the equation (9) with the linear homogeneity of the input distance function. Then, the equation (9) can be used to compute the ratio of the shadow prices of the goods and one price (here this is the price of x_2, P_2) does not exist in the market. Finally, P_2 which is the price of x_2 can be calculated with p_1 as following equation (10) (Kang and Kwon, 2005; Kwon, 2019).

$$P_2 = \frac{\partial D_i(y,x)/\partial x_2}{\partial D_i(y,x)/\partial x_1} \cdot P_1 \qquad (10)$$

3.3. Estimation model

In order to calculate the equation (10), we need to estimate the input distance function, $\mathrm{D_{ik}}(\mathrm{y},\mathrm{x})$ and $\mathrm{D_{ik}}(\mathrm{y},\mathrm{x})$ is specified into a Cobb−Douglass input distance function in this study.

$$ln\,\mathrm{D_{ik}}(\mathrm{y},\mathrm{x}) = \delta + \alpha_1\, ln\, y_{1k} + \Sigma_{i=1}^{N}\ \beta_i\, ln\, x_{ik} + \nu_k \qquad (11)$$
$$,\ i = 1, \dots, \mathrm{N}\ , \mathrm{k} = 1, \dots, \mathrm{K}$$

where the log form of a cobb−Douglass input distance function is for the case of the one output, x_{ik} means the i−th input of the k−th household and the number of inputs is N and there are K households. Also, y_{1k} means the output quantity of k−th household. ν_k is an error term which is assumed independent and identically distributed with $N(0,\sigma_v^2)$ (Färe and Primont, 1995). The ln represents a natural logarithm, and α_1, δ and β_i (i=1,...N) are unknown parameters to be estimated.

As the x variables, we employ inputs of land, labor inputs of male adult, female adults, teenagers and child, agricultural inputs of farm equipment, inputs of fertilizers, insecticides, seed cost and other agricultural inputs, and regional dummy variables. The output variable, y, is the quantity of all crops harvested in a household. In our study, we used the market value of the crops they cultivated instead of the data of quantity since the observations for y from the survey are not reliable. Table 3 shows the descriptive statistics of variables used in Shadow wage estimation.

$$\sum_{i=1}^{N} \beta_i = 1 \tag{12}$$

Furthermore, we impose the restriction for homogeneity of degree one on the inputs of the function as equation (12). Imposing the restriction of the equation (12), we get the final estimating equation (13) for the empirical data analysis (Coelli et al., 2005).

$$\begin{aligned} \ln \mathrm{D_{ik}}(\mathrm{y},\mathrm{x}) \quad = \quad & \delta + \alpha_1 \ln y_{1k} \\ & + \Sigma_{j=2}^{N} \ \beta_j \ln(x_{jk}/x_{1k}) + \nu_k, \end{aligned} \tag{13}$$

To apply a linear homogeneity condition for inputs in the Cobb-Douglass input distance functions, we should divide the input distance function and other inputs with the one of the inputs (Lovell et all., 1994). For explanation, we divide the input distance function and the other outputs with x_{1k} which is the 1^{st} explanatory variable input and then get the equation (14).

$$\begin{aligned} \ln(\mathrm{D_{ik}}/x_{1k}) \quad &= \quad \delta + \alpha_1 \ln y_{1k} \\ &\quad + \Sigma_{i=2}^{N} \ \beta_i \ln(x_{ik}/x_{1k}) + \nu_k, \end{aligned} \tag{14}$$

$$, i = 2, \dots, N, \qquad k = 1, \dots, K$$

$ln\, \mathrm{D_{ik}}(\mathrm{y,x})$ is the efficiency of k-th household and is not able to be observed. According to Coelli et al (1998, p. 184), this unobserved $ln\, \mathrm{D_{ik}}(\mathrm{y,x})$ in the equation (14) can be replaced with υ_k which means the error term of inefficiency. Thus, we can obtain the equation (15) after we move υ_k on the right side.

$$\begin{aligned} -\ln x_{1k} \quad &= \quad \delta + \alpha_1 \ln y_{1k} \\ &\quad + \Sigma_{j=2}^{N} \ \beta_j \ln(x_{jk}/x_{1k}) + \varepsilon_k, \end{aligned} \tag{15}$$

$$\text{where,} \ \ \varepsilon_k = \ \nu_k - \upsilon_k$$

The distribution of inefficiency error term υ is assumed to be a non−negative on the normal distribution as Aigner, Lovell and Schmidt (1997). According to the previous study, υ also identically normal distributed based on μ but truncated on 0, which is iid~$N(\mu, \sigma_u^2)$. Given these distributional assumptions, the values for unknown parameters can be obtained by the method of maximum likelihood (Coelli et al., 2005).

To sum up, we built up input distance functions using the Cobb−Douglas production function and estimate the input distance function with the advanced methodology of econometrics: the Stochastic Frontier Analysis using the Maximum Likelihood.

A stochastic frontier function model from a production function benefits that the presence of actual inputs exceed the minimum inputs at a given output. The ratio of actual inputs to minimum inputs shows the technical efficiency of the factor inputs utilized in the actual data. The stochastic frontier function model is a parametric approach that can be used to distinguish between measurement and technical inefficiencies in production (Kang, 2017).

3.4. Variables and descriptive statistics

This study estimates the shadow wage of family laborers by gender and age, and also analyzes driving factors of female farmers' contribution to the agricultural production in their farm. This empirical analysis is carried out with data from the well-structured World Bank surveys at household and individual levels in Tanzania in 2014/2015. Variables used for the shadow wage estimation and determinant analysis as well as several assumptions on the process of data collecting made in our research are as follows.

Input distance function estimation

First, the output was aggregated from the harvested crops such as maize, paddy, cassava, banana, and mango. Due to the heterogeneity of the inter-crop units and the difficulty of data collection, the nominal prices of crops were recalculated and used as agricultural production by dividing the sales price (nominal price) with the GDP deflator (real price) of the year[⑧] which is provided by

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[⑧] The GDP deflator of Tanzania in 2014 is 92.944 and the base year of Tanzania is 2015.

World Bank Database.

Independent variables as inputs of production function are employee's working hours, male adult member's working hours, female adult family member's working hours, children's working hours, capital, and sum of other agricultural inputs. Among them, land is arable land for production, which includes paddy fields, fields and orchards. In the case of capital, it includes the cost of agricultural machinery rented, agricultural tools rented, and depreciation of agricultural machinery they have. Depreciation expenses were regarded as the prices expected by farmers to sell their farm machinery or items. The variable named Input includes fertilizers, pesticides, herbicides and seed costs. We use the hourly wage for the labor employed by each farm by dividing the total cost of hiring employees in a farm house with the total hours the employees worked. Employment costs and workers' hours were surveyed in the questionnaire with no distinction of sex. Under this constraint of survey, the employment labor and wage were not able to be segregated by sex in data collection.

The inputs and outputs of the production function are summed over short and long rainy seasons. Similarly to outputs, the inputs of capital and other inputs are divided by the GDP deflator, taking into account the heterogeneity of units or materials. The basic statistics of these variables are summarized in table 4.

Table 3. Descriptive statistics of variables for the shadow wage estimation

Variable	Explanation	Unit	Mean	S.D.	Min	Max
Output	Value of all crops harvested	1000 TSH	492.52	849.02	0	2,460
Land	Size of land for cultivation	Acre	5.35	12.7	0.1	251
Employee	Total working hours of hired external workers	Hour	53.46	132.07	0	2,304
Male adult	Hours farm work, male, ages 18−65	Hour	353.14	490.23	0	5,736
Female adult	Hours farm work, female, ages 18−65	Hour	409.98	538.30	0	8,361
Teenager	Hours farm work, male and female teenagers, ages 11−17	Hour	70.01	223.19	0	3,440
Child	Hours farm work, male and female children, ages 6−10	Hour	83.99	280.47	0	5,574
Capital	Value of farm equipment and machinery owned or rented	1000 TSH	280.98	895.66	0	1,624
Input	Expenditure on fertilizer, insecticides, seed cost and other agricultural inputs	1000 TSH	52.77	191.75	0	5,140
Employee	hourly wage of hired employees	TSH	659.26	796.79	0.77	10,000
Dummy1	Dar es salaam = 1, otherwise = 0	Dar es salaam	0.033	0.181	0	1
Dummy2	Rural = 1, otherwise = 0	Rural	0.834	0.371	0	1
Dummy3	1=Other urban, otherwise = 0	Other urban	0.131	0.337	0	1

Determinants analysis

This study analyzes driving factors affecting female farmers' agricultural contribution share utilizing household characteristics, farming characteristics and several average properties of individual characteristics per family such as average age of female family members and average schooling years of female family members, which is provided in Table 4. Considering the characteristics of sample which has a highly left-skewed distribution of women's agricultural contribution and a large deviation of it as shown in Figure 7.

Trommlerová, et al (2015), Damisa and Yohanna (2007) argued that womem's agricultural contribution is causally related to education, age, marital status, economic activity, and health. The explanatory variables employed in the determinant analysis model follow the previous literatures which are mentioned in chapter 1 and chapter 2. The first two explanatory variables are women's individual characteristic variables such as age and schooling year. We use the mean of their ages and education periods because the dependent variable, the share of agricultural contribution in the total agricultural contribution by family is not a contribution ratio of one female individual, but one of female members in a house. Other variables are household characteristics and farming characteristics such as the size of family members, the size of crop areas, the number of children under 6 years and dummy variables of paddy and cash crop. Size of crop areas they hold or rent to cultivate crops are measured in acres. Also, we apply variables which shows the extent of men's participation in family faming and the extent to women's participation in housework respectively. The detailed list of explanatory variables with their descriptions, mean, standard deviation and indications of expected effects is provide in Table 4.

Table 4. Variable descriptions, means, standard deviations on the determinants analysis

Variable	Description	Obs.	Unit	Mean/%	S.D.
Dependent variable					
Contribution share	The estimated share of female adult members' labor in the total value of labor of whole family workers	801	–	0.67	0.28
Explanatory variables					
Age	Age on average among the female adult members	801	Year	31.79	16.37
Ede	Schooling year on average among the female adults members	801	Year	4.28	3.37
HHsize	The number of household members	801	Person	5.32	3.00
Children	The number of children, under 6 years old	801	Person	1.1	1.2
Chore	Female adults' average participation during a week (Growing water, picking up firewood)	801	Hour	0.58	1.18
Head edu	Schooling year of household head	801	Year	5.12	3.53
Land	Size of land for cultivation	801	Acre	6.04	11.59
Paddy	The farm cultivates paddy = 1, otherwise = 0	801	–	0.40	0.49
Cash crop	The farm cultivates cash crops such as tobacco, coffee, tea, sugar cane, medical plant, otherwise = 0	801	–	0.26	0.43
L_input	Input costs per a unit of land size	801	TNS/Acre	88,192	49,399
L_capital	Machinery values per a unit of land size	801	TNS/Acre	64,751	170,945
Man labor	The share of male adult members' working hours in total family workers' working house in farm	801	–	0.40	0.28
Dummy2	Rural area = 1, otherwise = 0	801	–	0.90	0.30

Chapter 4. Results

4.1. Estimation of the input distance function

The result of the stochastic frontier estimation of the input distance function in Chapter 4 is shown in table 5. The log likelihood value of this estimated model is −1899.603 and the mean efficiency is 0.70. In addition, the estimated result is constrained to meet the equation (12). The parameter of Ln(output) is negative as we expected, which means $D_i(y,x)$ increases as the quantity of output decreases, and reciprocally. $D_i(y,x)$ is over 1 and it is getting bigger when the farm house uses more inputs to produce the same quantity of output. Thus, if more is produced with the same input sets, the value of the input distance function is decreased and more efficiency is reached. Since the absolute value of the Ln(output) is smaller than 1, we found that their production increases return to scale, which is regularly reported in production function studies.

The signs of parameters also satisfy the monotonicity restrictions given by inequalities 3 and 5. All explanatory variables of the production function are positive and their sum is 1.

The parameter of Ln(Input/Female adult) is significantly positive with an estimated value of 0.01, meaning that when the house changes the input ratio between land and female labor increases by 1%, the usage of female farmers' working hours decreases by 1% on average when the other inputs are fixed. Between the use of agricultural input and capital input, the marginal input ratio between Input and Female adults is bigger than the one between Capital and Female adults even though the coefficient of Ln(Capital/Female adult) was not significant.

Among four types of laborers such as male adult, teenager, child and employee, the usage of teenager, child, and employee are seen to substitute female adult labor significantly. Especially, when hired laborers are employed longer, female adults would tend to work less than they would with teenager or child labor instead, under the assumption of the same quantity produced. The input ratio of Male adult's labor on Female adult also negatively affects the input of female adults' labor (0.010) but the outcome was not significant ($p=0.156$).

Regional dummy variables show that the farm houses in the capital city, Dar es Salaam, and the other urban areas tend to use less female adults' labor in their house farming while the farm houses in rural areas would prefer using female adults when they cultivate crops in their farm. The coefficient of Dummy 1 (Dar es salaam = 1), 0.226, was not statistically significant ($p=0.220$).

With the coefficient we estimated from the input distance function model and the data of hourly wages of hired employees by each farmhouse, we can obtain the average shadow price of each group of family laborers. The average shadow wages for each group of family laborers such as male adult group, female adult group, teenage group, and child group in each farm house is calculated and the distributions of the shadow wages on each five type of farm laborers including hired employees' wages are summarized in Table 6.

Table 5. Input distance function of Cobb−Douglass production function (MLE) estimates

Variables	Cobb−Douglass production function		
	Estimates	Std. Error	z−value
Intercept	3.799***	0.242	15.673
Ln(Output)	−0.363***	0.017	−21.134
Ln(Land/Female adult)	0.010***	0.004	2.737
Ln(Input/ Female adult)	0.882***	0.019	47.331
Ln(Capital/ Female adult)	0.015	0.012	1.313
Ln(Male adult/ Female adult)	0.010	0.007	1.418
Ln(Teenager/ Female adult)	0.014**	0.007	1.978
Ln(Child/ Female adult)	0.014**	0.006	2.163
Ln(Employee/ Female adult)	0.026***	0.006	4.296
Dummy1 (Dar es salaam=1)	0.266	0.217	1.225
Dummy2 (rural =1)	−0.453***	0.088	−5.157
Sigma−squared	1.813***	0.465	3.897
Gamma	0.645***	0.099	6.511
Mu	−2.162*	1.301	−1.662
Mean efficiency	0.707033		
Log Likelihood Value	−1899.603		
N	1,468		

Note: ***,**,* designate significance at 1%, 5%, 10%, respectively.

Table 6. Distributions of average agricultural contribution by labor groups in farm house

(Unit: Tanzania Shilling)

Cobb−Douglass input distance function					
Percentile	Employee	Male adult	Female adult	Teenager	Child
5%	105	6	17	2	2
10%	143	11	31	3	3
25%	250	28	73	5	8
50%	500	86	205	18	24
75%	770	221	555	53	65
90%	1,250	530	1,315	202	224
95%	1,875	936	2,531	673	438
Mean	680	250	544	121	86
Std. dev.	840	694	930	401	182
Minimum	0.49	0.02	0.44	0.30	0.35
Maximum	10,000	9,295	7,116	4,012	1358

Note: We identified the shadow wages > 10,000 Tanzania Shillings per hour as outliers with the consideration based on the report of the minimum daily and hourly wage in Tanzania's agricultural sector (Etyang, 2017). Thus, 8 outliers were counted out of 809 observations. The results are rounded up to the one place and minimums are rounded up to the second digit after the decimal point.

According to Etyang (2017), the minimum wage of a hired laborer in agriculture is around 512.85 TSH in 2014. In our study, the mean of hired employee's wages from our samples is bigger than the real minimum wage which Etyang (2017) provided in his research. But the median of hired employee's wages is similar with the provided market data. So, in the comparison of shadow wages by gender with the mean of employees' wages, the estimated shadow wages would be slightly overestimated than the reality.

Overall, the average shadow wages of each family worker group are lower than the employees' wages. Between male adults group and female adults group, the monetary value of the female members' contribution in their house farming is estimated to be 544 Tanzania Shilling and the monetary value of the male members' contribution is calculated 250 Tanzania shilling on average. From this result we can consider that the contribution of female family workers in their house farming is bigger than the one of the male family workers.

In order to test the three types of hypothesis on the gap of prices, we conduct t-test between the sample means of the employee group and two genders. The null hypothesis (H_0) is that the two sample means of two groups are same ($\boldsymbol{\mu_{SAMPLE\ A} - \mu_{SAMPLE\ B} = 0}$). And the alternative hypothesis (H_1) is the sample means of two groups are different ($\boldsymbol{\mu_{SAMPLE\ A} - \mu_{SAMPLE\ B} \neq 0}$). The result of the t-tests rejected the three null hypothesis at the significant level 95%, which is presented in Table 7.

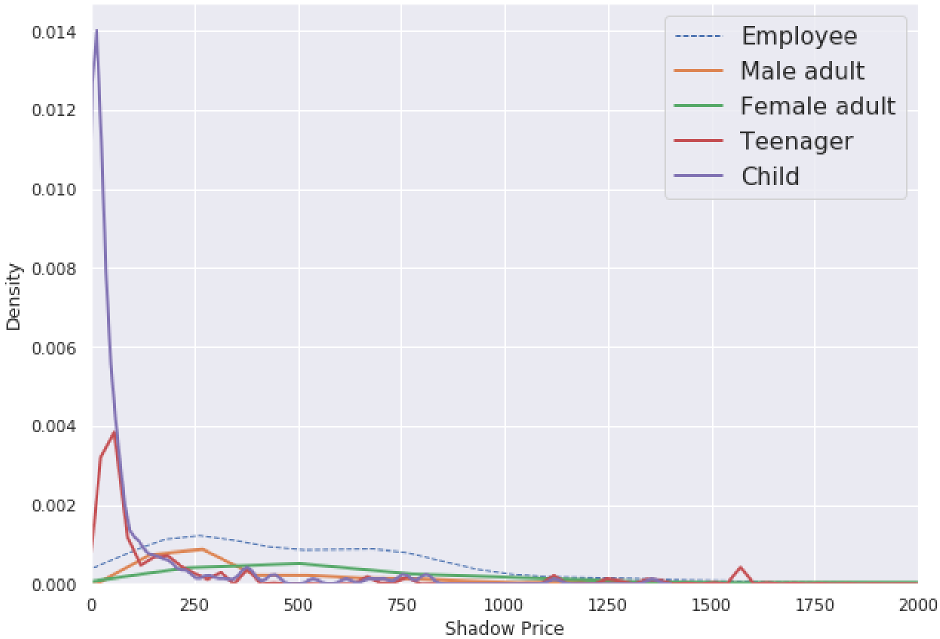
This result indicates that the sample means of three groups are significantly different. Specifically, the sample means of employee and female adult are different and the employee's wage mean is bigger than female's statistically at the significant level 95%.

Table 7. Hypothesis tests for sample means

Null hypothesis (H_0)	t-value	p-value
$\mu_{Employee} - \mu_{Male\ adult} = 0$	10.4263	0.0000
$\mu_{Employee} - \mu_{Female\ adult} = 0$	2.9981	0.0028
$\mu_{Male\ adult} - \mu_{Female\ adult} = 0$	-6.5529	0.0000

The estimated wages of family members are shown to have highly asymmetric distributions compared with the distribution of the employee's wage. The distribution of the employee's wage has long right tail but still shows a low concave shape around the mean (680). However, distributions of family members have a long right tail and also shows a very left-skewed shape as shown in Figure 7.

Figure 7. Histograms of market price of hired workers and contribution value (shadow wage) of family workers by group



Note: We put the histogram of wages in the range of [0, 2,000] while the maximum value of the prices is 10,000 because of the highly left-skewed distributions of wages.

4.2. Contribution of female farmers to agricultural production in their houses

To compensate the big variation of estimated contributions by gender in money value and make them able to be compared with other degrees in the other farm houses, we create a new index for agricultural contribution by female farmers in self−cultivated farms as shown in the equation (16)

$$\text{Female adult members' share}_i = \frac{\mathit{Female\ adult}_i}{\mathit{Male\ adult}_i + \mathit{Female\ adult}_i + \mathit{Teenager}_i + \mathit{Child}_i} \quad (16)$$

, where i means each household in observations. ***Female adult***, ***Male adult***, ***Teenager*** and ***Child*** follow the nomenclature of values in Table 6. Applying the equation (16), we also get male adults' share in their total family contribution using the calculation above. Using a ratio is a useful tool to compare contributions between two gender groups in a house, and also manage them of female adults when we analyze determinants of it since the absolute value of contribution has big variance while it has a range from 0.44 to 7,116. Figure 8 describes the distribution of the share of total family labor's agricultural contribution by gender which has a range from 0 to 1.

Figure 8. Distribution of share in total family labor's agricultural contribution by gender

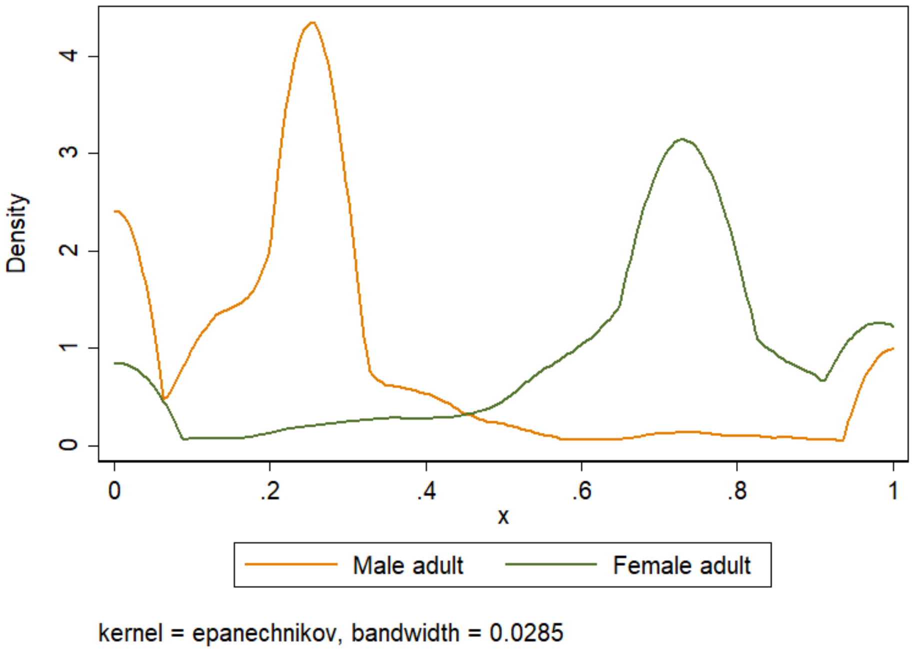


Figure 8 shows that the mean of female farmers' shares (0.727) in family farming is bigger than that of male farmers (0.347), and they are relatively widespread. The distribution of female adults shows that female members inside a household generally represent over half of the total family workforce in farming, while male members only 34.7% of the total agricultural contribution.

Table 8. Means of contribution share in each range of deciles by gender

Decile ranges of contribution by gender	Mean	
	Male adult	Female adult
0~10%	0.283	0.683
10~20%	0.258	0.684
20~30%	0.294	0.694
30~40%	0.339	0.675
40~50%	0.316	0.752
50~60%	0.340	0.714
60~70%	0.311	0.715
70~80%	0.360	0.773
80~90%	0.446	0.739
90%~100%	0.522	0.838
Mean	0.347	0.727

As shown in Table 8, in each decile of shadow wages, the mean of female adults' contribution share is bigger than that of male adults. This result explains that one agricultural input of female family members' labor accounts for a high proportion of the whole agricultural workforce by a family, even if the absolute value of agricultural contribution of the female members belongs to the lowest contribution decile. Male members' agricultural contribution in their family farm represents a large portion of the total family contribution as its monetary value is getting higher. In the last decile, the mean of the degree of agricultural contribution compared with total family labor contribution by men is 52.2%, whereas in the lowest decile it represents 28.3%.

Table 9. Determinants of female farmers' contribution to agricultural production by quantile regression analysis

Dependent variable: Contribution share	(1) Q= 0.25	(2) Q= 0.5	(3) Q=0.75	(4) OLS
Age	0.005*** (−0.001)	0.005*** (−0.001)	0.003*** (0.000)	0.006*** (−0.001)
Edu	0.012*** (−0.004)	0.007*** (−0.003)	0.003** (−0.002)	0.008*** (−0.003)
HHsize	−0.025*** (−0.005)	−0.013*** (−0.005)	−0.004 (−0.003)	−0.010*** (−0.004)
Children	0.060*** (−0.012)	0.041*** (−0.012)	0.012*** (−0.006)	0.040*** (−0.009)
Chore	0.028*** (−0.006)	0.014*** (−0.006)	0.010*** (−0.005)	0.027*** (−0.006)
Head edu	−0.002 (−0.004)	0.005 (−0.003)	0.001 (−0.001)	0.001 (−0.002)
Land	−0.001 (−0.001)	0.001 (−0.001)	0.0001 (0.000)	0.0003 (−0.001)
Paddy	0.026 (−0.023)	0.001 (−0.018)	−0.002 (−0.009)	0.024 (−0.017)
Cash crop	−0.072*** (−0.024)	−0.046*** (−0.020)	−0.022* (−0.011)	−0.070*** (−0.016)
L_input	1.30e−07 (0.000)	−3.11e−08 (0.000)	−1.63e−08 (0.000)	2.26e−07 (0.000)
L_capital	4.35e−08 (0.000)	1.18e−07 (0.000)	5.10e−08 (0.000)	2.89e−08 (0.000)
Man labor	−0.580*** (−0.070)	−0.475*** (−0.045)	−0.386*** (−0.022)	−0.421*** (−0.030)
Rural region	0.034 (−0.050)	0.003 (−0.038)	−0.024 (−0.016)	0.043* (−0.026)
Constant	0.605*** (−0.076)	0.722*** (−0.078)	0.874*** (−0.035)	0.582*** (−0.042)
Observations	801	801	801	801
Pseudo R2	0.41	0.20	0.26	0.44

Note: ***,**,* designate significance at 1%, 5%, 10%, respectively.

This result explains that one agricultural input of female family members' labor accounts for a high proportion of the whole agricultural workforce by a family, even if the absolute value of agricultural contribution of the female members belongs to the lowest contribution decile. Male members' agricultural contribution in their family farm represents a large portion of the total family contribution as its monetary value is getting higher. In the last decile, the mean of the degree of agricultural contribution compared with total family labor contribution by men is 52.2%, whereas in the lowest decile it represents 28.3%.

Table 9 presents the results of this analysis. The quantile regression analysis shows the different results depending on the quantile. When we see the effects of average individual characteristics of female farmers at first, the mean age of female farmers in a house has a positive effect on female farmers' contribution to agricultural production. When the average age of female members who participate in family farming increase by 1 year, the contribution share in family farming is generally increasing 0.5% when the other driving factors are fixed at 25% percentile and 50% percentile, and in 75% percentile the age is positively effective on females' agricultural contribution. In Tanzania, age of female farmers is positively correlated with agricultural productivity as it is in the other African countries (Oni et al., 2009). An average year of education of female farmers in household is seen similar as the effect of age. One more year of average schooling years of female farmers increases a ratio of female farmers' agricultural contribution in household in each quantile regression. However, coefficients get getting lower as the absolute value of agricultural contribution is higher. In other words, the marginal effect of education gets bigger on female farmers whose agricultural contribution is located in the lowest quantiles.

Second, the household characteristics show significant marginal effects on female farmers' agricultural contribution except schooling years of a household head. The number of total family members in household has significantly negative effect on the ratio of female farmers' contribution to agricultural production, but the coefficient is relatively low such as −0.004 when the female farmers' contribution has a higher monetary value of it. About the time allocation of female farmers, unlike our expectation, the number of children under 6 years old is found to have a positive coefficient on each quantile. In a previous studies, the population of pre−school children would have positive effect on females' participation in farming for a reason of a burden of bigger consumption (Thapa et al., 1996). Moreover, the marginal effects of house chore are 0.028, 0.014, and 0.010 on female farmers' contribution respectively. These values mean that the more time they spend on housework, the more proportion they take up on the whole agricultural contribution of their family members. From these results, the joint contribution of female members in household seems unconstrained by childcare and household chores.

Lastly, among farming characteristics, cash crop is found to be the only significant driver on female farmers' agricultural contribution. When a farm house grows cash crops which are usually cultivated to sell for profit such as tobacco, coffee, tea, sugar cane, and medical plant, the contribution of female farmers in the farm house is likely to be low as we demonstrated. In the lowest percentile, the marginal effect of cash crop is significantly −0.072, and that in the highest percentile is also significantly −0.002. This situation seems to be driven by a specific phenomenon in Africa where cash crops such as tobacco, cotton and hybrid maize are usually considered as men's cash crops (Gladwin et al., 1986/87) while at the same time women cultivate subsistence crops (Schneider et at., 2009). In addition, the increase of the share of male labor participation in family farming decreases the share of female farmers' contribution. Regional dummy variables are not significant in the quantile regression analysis but significantly positive in OLS estimation. The female farmers in rural area are more likely to represent up large part of family contribution to their agricultural production than them in urban areas according to the result of the OLS estimation.

Chapter 5. Conclusion

As a result of shadow wage estimation, we derive average contribution values of female member group in households in a monetary term and compare them with the labor market price of hired employees, by gender among other things. Overall, contribution of family laborer was significantly lower than the wage of hired workers. Monetary values of contribution female family members jointly generate in household are higher than those of male family members on average. This means that the average contribution of female family members is higher than the average contribution of males in households if the average productivity of female laborers and male laborers are measured in group and not individually.

From the quantile regression analysis with the proportion of women labor to the total amount of agricultural contribution made by all family members as the dependent variable, the average age and schooling year of women who participate in agriculture are shown to have positive effect on female farmers agricultural contribution. Also, childcare and housework do not affect negatively their agricultural contribution. On the other hand, farms growing cash crops, such as tobacco, coffee and tea, show that women's joint contribution to agricultural production in family farming is generally lower than that of female farmers in the opposite farms.

According to Ember (1974), more agricultural contribution to subsistence activities is generally seen from female farmers in matrilocal societies. However, the majority of communities in

Tanzania follow patriarchal practices with a few rural communities following matrilineal (Fletcher and Kubik, 2016). At this point, Tanzania female farmers are constrained by unequal access to land and agricultural inputs under the customs of paternal society and are also treated unfairly with regards to the value they yield, according to our empirical result which gives the evidence that they work as important and major labor force in family farm activities to sustain their family. In order to encourage their contribution to agricultural production in Tanzania, it is required to recognize the importance of their workforce and make policies to guarantee fair and reasonable social compensation to female farmers in Tanzania. Since female farmers in Africa agriculture are generally burdened by multiple roles such as burden of reproduction, productive and social activity (Thapa et al., 1996), programs on women and children's affairs would be helpful to lighten their burden to housework and farm activities although time constraint by housework has not been covered in our study. Regarding education, promoting basic education for women, encouraging them to participate in agricultural training courses, and also providing those extension programs targeted for women could be keys to improve their contribution to agricultural production.

There are several limitations in this study. We want to conclude our study in informing them we faced in order to initiate further research with more sophisticated data processing and better methodologies on this topic. First, the output used in this production function may be underestimated since the majority of Tanzanian farmers are engaged in self-sufficient farming and we used values of the quantity of crop yield as the Output variable from the data of product sale prices for the convenience of research. Second, the shadow wage for Tanzanian farmers' intra-household farming may be slightly lower than the amount estimated in our study. This is because shadow wages are estimated only among households employing external workers in agricultural activities. Also, the average hourly wage paid to the external employees in our micro data was found twice higher than the average minimum hourly wage reported in a literature. Nevertheless, the result of this study can contribute to the existing research on women's agricultural contribution in Africa studies, and also government policy and development strategy plan by measuring the agricultural contribution of Tanzanian female farmers to agricultural production in money value and identifying the determinants of them in family farming.

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국문 초록

탄자니아 여성 농업인의 농업생산 기여도 분석

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김나리

본 논문은 탄자니아를 중심으로 탄자니아의 농업 노동력 중에서 그 중요성이 더욱 부각되고 있는 여성 노동력의 자가 농업 노동 가치를 측정하고 가정 내 농업 생산에 있어서 여성들의 기여도에 영향을 미치는 가구 및 영농 특성 요인을 분석하였다. 먼저, 본 논문에서는 투입물거리 함수추정 및 잠재임금추정 방법을 사용하여 개별 가구 단위로 성인 여성, 성인 남성, 십대 청소년, 아동 등 4가지 가족 집단 별 농업생산 기여도를 화폐가치로 계측하였다. 이를 가지고 개별 농가 내 여성들의 농업 생산 기여도가 전체 가구 구성원들의 농업 생산 기여도에서 차지하는 비중을 구하여 가구 내 여성농업인 기여도를 새롭게 지표화 하였다. 둘째로, 여성농업인의 농업 생산 기여도에 영향을 미치는 요인을 조사하였다. 투입물거리함수 추정에 기반한 잠재임금추정 방법은 가족 구성원의 농업생산 기여도를 추정하는 데 사용되었다.

각 가구 구성원 그룹의 농업 기여도를 화폐가치로 추정한 결과, 전반적으로 가족 농업 노동의 시간당 기여도는 고용 노동자들의 시급보다 유의하게 낮은 것으로 나타났다. 대신에, 가구 내 가족 농업 노동에 대한 여성들의 기여도는 남성들의 평균 기여도 보다 높게 나타났다. 이는

여성 노동 기여도와 남성 노동 기여도를 개개인이 아닌 가정 내 성별 집단 별로 평균치를 측정하였을 때 여성 가족 구성원들의 기여도가 가구 내 남성들의 기여도 보다 높다는 것을 의미한다. 각 농가를 기준으로 가족 농업 노동 기여도 총 액 대비 여성들 기여도 비중을 가지고 농가 특성 변수들과 구간별 분위회귀분석을 시행한 결과, 탄자니아 가구 내 농업을 참여하는 여성들의 연령이 높을 수록, 교육 연수가 높을수록, 여성들의 가족 농업 노동 기여도도 높은 것으로 나타났다. 담배, 커피, 차 등 수출용 상품작물을 재배하는 농가의 경우 여성들의 농업 생산 기여도는 낮아지는 것으로 나타났다. 또한 가구 내 남성들의 가족 농업 노동 참여 비중이 높아질수록 여성들의 기여도는 낮아지며 가구 내 0세에서 6세 이하 아동의 수는 여성 구성원들의 농업 기여도에 제약이 되지 않는 것으로 나타났다.

본 논문에서 추정된 탄자니아 여성 가족 구성원들의 가정 내 농업 생산 기여도 자료는 탄자니아 여성 농업인들의 농업 생산 노동력의 가치 평가자료로 활용될 수 있을 것으로 보인다. 특히 그 간 여성 가구주와 남성 가구주를 중심으로 이루어졌던 아프리카 여성들의 농업 기여도 연구들에서 더 나아가 여성 가구주와 더불어 비가구주 여성농업인들의 가족 농업 노동 생산 기여도를 분석하였다는 점에서 의의가 있다. 이는 가족 농업에 참여하면서도 농업 생산의 주요한 생산 주체로서 그 지위를 제대로 인정받지 못하고 있는 탄자니아 여성들의 기여도에 대한 실질적인 가치를 정립하는 데 유용하게 쓰일 수 있을 것으로 보인다. 더불어, 탄자니아 농업정책 및 탄자니아 농촌개발정책을 계획하고 실행함에 있어서 유용한 자료로 활용될 수 있을 것이다.

주요어: 여성 농업 생산 기여도, 가족 농업 노동, 투입물거리함수, 확률변경분석, 잠재임금추정법, 탄자니아

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