Gender Empowerment Dividends on Smallholder Farm Incomes in Kenya

by Henry Muli Mwololo, Jonathan Makau Nzuma, and Cecilia Nyawira Ritho

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Abstract

Gender disparity is a priority for policy and development initiatives. However, the major focus of these initiatives has been on closing inequality gap by moving women empowerment closer to that of men. Thus, gender empowerment interventions have become synonymous with women empowerment, an approach that could be misleading if the men used as benchmark are not empowered. We employ a control function to assess the gender empowerment dividends on per capita farm income disaggregated by sex of the household head on a sample of 835 households in Kenya. Production, income and leadership were the key domains enhancing gender empowerment in Kenya. Unlike male farmers who benefit from the overall empowerment in agriculture, female farmers do not because they are constrained in other drivers of empowerment especially resources and income. Interestingly, involving women in the income domain more than doubles their empowerment dividends. We conclude that gender empowerment in agriculture is a necessary driver of farm income and recommend that policy interventions should target specific domains while controlling for household heterogeneity.

Key words: Dividends, Empowerment, Gender, Heterogeneity, Farm income

JEL: C36, J16, O15

1. Introduction

A tenth of the global population survives on less than a dollar a day against the desired 1.95 dollars (Mahembe and Odhiambo, 2018; World Bank, 2016). Christiaensen *et al.* (2006) report that majority of the poor people live in Sub-Saharan Africa (SSA) with agriculture as their main source of livelihood. This could explain the observation that, agriculture is more effective in reducing poverty than non-agricultural sectors (Dorosh and Thurlow, 2018; Bezemer and Headey, 2008). Ending poverty is therefore a global priority as shown by the pursuit of the first Sustainable Development Goal [SDG] (United Nations Development Programme [UNDP], 2020), the aspiration of the Africa Union's 2063 agenda (African Union, 2015), and the promotion of equity as outlined in the Kenya Vision 2030 (Republic of Kenya 2007).

Gender inequality exacerbates poverty with literature showing significant gender disparities in various aspects including labor markets and decision-making. Unpaid work for women can be as high as 69% of their total work as compared to 28% for men (Folbre, 2014). Moreover, Murray *et al.* (2016) found that women worked for longer hours compared to men in Malawi. According to the UNDP (2020), on the average women earn 23% less income than men. Shemeles *et al.*, (2018) and Kameri-Mbote (2005) decry the patriarchal system in Africa, which excludes women from owning land especially through inheritance.

The Food and Agricultural Organization of the United Nations (FAO, 2011) argues that agricultural yields of women would increase by up to a third if only they had similar access to productive assets as men. This would reduce the number of hungry people by up to 150 million globally. Despite the existing gender biases against women, they play a 'front line' role in food production, contributing 47% of labor force in SSA (Shemeles *et al.*, 2018).

The above gender disparities make the fifth SDG on gender equality relevant. Furthermore, the disparities have become a center of interest for researchers (Kassie *et al.,* 2020; Heckert *et al.,* 2019). Malapit and Quisumbing (2015) concluded that women empowerment was strongly associated with the quality of infant and young children feeding practices in Ghana, while, Murugani and Thamaga-Chitja (2019) found that women empowerment was associated with improved household food and nutrition security in South Africa. Diiro *et al.* (2018) used maize yields in Kenya to demonstrate that women empowerment had a positive association with technology adoption and farm productivity. Sraboni *et al.* (2014) demonstrated that women empowerment was positively associated with household calorie intake and dietary diversity in Bangladesh.

A common approach in analyzing the effect of gender empowerment on household welfare in literature has been the use of women empowerment in agriculture index (WEAI) or its abridged version (A-WEAI) (IFAD, 2017; Malapit *et al.,* 2015; Alkire *et al.,* 2013). The index has three strengths that make it analytically appealing. One, it measures gender inclusion in agricultural decisions. Two, it can be adapted to measure empowerment in agriculture and non-agriculture sectors (Alkire *et al.,* 2013). Finally, the index excludes variables such as education and wealth that are often considered as proxies of empowerment, making it possible to analyze its association with such variables.

Existing literature on gender empowerment in agriculture exhibit several gaps though. First, WEAI measures women empowerment using men in the same households as the benchmark. This leaves out households where the head is single, separated, divorced or widowed (Osanya *et al.,* 2020). The number of women headed agricultural households in developing countries can be significantly high to ignore, for instance 23% in our study. This approach is also oblivious of the fact that households are social units that are also linked to extended family ties and the head being single may not translate to full empowerment. Second, it is misleading to assume that closing the empowerment in agriculture gap between men and women farmers is adequate. This is true for cases where the men used as benchmark are not empowered based on the 80% empowerment threshold suggested by Alkire *et al.* (2013). Lastly, available studies analyze the association between WEAI and food and nutrition security (Murugani and Thamaga-Chitja, 2019), farm productivity (Diiro *et al.*, 2018), and child health (Malapit and Quisumbing, 2015), but none analyzes the effect of empowerment in agriculture on per capita farm income as we do in this paper.

Kassie *et al.*, (2020) highlight farm income as one of the main pathways through which agriculture influences household welfare. In this paper, we not only agree with Kassie *et al.,* (2020) but also argue that, income is a superior development outcome since it is a medium of exchange. As capital, income can influence production decisions as farmers can invest in modern technologies to increase yield and quality through value addition thus transforming subsistence farming into commercial agriculture. Moreover, income enables households to access other basic needs such as healthcare, clothing and shelter.

To fill the foregoing gaps, we compute an empowerment in agriculture (EIA) index for men and women farmers, an approach that lacks in previous studies as they only consider intra-households analysis. Besides, we use per capita farm income as the depended variable, which is not the case for existing studies and therefore adding new insights to existing empowerment in agriculture literature. Disaggregating the index to respective empowerment domains and by sex of the farmers is imperative because male and female-headed households may benefit differently even from the same empowerment interventions. Moreover, the magnitude of the effect of various domains on per capita farm income may vary.

Following IFAD (2017), Malapit *et al.* (2015), and Alkire *et al.* (2013), we apply five empowerment domains to compute EIA namely 1) decisions on production; 2) access to productive resources; 3) decisions on income use; 4) leadership and 5) time allocation. Empowerment domains are the areas of influence that allow individuals or groups of people to organize and mobilize themselves better toward desired social and political change (Laverack, 2005).

We find that production, income and leadership are the most important domains for enhancing agricultural gender empowerment in Kenya even though the results show high level of heterogeneity in empowerment dividends. Thus, the EIA is highly localized thus weakening the external validity of our findings. The reminder of this paper is structured as follows. Section 2 describes the study methods. Section 3 presents the estimated results while section 4 discusses them. Section 5 concludes and makes recommendations for policy and practice.

2. Study Methods

2.1 Data Source

We surveyed smallholder farmers in Kisii and Nyamira Counties over the October - December 2015 season using the preceding 12 months as the reference period. The two Counties receive adequate rainfall of between 1,500 and 2,100 mm on the average throughout the year making farming the main economic activity. The choice of the two counties was justified by the observation that 42% and 32.7% of the population in Kisii and Nyamira Counties respectively are poor as compared to a national average of 36.1% (KNBS, 2018).

The survey design used existing farmer groups, which is a common structure of farmer operations in Kenya. Using a list of registered farmer groups provided by the County Department of cooperatives, a two-stage sampling technique was used to select the households to interview. In the first stage, we selected 48 groups (32 from Kisii and 16 from Nyamira) from a list of 94 groups (71 from Kisii and 23 from Nyamira) using a simple random technique with a probability proportional to the existing number of farmer groups in each County. In the second stage, the same technique was used to select 20 farmers from each selected group. In cases where a group had 20 or fewer members, a group census was conducted. Although the target sample size was 960 farmers, 835 farmers were surveyed representing a non-response rate of 13 percent.

2.2 Measurement of Variables

2.2.1 Dependent Variable

Per capita farm income in Kenya shillings (KES) is the dependent variable used in this study. Annual farm income was calculated as the value of all farm produce (sold and unsold) less the production costs. The valued produce included edible parts such as grain and leaves as well as non-edible products like manure from crop and livestock enterprises. The production costs considered included cost of seed, labor, fertilizer and pesticides for crops and veterinary services, supplements and drugs for livestock. For the case of livestock, only the value of sold or consumed ones within the reference year was included in the computation because it contributed to farm income. We weighted the resulting income for household size by dividing by the number of members per household to derive per capita farm income following Datta and Meerman (1980).

Datta and Meerman (1980) argue that per capita income is a superior proxy compared to household income because a household with a higher income can be worse off if it has a higher number of members especially dependents. The per capita farm income approach also has an advantage over gross margin analysis because; gross margin analysis often omits important products. For instance in the case of pulses like cowpeas where the grain is valued omitting the leaves that are a valuable vegetable. In addition, most studies report gross margin per unit of land for crops and per Tropical Livestock Unit (TLU) for livestock. This makes it difficult to aggregate farm income in mixed farming systems due to the difference in the denominator, perhaps explaining why many farm analysis studies omit livestock (Makate *et al*., 2016; McCord *et al.*, 2015; Kankwamba *et al.*, 2012).

Two main constraints affect our approach of computing per capita farm income. The first constraint is missing data on price because smallholder farmers keep most of their produce for home consumption (Ogutu *et al.,* 2019). The second constraint is that prices are not entirely random but rather depend on the market type (farm gate prices are often lower) and quantity of produce sold (large volumes benefit from economies of scale). To avoid the two constraints, we computed sample mean prices from the marketed produce and applied it as the valuation factor following Ogutu *et al.,* (2019). As a result, the difference in revenue per commodity between farmers was because of the amount produced and not price.

2.2.2 Independent Variables

The independent variable of interest in this study is the EIA index. We use the five-empowerment domains as described by Alkire *et al.,* (2013) namely time, production, leadership, income, and resource to compute the EIA index. Although Alkire *et al.* (2013) suggested the use of 10 indicators; Malapit *et al.,* (2015) revised them to six resulting in the A-WEAI. This study adopted the latter because it is robust and leads to similar conclusions yet, it is less time and money consuming (Malapit *et al.*, 2015). However, we dropped the word 'women' from the index ending up with A-EAI since we considered men and women. We also adapted the indicators in the various domains as follows.

For the time domain, we did not ask farmers the number of hours they spent in their farm in the previous 24 hours as recommended by Malapit *et al.* (2015) and Alkire *et al.* (2013). This is because some of the farmers had not spent time in their farm in the previous 24 hours due to various reasons such as heavy rain, attending burials and other social functions among others. Instead, we asked farmers whether they contributed labor to their farm operations on full-time or on part-time basis. Part-time farming was considered to leave farmers with adequate time to seek for leisure and complementary off-farm and non-farm activities.

The production domain was split into two indicators, participation in decisions regarding the crops to grow and livestock to keep. Often, households assign farm enterprises to men or women depending on the enterprise type (Doss, 2016). For leadership, we did not ask whether a farmer was a group member because all farmers in the survey were members of a farmer group since we used groups as the sampling units. Instead, we asked whether a farmer was an official in the group.

For the resources domain, we asked whether the household head had a title deed. This is important because a title deed is a requirement in transactions like sale of land and can also be used as collateral. Furthermore, we asked whether the household head could have accessed credit during the reference period if they needed it. This was a departure from the norm of asking farmers whether they accessed credit given that it was possible that some credit worth farmers did not applied for it.

Table 1 presents the six indicators used and their respective cut-off threshold for adequacy. Each domain contributed 20-percentage points to the A-EIA index.

Table 1: Domains and Indicators of Empowerment in Agriculture

Domain	*Indicators*	*Adequacy criteria*	*Weight*
Production	Technology use.	Household head decided on the crops to grow, either solely or jointly.	0.1
		Household head decided on the livestock to keep, either solely or jointly.	0.1
Leadership	Group official.	Household head was an official in the farmer group.	0.2
Income	Control over use of farm income.	Household head decided on how to use farm income, either solely or jointly.	0.2
Resources	Title deed	Household head had a title deed.	0.1
	Access to credit	Household head could have accessed credit if they needed it.	0.1
Time	Labor contribution to the farm.	Household head contributed farm labor on part time basis.	0.2

To compute the A-EIA index, the indicators that met the adequacy criteria in Table 1 were coded one and zero otherwise. To derive the indicator score, we multiplied the indicator code by its weight. Using technology indicator in the production domain as an example to demonstrate how adequacy or lack of it was arrived it, farmers were asked, "who makes decisions on the crops to grow?'. The possible responses were (1) head, (2) spouse, (3) both, and (4) others. A respondent was to choose a single option and a response was adequate if the head or both option was chosen. This applied for all the indicators. The final empowerment index per household was the summation of individual indicator scores as specified in Equation (1).

$$I_i = \sum_{l}^{n} X_s \quad (1)$$

Where for the i^{th} household I_i is the A-EIA index and ranges from 0 – 1, and $\sum_{l}^{n} X_s$ is the sum of all individual indicator scores.

Table 2 presents the rest of the control variables, where as anticipated in Africa, male-headed households were 17% more empowered relative to female-headed households. The average annual per capita farm income was 23,380 Kenya Shillings (KES) and male-headed households had 5% higher per capita farm income than female-headed households. Male farmers were more empowered than female farmers by 17% percentage points. Female farmers were older but less educated by 3 years. Moreover, male-headed households were larger by one member and their assets were 2,735 KES more relative to female-headed households. Likewise, male-headed households had larger farms and were more diversified.

Table 2: Descriptive Statistics of the Variables used in the Regression Models

Variables	*Full sample*	*Men (M)*	*Women (W)*	*Mean difference (M-W)*
Per capita farm income (KES./year)	23,383.66 (15,948.41)	24,438.78 (16,051.80)	19,752.49 (15,072.32)	4,686.29 ***
Empowerment index (score 0 - 1)	0.41 (0.23)	0.45 (0.22)	0.28 (0.19)	0.17***
Accessed government extension (yes=1)	0.67 (0.47)	0.69 (0.46)	0.63 (0.48)	0.06
Age of household head (years)	49.08 (12.58)	48.48 (12.55)	51.13 (12.48)	-2.64***
Education of household head (years)	9.01 (3.74)	9.73 (3.24)	6.53 (4.22)	3.19***
Household size (number)	6.82 (2.15)	6.91 (2.15)	6.48 (2.12)	0.43***
Had off-farm income (yes=1)	0.85 (0.36)	0.85 (0.35)	0.83 (0.38)	0.02
Value of assets (KES)	6,322.50 (4,617.65)	6,938.29 (4,607.11)	4,203.28 (3,993.24)	2,735.01 ***
Risk attitude (score 0 - 10)	6.82 (2.54)	6.86 (2.56)	6.72 (2.47)	0.14
Distance to nearest market (km)	1.30 (0.76)	1.29 (0.76)	1.31 (0.75)	-0.02
Farm size (acres)	2.08 (1.06)	2.18 (1.06)	1.72 (1.02)	0.46***
Farm diversity (crop + livestock species)	11.93 (3.55)	12.18 (3.51)	11.05 (3.55)	1.13***
Observations	835	647	188	

Notes: Values are sample means. Standard deviations are in parentheses. 1 US$ = 100 KES in 2015. *** Difference is significant at the 1% level; Statistical differences determined using t-test.

2.3 Estimation Strategy

Since the dependent variable is continuous, Ordinary Least Squares (OLS) would be an ideal estimator. However, the A-EIA is potentially endogenous to income possibly due to reverse causality, measurement error or both. As a result, the OLS estimator would result in biased estimates. We use an instrumental variable (IV) in a control function (CF) approach to test and control for endogeneity. We opt for the CF approach because it is flexible compared to the two-stage least squares (2SLS) which is a close alternative (Wooldridge, 2015; Rivers and Vuong, 1988; Smith and Blundell, 1986).

The CF approach involves a first stage analysis where the determinants of the A-EIA index, including the instrument, are estimated using an appropriate technique (Wooldridge, 2015). In the first stage, we use a Tobit model following McDonald and Moffitt, (1980) because the A-EIA index is a score limited between zero and one. We specified the Tobit model as shown in Equation (2).

$$I_i = \alpha_0 + \boldsymbol{\alpha_n} \boldsymbol{X_n} + \varepsilon_i \quad (2)$$

Where for the i^{th} household, I_i is the A-EIA index, $\boldsymbol{X_n}$ is the set of determinants of empowerment in agriculture including the instrument (number of groups one is a member), $\boldsymbol{\alpha_n}$ is the set of parameter estimates, and ε_i is the error term.

After estimating Equation (2), we generated residuals and included them in Equation (3) that uses OLS to estimate the effect of the A-EIA index on per capita farm income.

$$\gamma_i = \beta_0 + \boldsymbol{\beta_1} \boldsymbol{I_i} + \beta_n X_i + \varepsilon_i \quad (3)$$

Where for the i^{th} household, γ_i is the per capita farm income, $\boldsymbol{I_i}$ is the A-EIA index, X_i is a set of other control variables as defined in Table 2, ε_i is the error term, and $\beta_{0\text{-}n}$ are the estimated parameters. The estimate of interest is β_1 and we hypothesis a positive and significant effect.

The significance level of the residual estimate in Equation (3) influences the choice of the results to interpret between the OLS and CF estimates. According to Wooldridge (2015), if the estimate of the residual term is statistically significant, we reject the exogeneity hypothesis of the A-EIA index and the estimates of the CF model, which corrects the endogeneity bias, are interpreted. However if the residual term estimate is not statistically significant, the results of the OLS model are interpreted because they are efficient. The validity of the instrument used in the CF models is determined by its relevance and exogeneity (Imbens and Wooldridge, 2009). An instrument is relevant if it is highly correlated with the independent variable of interest (A-EIA index in this study) and it is exogenous if it is uncorrelated with the dependent variable such as per capita farm income for our case. The number of groups a farmer belonged, other than the farmer group used in this study, was used as an instrument considering the important role of groups in empowering farmers.

Since the estimate of the instrument was positive and significant ($p = 0.00$) in the first stage regression (Equation 2) the relevance condition was met. In the second stage estimation (Equation 3), the estimate of the residual was insignificant implying that the exogeneity requirement was met. Since only one instrument was used, over-identification did not arise.

3. Results

3.1 Contribution of Various Domains to Empowerment in Agriculture

The results in Figure 1 show significant differences in the mean empowerment scores for men and women. Men were more empowered than women on the production, leadership and income domains. The most limiting domains for men were leadership, income and resource (Figure 1). The trend was the same for women with an addition of the production domain. It was surprising that there were no statistically significant differences between men and women on the time and resource domains as reported by Shemeles *et al.*, (2018) and Murray *et al.*, (2016). Perhaps, as women take the household headship due to the permanent absence of a spouse, they have more control of their time and resources. It is also a possibility that women's possession of the family's land title deed improved their credit worthiness enabling them to use it as collateral to access credit. They also have control over the use of the credit just like men.

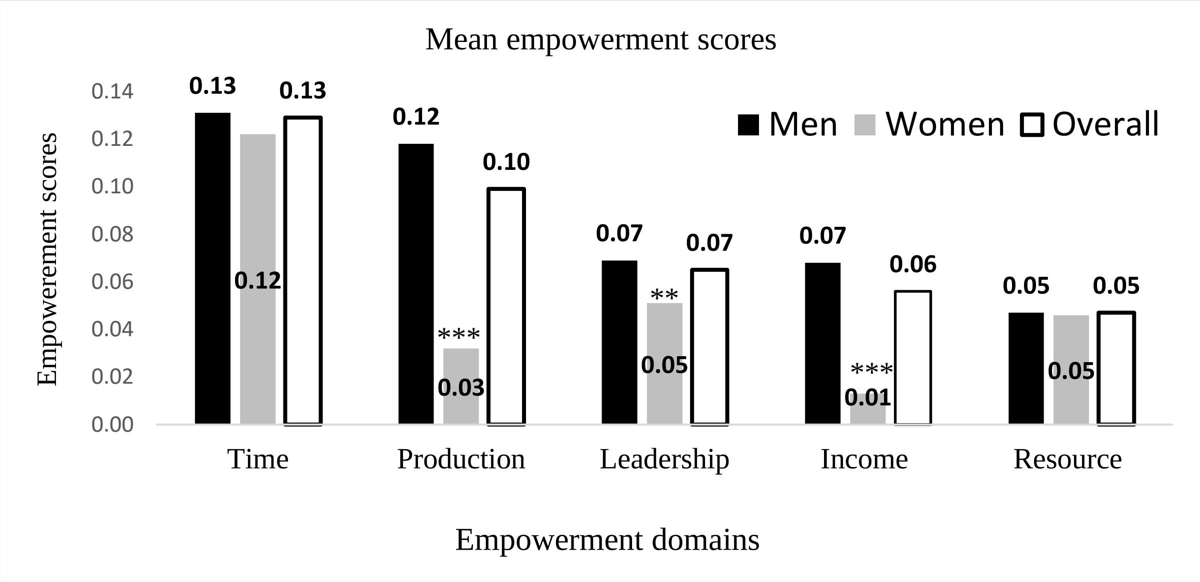

Figure 1: Contribution of Various Domains to Men and Women Empowerment.
; * t-test returned significant differences between men and women at 5%; 1% levels, respectively.

3.2 Effect of Empowerment in Agriculture on Per Capita Farm Income

Since residuals from the Tobit regression (appendix A) in the first-stage are insignificant when included in the CF models (Tables 3 and 4), we fail to reject the null hypothesis that A-EIA is exogenous to per capita farm income. Therefore, we discuss estimates of the OLS models, which are efficient in the absence of endogeneity. However, we show estimates of both models.

Table 3: Estimates of the Effect of Empowerment in Agriculture on Per Capita Farm Income

Variables	*Per capita farm income (KES)* [1] OLS	[2] CF	*Log of per capita farm income* [3] OLS	[4] CF
Empowerment in agriculture index (0 - 1)	11,478.34***	11,105.06***	0.74***	0.70***
	(5.50)	(4.50)	(4.56)	(3.82)
Accessed government extension (yes=1)	-115.78	-415.69	-0.00	-0.03
	(-0.11)	(-0.37)	(0.01)	(0.34)
Age of household head (years)	39.48	15.84	0.00	-0.00
	(0.83)	(0.31)	(0.10)	(-0.56)
Education of household head (years)	337.00**	275.10	0.03**	0.02
	(2.08)	(1.63)	(2.06)	(1.58)
Household size (number)	-1931.86***	-1870.76***	-0.11***	-0.10***
	(-7.97)	(-7.05)	(-5.79)	(-5.50)
Had off-farm income (yes=1)	-2997.76	-3330.25**	-0.26**	-0.29**
	(-1.91)	(-2.28)	(-2.24)	(-2.72)
Log value of assets (log of KES)	2419.12***	1673.90	0.20***	0.12
	(3.11)	(1.57)	(3.37)	(1.69)
Risk attitude (0 - 10)	-432.73**	-461.60**	-0.03	-0.03**
	(-2.15)	(-2.26)	(-1.95)	(2.18)
Distance to nearest market (km)	503.96	367.72	0.02	0.01
	(0.75)	(0.54)	(0.35)	(0.12)
Farm size (acres)	2521.43**	2469.72***	0.15***	0.15***
	(4.14)	(4.39)	(3.26)	(3.59)
Farm diversity (number of crops + livestock species)	372.75	395.17**	0.04***	0.05***
	(2.14)	(2.45)	(3.73)	(3.59)
County (Kisii=1)	-594.36	-673.22	-0.09	-0.10
	(-0.63)	(-0.59)	(-1.30)	(-1.16)
Gender (male=1)	-377.50	-2142.78	0.03	-0.15
	(-0.27)	(-0.95)	(0.27)	(-0.96)
Residue from first stage		14780.26		1.49
		(0.98)		(1.57)
Constant	2174.34	5971.33	7.71	8.09***
	(0.36)	(0.80)	(16.51)	(15.26)
Observations	835	835	835	835
R-squared	0.184	0.185	0.178	0.179
Wald Chi^2/F test	15.31***	190.67***	10.83***	144.67***

Notes: Dependent variable is annual per capita farm income. Estimates are robust with t-statistic shown in parentheses. For columns [1] and [3], standard errors are clustered at group level. For columns [2] and [4], standard errors are bootstrapped with 10,000 replications. OLS, ordinary least squares; CF, control function estimator. **, *** Significant at 5% and 1% levels respectively. 1 US$ = 100 KES in 2015.

Table 3 provides the changes in per capita farm income due to a 100% change in the A-EIA index. However, achieving an average unit A-EIA score is unrealistic. Therefore, we interpret a 10 percentage point increase in A-EIA index, which we consider realistic. Empowerment as measured by the EIA index had a positive and significant effect on per capita farm income (Table 3). A 10 percentage point increase in the empowerment index increased per capita farm income by 1,147 KES (column 1 of Table 3). This corresponds to an approximately 5% increase in per capita farm income relative to the sample mean income of 23,383.66 KES.

To minimize the dispersion of per capita farm income, we also estimated the model with the log transformed depended variable. Since the empowerment index estimates of the log-transformed models were larger than 0.1, the resulting percentage change in per capita farm income was computed using excel as (=exp (coefficient) – 1)*100). A 10 percentage point increase in the empowerment index increased annual per capita farm income by 11% (column 3 of Table 3). This represents a net empowerment dividend on per capita farm income that accrue to farming households after controlling for other covariates shown in Table 2.

We also analyzed the effect of empowerment on per capita farm income of male and female-headed households due to expected heterogeneity in the resulting empowerment dividends between men and women. The effect of EIA was positive and significantly different from zero for male-headed households, suggesting that they benefited from empowerment. Considering column (1) of Table 4, a 10 percentage points increase in the EIA index increased per capita farm income of male-headed households by 1,244 KES. Besides empowerment, an increase in farm size by an acre increased annual per capita farm income by 2,790 KES (column 1 of Table 4). Likewise, a one percentage point increase in the value of farm assets increased per capita farm income by 3,31 KES. (column 1 of Table 4). This implies that EIA is a necessary but not a sufficient driver of per capita farm income. Therefore, interventions aiming to increase the farm incomes of smallholder farmers should identify all the complimentary drivers of farm income.

Women-headed households did not benefit from overall empowerment in agriculture as measured by the EIA index (columns 5 to 8 of Table 4). This observation is of particular concern since it is against our expectation considering that many empowerment interventions target women hoping to improve their welfare including income. Possibly, the 373 KES increase in annual per capita farm income due to a 10 percentage increase in women empowerment index was too small to make statistical sense and economic sense. However, other factors were important in influencing the per capita farm incomes of female-headed households.

An extra crop and livestock species increased per capita farm income of female-headed households by 7% (column 7 of Table 4). Access to government extension services, household size and off-farm income had negative and significant effects on per capita farm income of female-headed households (column 5 of Table 4). On the one hand, it is rather obvious that larger households are more likely to have lesser per capita farm income especially as the number of dependents increase. On the other hand, access to off-farm income can mean that female farmers had lesser time to invest in farm activities explaining the observed negative effect.

Table 4: Gender Differentiated Estimates of the Effect of Empowerment in Agriculture on Per Capita Farm Income

	Male-headed households				Female-headed households			
	Per capita income (Ksh/year)		Log per capita income		Per capita income (Ksh/year)		Log per capita income	
Variables	[1] OLS	[2] CF	[3] OLS	[4] CF	[5] OLS	[6] CF	[7] OLS	[8] CF
Empowerment in agriculture index (0 - 1)	1,2443.24***	1,2201.29***	0.82***	0.80***	3,738.22	2,668.24	0.33	0.21
	(4.90)	(4.60)	(4.47)	(4.27)	(0.58)	(0.41)	(0.62)	(0.37)
Accessed government extension (yes=1)	1,554.47	1,346.50	0.09	0.07	-5,339.47**	-6,038.30**	-0.33	-0.40
	(1.46)	(1.05)	(1.09)	(0.80)	(-2.24)	(-2.26)	(-1.67)	(-1.78)
Age of household head (years)	40.05	25.90	0.00	-0.00	71.00	-20.45	0.01	-0.00
	(0.80)	(0.49)	(0.09)	(-0.31)	(0.55)	(-0.14)	(0.54)	(-0.42)
Education of household head (years)	402.82**	362.32	0.02**	0.02	373.61	151.94	0.04	0.01
	(2.27)	(1.91)	(1.84)	(1.43)	(0.84)	(0.35)	(1.07)	(0.43)
Household size (number)	-2,092.02***	- 2,058.69***	-0.10***	-0.10***	-1276.38**	-991.36	-0.10	-0.07
	(-9.30)	(-6.88)	(6.64)	(5.46)	(-2.04)	(-1.56)	(-1.93)	(-1.24)
Had off-farm income (yes=1)	-2,846.64	-3,052.03	-0.17	-0.19	-4,599.72**	-5,787.43**	-0.62***	-0.75***
	(-1.38)	(-1.80)	(-1.26)	(-1.59)	(-2.04)	(-1.89)	(-3.28)	(-2.76)
Log value of assets (log of KES.)	3,318.80***	2,847.22**	0.22***	0.18**	-86.9	-2,615.35	0.10	-0.19
	(4.53)	(2.47)	(4.79)	(2.43)	(-0.05)	(-0.84)	(0.59)	(-0.75)
Risk attitude (0 - 10)	-495.76**	-514.57**	-0.04**	-0.04***	-104.24	-183.12	0.00	-0.01
	(-2.29)	(-2.23)	(-2.47)	(-2.66)	(-0.23)	(-0.38)	(0.07)	(-0.16)
Distance to nearest market (km)	694.52	613.84	0.04	0.03	95.23	-488.75	-0.06	-0.13
	(0.97)	(0.81)	(0.78)	(0.65)	(0.05)	(0.31)	(-0.33)	(-0.87)
Farm size (acres)	2,790.62***	2,753.05***	0.17***	0.16***	1770.45	1,688.61	0.12	0.11
	(4.43)	(4.42)	(3.90)	(4.05)	(1.44)	(1.41)	(0.96)	(0.94)
Farm diversity (number of crops + livestock species)	415.74**	429.44**	0.04***	0.04***	333.20	415.69	0.07***	0.08**
	(2.31)	(2.36)	(3.19)	(3.00)	(0.89)	(1.12)	(2.64)	(2.10)
County (kisii=1)	-749.42	-797.72	-0.07	-0.07	-18.47	-191.01	-0.14	-0.16
	(-0.62)	(-0.61)	(0.89)	(-0.87)	(-0.01)	(-0.08)	(-0.91)	(-0.71)
Residual from first stage		9436.38		0.95		48644.22		5.43
		(0.59)		(0.98)		(0.95)		(1.43)
Constant	-8,069.72	-6,791.99	7.40***	7.53***	22,615.64	35,605.36	8.43***	9.89***
	(-1.30)	(-0.88)	(19.43)	(14.63)	(1.97)	(1.98)	(7.10)	(6.83)
Observations	647	647	647	647	188	188	188	188
R-squared	0.223	0.223	0.203	0.204	0.087	0.093	0.109	0.117
Wald Chi^2/F test	19.31***	186.33***	9.16***	124.62***	2.02**	18.66	3.57***	25.36**

Notes: Dependent variable is per capita farm income per year. Estimates are robust with t-statistic shown in parentheses. For columns [1] and [3], standard errors are clustered at group level. For columns [2] and [4], standard errors are bootstrapped with 10000 replications. OLS, ordinary least squares; CF, control function estimator. ** Significant at 5% level; *** Significant at 1% level. 1 US$ = 100 in 2015

3.3 Empowerment Pathways

Figure 1 shows that various domains do not contribute equally to empowerment in agriculture, implying that they may influence farm income differently as well. We analyze the effect of each domain on per capita farm income disaggregated by the sex of the household head. Suitable instruments were not available for the individual domains to control for possible endogeneity and therefore, the estimated relationships in Table 6 are interpreted as associations rather than causal. Table 6 omits other control variables than the domain proxies for brevity. Results with the complete set of variables are presented in appendices B1 and B2.

The production, income and leadership domains were important drivers of per capita farm income depending on the sex of the household head (Table 6). A 10 percentage point improvement in the leadership domain was associated with a 1,588 KES increase in annual per capita farm income of male-headed households (column 2 of Table 6). This represents a 6% empowerment dividend in per capita farm income relative to the sample mean.

Increasing the production empowerment domain by 10 percentage points was associated with a 2,579 KES and 2,853 KES increase in per capita farm income of male and female-headed households respectively (columns 4 and 9 of Table 6). This represents empowerment dividends in annual per capita farm income of 11% and 14% for male and female-headed households respectively. Empowerment in the income domain returned results that were even more impressive for female-headed households; it more than doubled the empowerment dividend in per capita farm income compared to male-headed households. A 10 percentage point improvement in the income domain was associated with a 25% increase in annual per capita farm income of female-headed households as compared to a 10% increase in per capita farm income for male-headed households.

Table 6: Sex Disaggregated OLS Estimates of the Effect of Empowerment Domains on Per Capita Farm Income

	Male-headed households					Female-headed households				
Domain	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Resource	6,392.20					-17,733.74				
	(0.85)					(-1.36)				
Leadership		15,880.54***					3,361.09			
		(2.56)					(0.24)			
Time			-4,518.02					3,340.15		
			(-0.66)					(0.23)		
Production				25,798.49***					28,533.24**	
				(3.61)					(1.99)	
Income					24,970.98***					48,615.52***
					(3.46)					(2.56)
Constant	-10,699.49	-9,061.38	-11,006.23	-9,904.43	-10,019.90	22,487.15*	23,116.44**	22,261.32	23,898.31**	24,786.25**
	(-1.60)	(-1.38)	(-1.63)	(-1.54)	(-1.54)	(1.97)	(2.06)	(1.96)	(2.13)	(2.20)
Observations	647	647	647	647	647	188	188	188	188	188
R-squared	0.196	0.203	0.196	0.219	0.216	0.095	0.086	0.086	0.103	0.108
F test	13.78***	15.12***	13.46***	15.72***	16.73***	2.08**	2.15**	1.98**	2.61***	2.97***

Notes: Dependent variable is per capita income per year in Kenya shillings. Weight, 0 if domain is inadequate and 0.2 if adequate. Estimates are robust with t-statistic shown in parentheses. OLS, ordinary least squares. ** Significant at 5% level; *** Significant at 1% level. 1 US$ = 100 KES in 2015. Covariate factors controlled for were Access to government extension services, age, education, household size, off-farm income, log of value of farm assets, risk attitude, distance to the nearest market, farm size, farm diversity and county of residence.

4 Discussion

The finding that empowerment in agriculture is a significant driver of household per capita farm income underscores the importance of the many on-going interventions to eradicate poverty at the global and the local levels. Thus empowering farmers can contribute significantly in reducing income poverty. This is particularly important since income security can enable farming households to secure basic needs including quality diets. In addition to empowerment, it is worth noting that socioeconomic factors are also important in influencing household per capita farm income. The significant effect of the value of farm assets and farm size implies that richer farmers may be able to afford improved technologies such as inputs that are a requisite to catapult per capita farm income by increasing yields. The observation that the value of assets and farm size had a larger effect on annual per capita income than empowerment is expected since the two are factors of production.

Male-headed households were heterogeneous from female-headed households and did not enjoy empowerment dividends to the same extent. Although men-headed households realized an increase in annual per capita farm income from empowerment, female-headed households did not. This unusual finding may suggest that women are constrained in other key drivers of per capita farm income besides empowerment. For female-headed households, asset value and farm size (two of the most important drivers of farm income) were 39% and 21% respectively lower as compared to male-headed households. This underscores the need for comprehensive interventions in the smallholder farm sector.

Disaggregating the empowerment index into specific domains and sex of the household head provides more focused insights for policy and practice. It was not surprising that improving the production and income empowerment domains was a significant driver of per capita farm income among female headed households given that they were the most limiting domains contributing only 3% and 1% to their A-EIA index respectively.

Farmers maximize farm profitability (Doss, 2016) which can also be used as a proxy for measuring per capita farm income. Their involvement in production decisions can have important bearing on their per capita farm incomes. This is plausible because farmers are able to adopt and utilize technologies and practices that enhance yield, save costs or both translating to higher gross margins amid other factors of production such as farm size. Diiro *et al.*, (2018) found a positive and significant effect of the production domain on maize productivity in Kenya. Similarly, farmer involvement in income allocation decisions has a positive and significant implication on per capita farm income. Farmers are able to invest in high yielding and cost saving technologies thus the positive association.

Empowerment in the leadership domain among male farmers had a positive and significant effect on per capita farm income. Groups as a key component of social networks have been shown to contribute to improved household food security (Kelemu *et al.,* 2017). Group members have access to information about existing and new technologies and further they can receive new technologies from fellow group members enhancing adoption and thus income (Matuschke and Qaim, 2009).

5 Conclusions and Recommendations

The fact that male farmers were 16% more empowered than their female counterparts underscores the importance of eliminating gender disparity among smallholder farmers in making resource, production and income decisions. This makes the numerous gender empowerment policies such as the National Policy on Gender and Development in Kenya relevant (Republic of Kenya, 2019). However, given that the mean A-EIA index for male farmers was 35% lower than the 80% frontier suggested by Alkire *et al.,* (2013), we conclude that male farmers are not as empowered as is commonly thought. While eliminating gender empowerment disparity between men and women may lead to empowerment improvement amongst women farmers relative to men, it does not lead to absolute empowerment of either gender. Instead, policies and programs need to increase farmers' empowerment in absolute terms using the recommended minimum threshold of 80% as a benchmark.

We also conclude that gender empowerment dividends on per capita farm income accruing to farmers depend on their sex. Considering empowerment domains, the greatest gains are derived when female farmers participate in production and income allocation decisions. This calls for policies and programs that enhance inclusion. Since owners of resources including income often control decisions regarding their allocation, interventions that increase women income such as provision of employment opportunities targeting women and encouraging saving are worth pursuing.

Interventions should also enhance farmers' production knowledge through the provision of extension services. In this way, farmers' opinions in agricultural production are more likely to matter. Finally, group formation and management should be inclusive of men. Specifically, interventions should build the capacity of men on leadership, as this would have a positive and significant bearing on their per capita farm incomes.

In spite of the robustness of the results in this study, one limitation remains relevant. EIA may change even within small geographic areas thus weakening the external validity of the findings. This calls for similar studies in other geographical contexts.

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Appendices

Table A: Determinants of empowerment in agriculture index to test for the validity of the instrument (Number of groups)

Variable	Marginal effects	Robust standard error
Number of groups (number minus 1)	0.057***	0.01
Accessed government extension (yes=1)	0.016	0.02
Age of household head (years)	0.002**	0.00
Education of household head (years)	0.004	0.00
Household size (number)	-0.004	0.00
Had off-farm income (yes=1)	0.019	0.02
value of farm assets (log of KES)	0.051***	0.01
Risk (0 – 10)	0.001	0.00
Distance to nearest market (km)	0.009	0.01
Farm size (acres)	0.003	0.01
Farm diversity (number)	-0.003	0.00
County (kisii=1)	0.012	0.02
Sex of household size (male=1)	0.120***	0.02
Observations	835	
F statistic (13, 822)	18.43***	
Pseudo R squared	-1.455	

Notes: Independent variable is empowerment in agriculture index. **; *** Significant at 5% and 1% levels respectively.

Table B1: Effect of empowerment domains on per capita farm income of male headed households

Variables	OLS estimates				
Resource	6,392.20 (0.85)				
Leadership		15,880.54*** (2.56)			
Workload			-4,518.02 (-0.66)		
Production				25,798.49*** (3.61)	
Income					24,970.98*** (3.46)
Accessed government extension (yes=1)	1,891.95 (1.71)	1,554.35 (1.46)	1,809.80 (1.60)	1,703.60 (1.58)	1,349.13 (1.19)
Age of household head (years)	50.71 (0.96)	56.94 (1.14)	58.56 (1.13)	60.13 (1.13)	53.14 (1.03)
Education of household head (years)	438.98** (2.41)	401.12** (2.22)	465.90*** (2.63)	490.80*** (2.86)	484.64*** (2.75)
Household size (number)	-2,164.40*** (-9.05)	-2,158.02*** (-9.08)	-2,167.90*** (-8.91)	-2,142.54*** (-9.42)	-2,081.25*** (-8.71)
Had off-farm income (yes=1)	-2,527.89 (-1.22)	-2,858.78 (-1.36)	-2,440.28 (-1.18)	-2,545.34 (-1.21)	-2,181.54 (-1.03)
Log value of assets (log of KES)	4,003.39*** (5.31)	3,894.80*** (5.32)	4,110.10*** (5.42)	3,665.18*** (4.94)	3,787.89*** (5.13)
Risk attitude (0 - 10)	-414.31 (-1.86)	-484.21** (-2.19)	-426.72 (-1.93)	-514.92** (-2.41)	-438.31** (-2.04)
Distance to nearest market (km)	897.56 (1.26)	752.35 (1.04)	846.14 (1.18)	653.79 (0.85)	606.51 (0.86)
Farm size (acres)	2,816.88*** (4.35)	2,785.58*** (4.27)	2,806.24*** (4.31)	2,762.55*** (4.39)	2,757.65*** (4.18)
Farm diversity (number)	438.61** (2.40)	413.85** (2.25)	422.13** (2.31)	399.90** (2.14)	381.05** (2.10)
County (kisii=1)	-848.71 (-0.67)	-639.14 (-0.50)	-762.05 (-.056)	-886.74 (-0.71)	-601.25 (-0.46)
Constant	-10,699.49 (-1.60)	-9,061.38 (-1.38)	-11,006.23 (-1.63)	-9,904.43 (-1.54)	-10,019.90 (-1.54)
Observations	647	647	647	647	647
R-squared	0.196	0.203	0.196	0.219	0.216
F test	13.78***	15.12***	13.46***	15.72***	16.73***

Notes: Dependent variable is per capita income per year in Kenya shillings. Weight, 0 if domain is inadequate and 0.2 if adequate. Estimates are robust with t statistic shown in parentheses. OLS, ordinary least squares. ** Significant at 5% level; *** Significant at 1% level. 1 US$ = 100 KES on 2015.

Table B2: Effect of empowerment domains on per capita farm income of female headed households

Variables	OLS estimates				
Resource	-17,733.74 (-1.36)				
Leadership		3,361.09 (0.24)			
Workload			3,340.15 (0.23)		
Production				28,533.24** (1.99)	
Income					4,8615.52*** (2.56)
Accessed government extension (yes=1)	-5,370.39** (-2.28)	-5,297.80** (-2.22)	-5,195.17** (-2.23)	-5,524.15** (-2.33)	-5,569.54** (-2.30)
Age of household head (years)	90.68 (0.72)	77.29 (0.61)	76.19 (0.61)	100.60 (0.83)	54.98 (0.42)
Education of household head (years)	407.90 (0.97)	381.89 (0.88)	399.50 (0.93)	432.22 (1.03)	308.38 (0.66)
Household size (number)	-1,233.62** (-1.99)	-1,279.34** (-2.07)	-1,285.43** (-2.06)	-1,340.57** (-2.2)	-1,195.09 (-1.91)
Had off-farm income (yes=1)	-4,523.08** (-2.06)	-4,531.20** (-2.01)	-4,580.27** (-2.02)	-5,048.69** (-2.06)	-5,204.25** (-2.45)
Log value of assets (log of KES)	76.63 (0.05)	-13.18 (-0.01)	14.79 (0.01)	-463.90 (-0.27)	-140.92 (-0.08)
Risk attitude (0 - 10)	-220.80 (-0.48)	-155.66 (-0.34)	-132.75 (-0.29)	-52.36 (-0.12)	-98.25 (-0.22)
Distance to nearest market (km)	45.51 (0.02)	93.23 (0.05)	134.59 (0.07)	22.74 (0.01)	-269.48 (-0.14)
Farm size (acres)	1,941.65 (1.52)	1,806.37 (1.44)	1,812.81 (1.39)	1,650.19 (1.39)	1,488.74 (1.22)
Farm diversity (number)	305.43 (0.89)	299.61 (0.85)	307.75 (0.84)	416.79 (1.18)	420.85 (1.17)
County (kisii=1)	-13.44 (-0.01)	14.21 (0.01)	118.59 (0.06)	-341.36 (-0.17)	2.22 (0.00)
Constant	22,487.15* (1.97)	23,116.44** (2.06)	22,261.32 (1.96)	23,898.31** (2.13)	24,786.25** (2.20)
Observations	188	188	188	188	188
R-squared	0.095	0.086	0.086	0.103	0.108
F test	2.08**	2.15**	1.98**	2.61***	2.97***

Notes: Dependent variable is per capita income per year in Kenya shillings. Weight, 0 if domain is inadequate and 0.2 if adequate. Estimates are robust with t statistic shown in parentheses. OLS, ordinary least squares. ** Significant at 5% level; *** Significant at 1% level. US$ 1 was Kenya shilling 106.74 at the time of analysis.

Conflict of interest

None.

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