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Do farmer groups improve the situation of women in agriculture in rural Kenya?

RESEARCH ARTICLE

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Abstract

Production by smallholders in rural Kenya is limited by institutional, technical and investment constraints. Female farmers are the majority among smallholders and have significant roles in agriculture; nonetheless, they face constraints in accessing resources. Recent primary data of 347 farmers (proportional random sampling) was used to examine: (a) factors affecting women's participation in agriculture; (b) factors influencing female farmers' decision to join a farmer group; and (c) the effect of women's membership in a farmer group on crop yield. We applied Probit and linear regression with endogenous treatment maximum likelihood methods. Results reveal that women's participation is positively influenced by membership in a farmer group and land ownership. Women's decision to join a farmer group is positively affected by access to credit, and negatively by limited decision-making power and lack of access to land. Crop yield is positively affected by membership years in a farmer group and ownership of mobile phones, negatively by lack of credit. Farmer groups are a particularly effective platform to improve crop yields and other constraints confronting female farmers. Surprisingly, this platform is under-utilised. Policymakers should invest in human, financial and physical capital of farmer groups as a pathway to rural development, improved rural livelihoods and reduced poverty.

Keywords: farmer groups, female farmers, crop yield, rural Kenya, productive resources
JEL code: Q18, Q71

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1. Introduction

A majority of the rural population in sub-Saharan Africa (SSA), including Kenya, has agriculture as their main occupation (Davis *et al.*, 2017; FAO, 2011). A large percentage of the farmers are smallholders who live in regions of degraded lands of poor soil quality dependent on uncertain rainfall, thereby exacerbating their vulnerability to climate variability and lacking secure tenure (Grist, 2014; World Bank, 2008). A modest percentage of the rural people are wage labourers, displaced people and pastoralists. Across all categories, women tend to be the majority, because men migrate to the cities in search of work, thus several households are headed by women (Hill, 2011; World Bank, 2007), therefore women must engage in farming. The contribution of women to labour in African agriculture is in the range of 60-80% (FAO, 2011). Recent evidence using individual plot-level labour input data from nationally representative household surveys across SSA countries showed that the average female labour share in crop production varies from over 50% in countries like Malawi to below 24% in countries like Niger (Palacios-Lopez *et al.*, 2017).

Bobonis (2009) and Palacios-Lopez *et al.* (2017) report that women in Africa produce a large percentage of the continent's food, including both subsistence and market food on small landholdings; they also process the food, provide storage for and market the food. These reports suggest that women play an indispensable role in contributing to economic welfare and food security. Moreover, women's increased income is associated with greater food consumption and improved nutritional status of their households. Despite the significant roles rural women play in agriculture and food security, the extent to which women and men can access and benefit from productive resources differs (IFAD, 2016). Women often face greater challenges in access to and control over productive resources (Asiedu, 2012; IFAD, 2011; Meinzen-Dick *et al.*, 2014; Mikalitsa, 2010; Naadira, 2012).

For instance, there is a wide disparity in the proportion of women holding agricultural land, ranging from 5% in Mali to 30% in Botswana and Malawi (FAO, 2011). Consequently, there is a disproportionate representation of women among the landless who face food insecurity and are unable to meet basic needs. This tends to push women into wage farm labour, which not only endangers their livelihoods (FAO/IFAD/UNICEF/WFP/WHO, 2019) but also exacerbates their onerous daily tasks (Chinyoporo, 2017) and household-level inequalities, such as being voiceless in determining household priorities, spending patterns and distribution of benefits (Quisumbing and Maluccio, 2000).

The multiple constraints in the inequitable distribution of productive resources limit women's effective participation in agriculture and compromise women's production potential, thereby contributing to low crop yields with detrimental effects on the economic welfare of rural populations, food security and the price of food. This turn of events contributes to the high percentages of Africa's populations suffering from malnutrition; Africa is the only continent known to be experiencing rising child malnutrition, causing two-thirds of child deaths (Akombi *et al.*, 2017; UNICEF, 2013).

Increased research and development efforts have addressed productivity and market failures that smallholders face in developing countries, nevertheless, the status quo of the farmers has not led to positive outcomes. What can facilitate women's access to productive resources such as land, agricultural inputs, technology, financial services, market information, and extension services (Markelova *et al.*, 2009; Mojo *et al.*, 2007) resulting in increased women's participation in agriculture, increased food security, improved maternal and child nutrition as well as better rural livelihoods? Farmer groups can play important roles in overcoming the constraints faced by rural women; evidence shows that efficient farmer groups can empower their members economically and socially by offering them a range of services that facilitate access to productive resources (FAO, 2012; Sumelius *et al.*, 2015; Wanyama, 2014). We identify a research gap on finding out the enabling conditions for female farmers to gain better access to productive resources and for making female farmers participation in agriculture more effective.

Several studies indicate that farmer groups improve crop yields, leading to outcomes such as: (a) increases in food security through greater access to land, financial services, agro-inputs like fertiliser, pesticides, herbicides, agricultural machinery, and farm implements through subsidiaries at reasonable prices (Nkuranga and Wilcox, 2013; Saito *et al.*, 1994; Spielman *et al.*, 2011); (b) increases in women's income via the marketing of products through cooperative networks and diversification into profitable areas (Lecouetre, 2017); (c) offering micro insurance at affordable prices to meet the needs of the uninsured women (Banthia *et al.*, 2009); (d) diversification of rural livelihoods through improved functional literacy, training programmes to improve farmers' skills and innovation and providing technical leadership and business development services (Floro, 2002); (e) providing clean, abundant accessible water for irrigation, sanitation, and hygiene to improve health and nutrition, and to reduce the workload of women **(**Fletschner, 2009; Fletschner and Kenney, 2011); and (f) cultivating nutrition programmes to improve the quantity, quality, price, use and governance of nutritious foods and to increase women's resiliency to economic and climate-induced food insecurity (Miller, 2001; Smith *et al.*, 2003).

The findings of the majority of the studies suggest that farmer groups' activities have transformed agricultural productivity, consequently improving the wellbeing of farmers in general. Nevertheless, some studies, including Poulton *et al.* (2010) and Mwaura (2014), report that farmer groups fail to impact farmers positively. These contradictory findings could be partly due to the diverse nature of farmer groups as well as the analytical methods used. To underscore the minimal impact of farmer groups on farmers, the Food and Agricultural Organization (FAO, 2018a) indicates that the number of people in the world affected by undernourishment or chronic food deprivation is particularly high in South Asia and most regions of Africa; furthermore, women are more likely than men to be affected by severe food insecurity. Also, Beegle *et al.* (2016) project that the world's extreme poor will be increasingly concentrated in Africa. These alarming reports call for further assessment of the contribution of farmer groups in addressing the performance of smallholders, particularly women.

A greater part of the rural population's livelihood is rainfed agriculture on small, degraded lands of poor soil quality, and women happen to be the majority in Kenya. Women's agricultural activities range from agricultural production to the marketing of the products, thereby contributing to food security and better income levels. However, women face constraints in accessing productive resources due to social-cultural factors. Consequently, women lack secure land tenure surmounting to lack of collateral to get credit from banks. Farmer groups are a potential platform that can facilitate women farmers' access to input and output markets. Small-scale institutional innovations initiated by farmer groups tend to minimise inefficiencies in input and output markets (Barrett *et al.*, 2012). Unfortunately, little research has been done on how farmer groups can help women farmers. In Kenya, farmer groups' linkage of smallholders to small and medium-sized agro-enterprises aim to reduce transaction costs in both input and output markets by supporting and improving smallholders' competitive advantage and bargaining power has resulted in poverty reduction and rural development (Schneider *et al.*, 2010). Olagunju *et al.* (2021) found technical efficiency of members of cooperatives was constantly greater than that of non-members.

1.1 Study's objective and research questions

The overall aim is to investigate the circumstances that hinder women farmers from being successful in agribusiness management. The specific research questions are the following:

- Which factors affect women's participation in agriculture?
- Which factors influence rural women's decision to join a farmer group?
- Does women's membership in farmer groups affect crop yield?

The term crop yield means output per unit of land and is the measure of crop produced per area of land. Crop yield is easy to measure and is an important metric because it helps in understanding food security (Fischer *et al.*, 2014). Female farmers mostly have low yields due to little inputs, lack of knowledge and irrigation possibilities and yet not much is known about the impact of farmer groups on female farmers because a

majority of the current empirical studies are on farmer groups and farmers in general, with little research on female farmers specifically. We hypothesise that membership in a farmer group improves female farmers' crop yield.

Gender bias and lack of disaggregated data have inhibited the focus on those most in need of achieving sustainable development. The present study echoes and contributes to ongoing studies strategising specifically female farmers with specific problems in specific places – rural areas (Kharas *et al.*, 2019). We attempt to identify and understand female farmers (their characteristics), the kinds of constraints they face and the root causes of the constraints and potential ways out (cooperatives). In the rural areas, we targeted, to our knowledge we are the first to carry out a face-to-face survey focusing on female farmers. The personal interview survey we carried enabled exploring the responses of female farmers, thereby gathering more and deeper information.

This study is important due to women's significant contributions to crop yields. Investigations in female farmers will lead to increased crop yields, food security, and nourishment, thereby enhancing human productive capacity and better livelihoods for rural populations. Farmer groups are a potential platform to combat social-cultural norms that are oppressive to women. The findings can be applied to facilitate better service delivery by farmer groups, thereby enhancing female farmers' participation in agriculture. Furthermore, the empirical insight on the impact of farmer groups on farmers' yield has policy implications, especially for governments, donor agencies and agribusiness companies in changing policies or repackaging services for gender equality to promote smallholder productivity.

2. Literature review of smallholder farmers and farmer groups in Kenya

The multiple constraints female farmers face including lack of credit, missing marketing opportunities, lack of cooperatives and companies for providing input, credit as well as low yields and possibly lack of extension and irrigation and marketing opportunities prompt women to become members of farmer groups. In this study, a farmer group is defined as 25-35 farmers who support each other to serve their common interests; farmer groups are normally informal. A majority of the members are smallholders doing subsistence farming, whereas agricultural cooperatives are mostly formal groups with a larger membership, usually large-scale commercialised farming (Weenik *et al.*, 2007). Farmer groups can transform into cooperatives with time if they expand enough to meet the requirements of becoming a cooperative. Our focus is on farmer groups because a majority of farmer organisations in rural Kenya consist of farmer groups.

Smallholders play a significant role in Kenya's agricultural production; they predominate in both cash and food crop production. However, smallholders' yield per hectare is lower in comparison to large-scale farmers due to: (1) dependence on rain-fed agriculture; (2) the impact of environmental degradation; (3) lack of application of modern farming technology; and (4) dwindling access to farmer support services due to the government's liberalisation of the agricultural sector (FAO, 2005; Larson *et al.,* 2014; Riesgo *et al.,* 2016).

The proportion of Kenyans living on less than the international poverty line (US$ 1.90 per day in 2011 PPP) declined from 46.8% in 2005/06 to 36.1% in 2015/16. The latest available data for Kenya's rural poverty is 49.1% in 2005, based on the percentage of the rural population living below the national rural poverty line (World Bank, 2018). Kenya is among the low-income food-deficit countries (LIFDC), as well as one of the 51 African countries requiring external assistance for food. Kenya's food deficit is largely due to consecutive unfavourable rainy seasons culminating in severe drought conditions that affect crop and livestock production. About 2.35 million people are severely food insecure, mainly located in eastern, southeastern and coastal areas (FAO, 2018b).

2.1 The situation of women in agriculture

A large percentage of rural women are illiterate. Illiteracy is characterised by poverty and hunger, ignorance about nutritional requirements and is mainly a rural phenomenon that hinders rural development and food security. Illiteracy also threatens productivity and health, and limits opportunities to improve livelihoods, particularly for rural girls and women (FAO, 2005). Educated mothers are more knowledgeable about the benefits of small family size and thus will opt for family planning, in the process reducing fertility rates, thereby improving the quality of children born to them and the quality of life for both the children and themselves (Ingutia, 2017).

Women's access and control over land are crucial in empowering them economically, socially and politically. However, women's attempts to access and gain control over land are constrained due to social inequalities associated with customary and traditional tenure systems and reinforced by a lack of enforcement and implementation of new land laws and policies on gender equality in gaining access and control over land. On the other hand, rural women are allocated a small piece of land (not ownership) by their husbands to produce food crops including vegetables meant for home consumption and to a lesser extent for sale. The family plot used for cash crops takes priority, however, leaving women with limited time to work on their plots (Naadira, 2012; World Bank, 2008).

Female farmers lack collateral (usually land), and have a limited scale of enterprises, and thus are disadvantaged in accessing credit and loans. The terms of access to rural loans usually favour commercial enterprises, excluding important aspects related to food production and household nutrition. Moreover, women have less time and money to travel to credit institutions, which typically are situated in urban centres (Fletschner, 2009; Fletschner and Kenney, 2011). Female farmers receive only 1% of the total credit to agriculture, which negatively affects their incentives in pursuing productive income-generating opportunities (FAO, 1995).

Access to improved seeds, fertilisers and pesticides is limited mostly because extension services fail to cover women, and government subsidised inputs are generally not granted to women. Furthermore, women tend not to have the cash needed to purchase the subsidised inputs. Lack of appropriate technology has caused the production among women to be predominantly labour intensive, with most of the farm work done by family and child labour. High illiteracy levels among rural women is a barrier to accessing the benefits of research and innovation. Female farmers' main domain is food crops that are of low priority in research, while at the same time, their roles and needs are often ignored in the creation and implementation of new technologies (Mikalitsa, 2010).

Women also face constraints such as a lack of mobility, a shortage of qualified female extension staff, inappropriate extension packages and a lack of flexibility in extension services, with timetables that are not always compatible with women's daily chores. Projection in many extension services is oriented towards crops traditionally grown by men, and in some cases, cultural factors prohibit women from receiving training (Adenkule, 2013; Meinzen-Dick *et al.,* 2014). Low-income women tend to be marginalised by distant and poor market facilities. Insufficient emphasis has been placed on market facilities that attract the participation of women in marketing. Market information remains confined to the literate as well as more urban-based farmers at the expense of rural women. Information, particularly on food security, fails to reach female farmers (Asiedu, 2012; IFAD, 2011).

Table 1 depicts selected characteristics of women in Kenya; the low percentages of women in ministerial level positions and female land ownership, among others, suggests that social-cultural norms tend to limit women's participation in decision-making. Indeed, their presence in decision-making bodies, especially in leadership, remains weak, subsequently, their needs particularly as farmers rank low in policy and resource allocation. Consequently, female farmers produce below their production capacity (FAO, 2012). At the household level, women have no bargaining power or voice to influence decisions in production and marketing, including plot selection, the crop and variety to be planted, land preparation, fertiliser application, pesticide application,

Table 1. Selected characteristics of women (%) in Kenya 2000-2018 (World Bank, 2019).

	Female	Male
Family planning needs met	68	
% of firms with female participation in ownership	48	
% of firms with female top managers	16	
Proportion of women in ministerial level positions (%)	23	
Women deciding on contraceptive use (%)	56	
Employment in agriculture (% of female / male employment)	64	50
Bank account ownership female/male (%)	46	57
% of women/men who own land alone (not joint ownership)	7	30
Mobile money account ownership female/male (%)	62	70
Self-employed (% of female/ male employment)	79	50

labour hiring, harvesting, sale of farm produce, purchase and sale of farm machinery, purchase and sale of land, use of the proceeds from the farm and saving.

The impact of gender inequality in accessing productive resources can be summed up from the key message of the State of Food and Agriculture (FAO, 2011). The report states that gender equality would subsequently increase yields on women's farms by 20-30%, and consequently, agricultural output in developing countries would increase by 2.5-4%, thereby reducing the number of hungry people in the world by 12-17%. Social-cultural institutions still override the constitution of gender equality, the former prohibit or restrict women from owning land. Therefore, support to women farmers can contribute to women's access to productive resources if farmer groups and cooperatives are provided gender equality training and are in support of these measures, and simultaneously set gender equality strategies or gender equality plans of action (Duguid and Weber, 2016; Sexsmith, 2019).

2.2 Farmer groups

The situation of female farmers reflects the circumstances of smallholders in general since female farmers are the majority. Smallholders in Kenya are predominantly resource poor, and their participation in commercialised production is generally limited by various institutional, technical and investment constraints. Faced with these constraints, particularly access to productive resources in the pursuit of guaranteeing household food security and maximising income from agriculture (Bibby and Shaw, 2005; Birchall and Simmons, 2009), individual farmers from the grassroots-level pool their resources and work together as members of farmer groups. Farmer groups have existed since the precolonial era, the earlier farmer groups were informal and seasonal self-help groups. Presently, farmer groups range from small informal groups to large formal cooperatives (Poole and Frece, 2010).

The informal groups are largely self-help groups and are built around customary principles and ideas of promoting and protecting individuals as well as collective wellbeing. Farmer groups are groups of farmers that leverage collective action to access certain services, including the exchange of information, providing representation and voice to members, the marketing of produce and the buying of inputs. The economic benefits from the sale of farm products are normally distributed to members after covering transaction costs (Shiferaw and Muricho, 2011). Governments, development agencies and agribusiness companies have embraced farmer groups' approaches because the majority of smallholder farmers are members of farmer groups; these groups are suitable pathways to reach the very poor at the grassroots level. Moreover, the delivery of extension services, including credit, input, marketing, technical training and education, is done through the channel of the group approach. Farmer groups allow for farmers to interact with each other while sharing knowledge, experiences and resources (Ainembabazi *et al.,* 2017; Bernard *et al.,* 2008a; Wanyama *et al.,* 2009; Woomer *et al.*, 2004).

Extension services mainly involve technology transfer, with the village extension worker transferring knowledge from the research station to farmers by using farmer groups or mass media methods. The elite of the rural communities typically captures the services and resources, while the poor and women are excluded or receive very little benefits. Minimal efforts have been made to train group leaders, group members or the village extension workers (Chamala and Shingi, 1996).

The same socio-economic constraints that limit women's access to productive resources, often challenge their participation in farmer groups. A case in point, female membership in agricultural cooperatives is limited because women fail to meet membership requirements such as land ownership. However, there are some cooperatives and farmer groups formed with both flexible membership requirements and to suit activities traditionally performed by women, including horticulture, small animal husbandry and food crop marketing. These cooperatives and farmer groups work with female farmers: (a) through the power of association; farmer groups normally demonstrate their capacity to help smallholders to overcome barriers and gain better access to resources, thereby enabling them to increase their crop yields; and (b) by offering networks of mutual support and solidarity that allows women's social capital to grow, improving their self-esteem and self-reliance. This enables women to acquire a stronger voice in decision-making and to collectively negotiate better contract terms, prices and access to a wide range of resources and services including agricultural resources and assets, markets to commercialise their produce, and credit, capital and other financial and social services.

Differences in dynamic and lagging regions present smallholders with different opportunities and challenges; consequently, farmer groups in Kenya operate at various levels, depending on their respective circumstances. Some smallholders are successful in marketing high-value perishable products such as fruits, vegetables and milk, but a majority are not. Some are still net sellers of food, whereas others are net buyers. Some resort to non-farm income in situations where many opportunities abound; conversely, there are situations where non-farm income is a coping strategy that prevents or slows their descent into deeper poverty. A study by Sumelius *et al.* (2015) on cooperatives' competence in reducing poverty in Tanzania concluded that cooperatives' business models for poverty reduction can take very different forms. While some cooperatives were not effective in poverty reduction, others had succeeded in improving the living conditions of their members.

Figure 1 is on the conceptual framework of women farmers productivity with farmer groups as a platform to boost productivity.

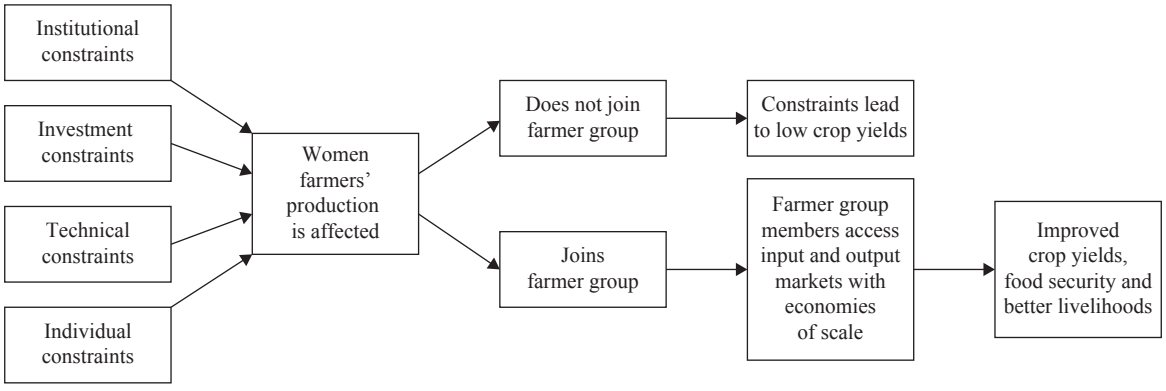

Figure 1. Conceptual framework of women farmers productivity with farmer groups as a platform to boost productivity.

The literature review points out the numerous challenges female farmers face thereby hindering their effective participation in agriculture, regardless of women's large contribution to crop yields. These contradictory circumstances demand the analysis of the factors affecting women's participation in agriculture. The factors can be specified as:

$$Y = \beta_0 + \beta_i x_i + \varepsilon \quad (1)$$

where Y is a dependent binary variable (Y=1 for female farmers, Y=0 if otherwise), β_0 is the intercept, β_i represents the regression coefficients that explain the factors affecting female farmers' participation in agriculture, χ_i represents the parameters to be estimated (i = 1, 2, 3,…), and ε is the error term.

2.3 Female farmers' membership decisions

We assume that a female farmer makes a binary decision on whether to participate in a farmer group or not. The probability of participating in a farmer group, holding other things constant will depend on the outcome of the comparison of the expected benefits (G^*_M) from participation, and the expected benefits (G^*_N) from non-participation. A female farmer's membership decision can be specified as:

$$M^* = M^M \text{ if } (G^*_M > G^*_N) \text{ or } M^* = M^N \text{ if } (G^*_M < G^*_N) \quad (2)$$

$$M^* = \beta_0 + \beta_i x_i + \varepsilon \quad (3)$$

where M^* is the membership decision chosen by the farmer (assigned a value of either one or zero), M^M represents membership, while M^N represents non-membership, G^*_M are the expected benefits from participation, and G^*_N are the expected benefits from non-participation, β_0 is the intercept, β_i represents the regression coefficients that explain the probability of female farmers' participation in farmer groups, x_i represents the parameters to be estimated, while ε is the error term. The probability of participating in a farmer group is specified as:

$$Pr\,(M^* = M^M) = Pr\,(G^*_M > G^*_N) \quad (4)$$

Since farmers are generally heterogeneous, not all the female farmers will belong to the farmer groups. However, farmer group participation is expected to be associated with a higher yield, relative to female farmers who are not members of farmer groups. Moreover, the effect of socio-cultural constraints that limit women's access to productive resources is stronger among female farmers that are not members of farmer groups.

3. Materials and methods

3.1 Description of study areas

Since the survey covers agricultural yields, it was conducted in October 2018 to coincide with the harvesting season (September and October) in the sub-counties of Navakholo (Esumeiya Ward) and Lurambi (Butsotso Central Ward) in Kakamega County, Kenya. Both Lurambi and Navakholo belong to the upper-medium ecological zone. Butsotso Central's population is 25,744 and the land area is 48.8 km^2, while Esumeiya's is 25,352 and 48.4 km^2, respectively. Small-scale subsistence farming is the main livelihood, carried out on land averaging 1.5 acres in size; the crops include maize, beans, bananas, sugarcane, sweet potatoes, fruits and vegetables, and minimal livestock farming mainly includes dairy cattle and poultry (The County Government of Kakamega, 2013). Numerous, mostly informal farmer groups exist, with poor sustainability measures and no funds.

3.2 Model

■ *Theoretical model*

Based on figure 1 and the references in the literature review we formulate the following theoretical model:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 F_{3i} \ldots \ldots + \beta_7 d_i \quad (5)$$

where i denotes the ith observation in the sample, P is the dependent variable, β_0 is the intercept term and $\beta_1, \beta_2 ... \beta_7$ are the coefficients associated with the explanatory variables $X_1, X_2 \ldots X_7$. We include endogenous binary indicator F for a female farmer being a member of a farmer group.
Y_i = Agricultural production of women farmers
X_1 = Institutional constraints
X_2 = Investment constraints
F_3 = Female member of farmer group
X_4 = Individual constraints
X_5 = Technical constraints
X_6 = Access to productive resources
X_7 = Change in yields
d_i = Regional dummies $d = 1$, $d = 0$

The determinants of women farmers' agricultural productivity including institutional, technical, investment and individual are interrelated, with institutional constraints being the starting point. Institutional issues such as social norms limit women's land rights thereby restraining women's collateral to access credit. While gender inequality in education leaves most women illiterate and ignorant (Netsayi *et al.,* 2017). Agricultural extension and information workers tend to bypass women farmers, besides that illiteracy is a barrier to women's adoption of modern agricultural technologies and thus have limited knowledge and training in agribusiness management. Furthermore, cultural norms limit women's decision-making power (Netsayi *et al.,* 2016) and therefore do not participate in crucial agricultural development programs where decisions taken fail to consider gender issues contributing to the high disparity in women's and men's agricultural productivity.

Given that gender norms dictate ownership of assets limits women's potential to invest in more profitable agribusiness of high-value products since women are mostly unable to increase their control over production, income, and assets (Quisumbing *et al.,* 2015). Women's low agricultural productivity due to low investment ability is mostly due to gender inequality in the adoption of technology attributed to unequal access to land, information and other farm inputs exacerbated by gendered patterns of division of agricultural labor, household enterprises and household food consumption decisions (Doss, 2018).

■ *Analytical model*

A probit model is applied in running empirical regressions, the explanatory variables include farmer group membership (1 = member; 0 = non-member) and household characteristics. We apply an extended probit regression model (eprobit) to evaluate (a) factors affecting female farmers' participation in agriculture and (b) the change in yields after becoming a member of a farmer group. We use extended probit regressions to account for endogenous covariates, treatment and sample selection complications in our estimates. Several studies, including Spielman *et al.* (2011) and Nkuranga and Wilcox (2013), suggest that farmer groups play a significant role in improving crop yields by facilitating access to productive resources; therefore, farmer group membership is a major factor in positively boosting female farmers' participation in agriculture. On the other hand, low crop yields due to lack of access to productive resources is an incentive for female farmers to join farmer groups. This bidirectional causality between female farmers (dependent variable) and being a female member of a farmer group (independent variable) implies that the disturbance term is correlated with some components of regressors in this case female member of a farmer group is endogenous. The

presence of endogeneity makes the application of probit estimation yield inconsistent estimates; thus we apply extended probit regression to resolve endogeneity.

The probability of being a female farmer or changes in yield after joining farmer group is (P_i), while the probability of not being a female farmer or no changes in yield after joining farmer group is ($1–P_i$). The eprobit model of the relationship between being a female farmer or changes in yield after joining farmer group (dependent variables) and their explanatory variables based on Equation 5 are specified as:

$$(1–P_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 F_{3i} \ldots \ldots + \beta_{11} d_i \quad (6)$$

where P is the probability of the outcome, and the rest of the equation remains unchanged.
P = Dependent variables – Female farmer; change in yield after joining farmer group
X_1 = Information on family planning
X_2 = Farming is profitable
F_3 = Female member of farmer group
X_4 = Marital status
X_5 = Access to credit before joining farmer group
X_6 = Land ownership
X_7 = Mobile phone ownership
X_8 = Membership years
X_9 = Irrigation
X_{10} = Non-farm business
d_i = Butsotso Central $d = 1$, Esumeiya $d = 0$

To answer the question on factors influencing female farmers in making decisions to become members of farmer groups, firstly we use probit regression. Selection bias may arise due to the treated group (farmer group members) differing from the non-treated group (non-members) for reasons other than treatment status. Secondly, we use linear regression with an endogenous treatment model (Woolridge, 2013) to allow for a specific correlation structure between the unobserved reasons that affect the treated group (farmer group members) and the unobserved reasons that affect the potential outcome. The estimation is performed using a maximum likelihood estimator.

The endogenous treatment regression model is composed of an equation for outcome y_j and an equation for endogenous treatment t_j:

$$\begin{aligned} \sqrt{y_j} &= \sqrt{x_j \beta} + \sqrt{\delta t_j} + \varepsilon_j \\ \sqrt{t_j} &= \begin{pmatrix} 1, \textit{ if } w_j \gamma + \mu_j > 0 \\ 0, \textit{ otherwise} \end{pmatrix} \end{aligned} \quad (7)$$

where x_j are covariates used to model the outcome, w_j are covariates used to model treatment assignment, and the error terms ϵ_j and u_j are a bivariate normal with a mean of zero and a covariance matrix of:

$$\begin{bmatrix} \sigma^2 & \rho^\sigma \\ \rho^\sigma & 1 \end{bmatrix} \quad (8)$$

The covariates x_j and w_j are unrelated to the error terms, suggesting they are exogenous.

3.3 Sampling and data collection

Purposeful sampling was applied for selecting the study areas due to their geographical locations and accessibility. Butsotso Central is situated right next to Kakamega municipality, and farmers were therefore assumed to have easy access to input and output markets along with extension services. On the other hand, Esumeiya is in the interior of the county, further away from both input and output markets. The author that travelled to the survey areas spoke the local language of the regions, an advantage when interacting with the farmers.

Proportional sampling was used to randomly sample rural small-scale female farmers that were members of farmer groups. The sampling was based on a list of all multi-purpose farmer groups in both study areas, and the number of women per group. A total of 347 smallholder farmers, comprising 137 farmer group members and 210 non-members, were randomly selected and interviewed (female farmers were our target group, however, male farmers responded to the questions in some households) using pre-tested structured questionnaires. Also, leaders of respective farmer groups were interviewed. Our total number of households (347) is representative of the members and non-members of the farmer groups in the areas under study, considering the rule of thumb is having at least 30 observations. Data were gathered on several factors including farm and household characteristics, production and marketing activities along with health, nutritional status, and food security issues. The field survey was conducted with the help of trained research assistants.

3.4 Data analysis

Statistical tools employed include descriptive statistics (Excel data analysis (Microsoft Excel, Microsoft, Redmond, WA, USA)) and econometric analysis with the help of the STATA software package (StataCorp LLC, College Station, TX, USA). Table 2 presents the definition and summary statistics of variables used in empirical analysis. Table 2 indicates that, on average, a farmer in the sample is about 42 years old and has about 8 years of formal education. Of the farmers in the sampled population, 69% are women and 31% of the female farmers participate in farmer groups. They cultivate 1.5ha and increased their crop intensity after joining a farmer group by 53%, leading to 85% higher crop yields. Of the female farmers, 58% confirmed that farming is profitable, and only 42% had received information about the importance of family planning. Family planning questions were based on the benefits of family planning; the knowledge of respondents was tested by answering true or false questions. The variable on food safety storage is an average of the questions on perishable and cooked food storage practices. While market information is the responses to whether respondents receive market information and have easy access to markets.

Table 2. Variable definition and summary statistics.

Variable	Definition	Mean	Std. Dev.[1]
Respondent_age	Age of respondent (years)	41.95	14.65
Female group member	1 if female farmer participates in farmer group, 0 otherwise	0.31	0.46
Female farmer	1 if farmer is female, 0 otherwise	0.69	0.73
Youth	1 if youth (18-35 years), 0 otherwise	0.39	0.49
Average household size	The average of household size	4.80	2.17
Education	Education respondent (years)	7.50	4.15
Land ownership	1 if the family owns land, 0 otherwise	0.96	0.19
Total farm land	Total farmland under family's control (hectares)	1.50	1.13
Farming profitable	1 if farming is profitable, 0 otherwise	0.58	0.94
Food safety storage	Average (%) food safety – clean, separate, cook, storage	34.35	23.71
Timely payment of production	1 if farmer groups pay farmers in time, 0 otherwise	0.27	0.45
Nonfarm business	1 if farmer is involved in non-farm business, 0 otherwise	0.56	0.50
Market information	1 if farmer receives market information, 0 otherwise	0.45	0.75
Farming decisions	1 if farming decisions are not made by self, 0 otherwise	0.69	0.47
Electricity access	1 if farmer has access to electricity, 0 otherwise	0.36	0.48
Access to credit	1 if farmer has access to credit, 0 otherwise	0.32	0.47
Information family planning	1 if farmer has ideas about family planning, 0 otherwise	0.42	0.34
% change in crop intensity	% change in crop intensity after joining farmer group	52.62	58.97
% change in yield	% change in crop yield after female F. joint farmer group	85.42	141.66
% change in income	% change in income after female farmer joined farmer group	189.20	219.61
Butsotso Central	1 if farmer is in Butsotso Central, 0 otherwise	0.41	0.49
Esumeiya	1 if farmer is in Esumeiya, 0 otherwise	0.59	0.49

[1] Std. Dev. = standard deviation.

Given that our dependent variables are dummy variables (categorical, coded as 0, 1) fails to fulfil a key implicit assumption in ordinary least squares (OLS) regression that requires the dependent variable to be continuous. Furthermore, a great concern for purposes of interpretation is that the predicted probabilities of OLS can be greater than 1 or less than 0, which can be a problem for subsequent analysis. Probit models are estimated with maximum likelihood estimation, not with OLS so the standard problem with heteroskedasticity does not apply to the probit model. That is why we have chosen a probit model as a suitable analytical tool.

In Table 3 standardised Beta coefficients were used to obtain the combined effects of the independent variables on the dependent variable because they allow the comparison of relative effects of predictors measured on different scales (Bryman and Cramer, 2009; Nieminen *et al.,* 2013). While in Table 5 marginal effects were computed to allow for a better interpretation of the results (Greene, 2012).

4. Results and discussion

4.1 Factors affecting female farmers' participation in agriculture

Table 3 presents estimates of the factors affecting female farmers' participation in agriculture. The benefits of being a member of a farmer group, such as the creation of social relationships, that enable female farmers to achieve goals that they may not otherwise be able to achieve by themselves are evident through the estimate for female farmer membership in a farmer group, which is statistically significant at the 0.01 level. Furthermore, a 1-unit increase in female farmer membership in a farmer group increases women's participation in agriculture by 1.8 units. This is consistent with the finding by Quisumbing and Pandolfelli (2010) who report that farmer organisations are feasible mechanisms that enable resource-poor women to achieve economies of scale by lowering the costs of acquiring inputs or hiring services such as farm machinery, transport or storage.

Table 3. Factors affecting female farmer's participation in agriculture.[1]

Dependent variable: female farmer	**Beta coefficients**	**Std. Err.[2]**	**Z scores**	***P*-value**
Constant	0.056	0.323	0.17	0.862
Farming decision not made byself	-1.182***	0.197	-6.00	0.000
Female farmer group member	1.823***	0.541	3.37	0.001
Information on family planning	0.614**	0.245	2.51	0.012
Farming profitable	0.351**	0.171	2.06	0.039
Access to credit before group membership	-1.041**	0.493	-2.11	0.035
Marital status	-0.229**	0.105	-2.19	0.028
Land ownership	0.779**	0.343	2.27	0.023
Butsotso Central	-0.097	0.176	-0.55	0.580
Treatment variable: female group member				
Constant	-1.128***	0.162	-6.95	0.000
Collateral requirement	1.118***	0.324	3.44	0.001
Farmer group's good price for produce	1.163***	0.312	3.73	0.001
Farming decision not made byself	-0.600***	0.182	-3.29	0.001
Butsotso Central	0.521***	0.176	2.97	0.003
Corr. (e.female groupmember, e.female farmer)	0.636***	0.139	4.59	0.000
ATE[2]: female group member	0.384	0.054	7.00	0.000
ATET[2]: female group member	0.273	0.054	5.08	0.000
Number of observations	347			

[1] **, *** represent significance at 5 and 1% levels respectively.

[2] ATE = average treatment effects; ATET = average treatment effect on the treated; Std. Err. = standard error.

Female farmers need to participate in vital decision-making in farming, including the kind of crops grown, the purchase and application of farm inputs, the marketing of farm products and how to utilise the proceeds. Social-cultural factors that limit women's participation in decision-making negatively affects women's participation in agriculture. Moreover, Table 3 shows that the estimate for farming decisions not made by female farmers is statistically significant at the 0.01 level, a 1-unit increase in farming decisions not made by female farmers decreases women's participation in agriculture by 1.2 units.

Generally, farmer groups tend to obtain higher prices for marketed products and lower prices for purchased products. Individually, female farmers, in particular, have little influencing power, but as part of farmer groups, their collective action increases the market price of their products. Moreover, results in Table 3 show that the estimate for farmer groups' good prices for farm products is statistically significant at the 0.01 level. Furthermore, a 1-unit increase in farmer groups' good prices for farm products increases female farmers' participation in agriculture by 1.2 units, which is consistent with the finding of Bernard *et al.* (2008b) and Fischer and Qaim (2012).

Low birth interval negatively affects the health of both the mother and child; mothers under these circumstances are depleted, spending more time nursing the sickly underweight children and having no energy to participate in agriculture. The estimate information on family planning is statistically significant at the 0.10 level, furthermore, a 1-unit increase in information on family planning increases women's participation in agriculture by 0.61 units. Table 2 indicates that only 42% of the female farmers have received information on family planning.

Table 1 indicates that only 7% of the women in Kenya owned land during the period 2000-2018. Table 3 shows the estimate for land ownership is statistically significant at the 0.10 level, furthermore, a 1-unit increase in women owning land increases women's participation in agriculture by 0.77 units. Presently, as pointed out above, women are allocated a piece of land by their husbands, but women have no control over the allocated land, for instance, to use it as collateral in obtaining credit.

Table 3 shows the correlation between female membership in a farmer group and female farmer (the dependent variable) is 0.64, implying they are endogenous; the more female farmers join farmer groups the more they become effective participants in agriculture. The average treatment effects (ATE) is the average of the difference between female farmers when each female farmer is a member of a farmer group (the treated) and female farmers when none of the female farmers are members of a farmer group (control group). The results of ATE in Table 3 show that if all female farmers were members of farmer groups the number of female farmers' effective participation in agriculture would increase by 0.38 units. The causal effect among female farmers who are farmer group members, known as the average treatment effect on the treated or ATET, has increased by 0.27 units in Table 3.

Table 4 presents estimates of the factors influencing a female farmer's decision to participate in a farmer group. We find that the decision to participate in a farmer group is positively and significantly influenced by accessibility to sufficient credit. Farmer groups with credit facilities increase female farmers' probability to participate in farmer groups by 47%, as revealed by the marginal effect. Lack of collateral (usually land) has constrained women from accessing credit facilities. Microfinance lending institution services are more accessible to rural women because they charge lower interest rates than money lenders and mostly replace collateralised loans with peer-supported guarantees of group lending, whereby becoming a member of a farmer group facilitates access to credit (Ingutia, 2017). Farmers with access to credit are not only enabled to fulfil their group obligations, including membership fees and periodic cash contributions, but they can also procure production inputs such as farm equipment, fertiliser and chemicals as well as pay for labour expenses.

As noted in Section 2.1, the land is the most valuable asset in most rural households' portfolios; it is the key collateral in obtaining credit, and yet female farmers have limited access to land. In Table 4a, we find that the estimate for not owning land is statistically significant with a negative effect. Additionally, it has about

Table 4a. Probit model estimates of factors influencing female farmer's decision to participate in farmer group.[1]

Dependent variable: Female group member	Probit coefficients		Marginal effects	
	Coefficients	Std. Err.[2]	Coefficients	Std. Err.[2]
Constant	-0.759*	0.452		
Access to credit after group membership	1.566***	0.308	0.470***	0.094
Education	-0.059**	0.026	-0.015**	0.007
Land ownership	-0.709**	0.444	-0.227*	0.164
Membership years	0.157***	0.039	0.039***	0.010
Market access	-1.144***	0.311	-0.288***	0.073
Farming decision	-0.648***	0.232	-0.173**	0.064
Collateral requirement	0.807***	0.295	0.237**	0.096
Extension visit	0.563**	0.258	0.148**	0.069
Butsotso Central	0.921***	0.228	0.247***	0.062
R^2	0.57			
Number of observations	347			

[1] *, **, *** represent significance at 10, 5 and 1% levels respectively.

[2] Std. Err. = standard error.

Table 4b. Linear regression with endogenous treatment. estimator maximum likelihood.[1]

Dependent variable: Female group member	Coefficients	Std. Err.[2]	Z scores	*P*-value
Constant	0.169**	0.095	1.78	0.076
Access to credit after group member	0.390***	0.064	6.12	
Education	-0.008**	0.004	-2.13	0.033
Land ownership	-0.282***	0.096	-2.96	0.003
Membership years	0.032***	0.007	4.38	0.000
Market access	-0.147***	0.038	-3.85	0.000
Farming decision	-0.059**	0.033	-1.80	0.072
Collateral requirement	0.175***	0.057	3.05	
Extension visit	0.599***	0.064	9.43	0.000
Butsotso Central	0.141***	0.043	3.28	0.001
Treatment variable: Extension visit				
Constant	-1.337***	0.325	-4.11	0.000
Land ownership	0.802**	0.325	2.47	0.014
Respondent gender	0.643***	0.114	5.63	0.000
Butsotso Central	-0.067	0.135	-0.50	0.619
Number of observations	347			
athrho	-1.316	0.159	-8.29	0.000
Sigma	0.385	0.024		
lambda	-0.334	0.034		

[1] *, **, *** represent significance at 10, 5 and 1% levels respectively.

[2] Std. Err. = standard error.

a 23% probability of influencing female farmers' decision to not participate in farmer groups that require land ownership for membership, Meinzen-Dick *et al.* (2017) also found land to be an invaluable asset.

Women's farming decisions not being able to be made by themselves exert a negative and significant effect on women's decision to participate in farmer groups. Women's limited participation in decision-making

decreases their probability to participate in a farmer group by 17%. Women's limited representation in leadership positions (Table 1) has largely contributed to their needs not receiving the due attention in policy and resource allocation. However, farmer groups create an enabling environment for farmers through collective bargaining power in input and output markets and active participation in decision-making from the grassroots to policy formulation to access services at more affordable prices, thereby reducing costs and increasing yields, sales, and profits (Elbehri and Lee, 2011).

Table 4a results indicate that relative to Esumeiya (reference district), farmers located around the Butsotso Central district have about a 0.92% probability of participating in farmer groups. These findings suggest that location fixed effects also influence farmers' decisions to participate in farmer groups.

Endogeneity, treatment and sample selection bias issues may arise, for instance, people who seek extension services are mostly the older and more educated households with access to credit and extension services; this same set of people are more likely to become farmer group members (Wossen *et al.,* 2017). Not all female farmers are facing constraints, there could be some older and more educated female farmers with access to credit and extension services who are more likely to be farmer group members than non-members. This set of female farmers' decisions to participate in farmer groups is influenced by factors other than the benefits associated with joining farmer groups (treatment status). To correct for endogeneity and selection bias issues, we use maximum likelihood to estimate the parameters of linear regression with endogenous treatment effects (Table 4b). We note that the probit model (Table 4a) coefficients' values are far higher than the selection model coefficients for maximum likelihood (Table 4b), the only exception is the estimated coefficient of extension visit, which is 0.563 in Table 4a and has increased to 0.569 in Table 4b. These findings suggest that the maximum likelihood estimator using endogenous treatment effects has corrected for endogeneity and selection bias, thus producing more consistent results.

Table 5 presents estimations of the percentage change in crop yields after female farmers joined a farmer group, we apply the extended probit regression model as mentioned in Section 3.2. We find that female farmers' membership years in a farmer group contributes to the percentage change in yields. The estimate for membership years is statistically significant at the 0.05 level, furthermore, a 1-unit increase in membership years has the probability of increasing crop yield by 0.14%. These results suggest that higher yields can be associated with the benefits of membership years in farmer groups including easy access to credit, farm inputs, information, and extension services, among others. A similar finding is reported in other studies (Mwaura, 2014).

Mobile phone ownership has the transformative potential to improve the crop yields of female farmers in Kenya because those without bank accounts can now receive money transfers on their mobile phones through M-PESA (mobile banking service). Moreover, farmers can now have access to crop prices, be connected to buyers and sellers and receive weather alerts through mobile phones. In Table 5, the estimate for having a mobile phone is statistically significant at the 0.01 level, a 1-unit increase in mobile phone holders has the probability of increasing crop yields by 2.4%; Krell *et al.* (2020) and Baumuller (2015) had similar findings. The estimate for being a female member of a farmer group lost statistical significance in explaining changes in crop yield after joining a farmer group because of the presence of the estimate for membership years and having a mobile phone since mobile phone status facilitates access to services such as information that are mostly accessed through farmer groups.

Lack of access to credit has been depicted in Table 3 as a significant factor affecting female farmers' effective participation in agriculture, while Table 4 indicates access to credit is a crucial factor influencing female farmers' decisions to participate in agriculture. The same theme is carried on in Table 5, where the estimate for lack of access to credit before joining a farmer group is statistically significant at the 0.01 level. A 1-unit increase in the number of female farmers without access to credit has the probability of decreasing crop yield by 1.4%.

Table 5. Extended probit regression of percentage change in crop yields after joining farmer group.[1,2]

Dependent variable: Change in yields	Coefficients	Std. Err.[3]	Z scores	*P*-value
Constant	-0.325	0.957	-0.01	0.990
Mobile phone	2.385***	0.489	4.87	0.000
Membership years	0.139**	0.060	2.31	0.021
Lack access to credit before group member	-1.413**	0.567	-2.49	0.013
Irrigation	1.067**	0.521	2.05	0.041
Nonfarm business	-0.656**	0.360	-1.82	0.069
Farm machinery	-1.985**	0.805	-2.46	0.014
Female group member	1.555	0.946	0.01	0.990
Butsotso Central	-0.388	0.372	-0.01	0.990
Treatment-endogenous: Female group member				
Constant	-1.366***	0.201	-6.81	0.000
Collateral requirement	2.235***	0.223	10.02	0.000
Strategies for food security	0.611***	0.204	2.99	0.003
Farming decision	-0.441**	0.186	-2.37	0.018
Market accessibility	-0.769***	0.237	-3.24	0.001
Butsotso Central	1.366***	0.201	6.81	0.000
Corr. (e. female group member. e. change in yields)	-0.515	0.392	-1.31	0.189
ATE[3]	0.275	0.071	3.90	0.000
ATET[3]	0.328	0.057	5.73	0.000
Number of observation	347			

[1] Crop yield represents output per unit of land it is the measure of crop produced per area of land.

[2] **, *** represent significance at 5 and 1% levels respectively.

[3] ATE = average treatment effects; ATET = average treatment effect on the treated; Std. Err. = standard error.

Table 5 indicates that the estimate of the correlation between the errors of the two equations (change in yields and female member of farmer group) is -0.51 and is significantly different from zero, implying there is endogeneity. Since the correlation is negative, we conclude that the unobservable factors that decrease the number of female farmers that are members of farmer groups also decrease crop yield. The results of the ATE in Table 5 show that if all female farmers were members of farmer groups the change in crop yield could increase by 27%, while the ATET of change in crop yield has increased by 33%.

Figure 2 depicts percentage changes in crop yields of female farmers after joining a farmer group ranging from 85-684%. The wide disparity can partly be attributed to female farmers being heterogeneous (e.g.

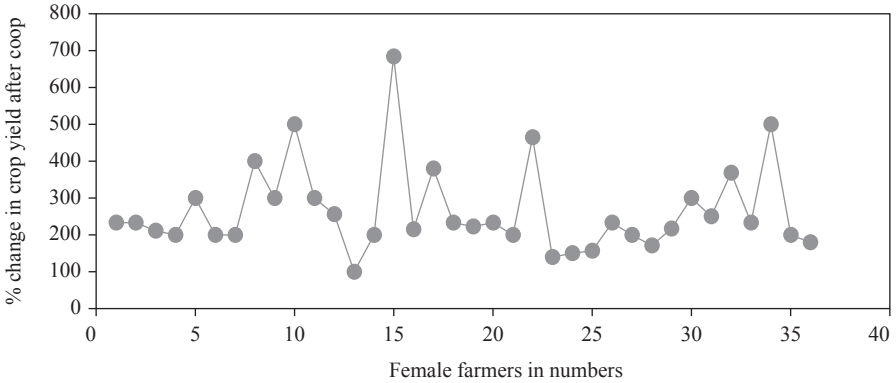

Figure 2. Percentage change in crop yield after joining farmer group.

social-economic status), therefore the impact of farmer group on situations of respective female farmers varies. Table 6 compares the socio-economic status of members and nonmembers of farmers groups to gauge if farmer groups make agribusiness more productive in the area under study. To minimise the biases that may arise by simply comparing members and non-members, we use Fisher's exact test and Mann-Whitney U test to test for any statistically significant differences between the two groups.

t-test comparison of the means of members and non-members, suggests that farmer groups make agribusiness more productive. Fisher's exact *P*-value indicates that members of farmer groups are not identical (evidenced by statistically significant differences) to non-members in crucial factors contributing to production including: (a) education which is crucial to enable farmers to participate in training in modern agricultural technologies; (b) access to extension visit services a platform for both training farmers and for providing farm inputs; (c) market information including better input and output market prices essential for agribusiness.

5. Conclusions

This study began by investigating the factors that affect women's participation in agriculture, followed by factors influencing the decision of female farmers in joining farmer groups. Finally, the role of farmer groups in improving women's crop yield was analysed. This was done using recent primary data of 347 farmers from the districts of Esumeiya and Butsotso Central in Kakamega County, Kenya. We used extended probit and maximum likelihood (endogenous treatment) for running regressions, with endogeneity, treatment and sample selection complications being accounted for. The empirical results revealed that membership

Table 6. *t*-test comparison of the means of members and non-members.[1]

Variables	Member		Nonmember		Difference	
	Mean	Std. Dev.[2]	Mean	Std. Dev.[2]	Pearson's	Fisher's
Respondent_age	41.63	12.37	42.19	16.01		
Illiteracy	0.17	0.38	0.23	0.42	0.136	0.175
Education	7.53	3.76	7.48	4.40	0.015	0.015
Youth	0.36	0.48	0.41	0.49	0.436	0.499
Average household size	4.90	2.02	4.80	2.27	0.365	0.349
Land ownership	0.99	0.12	0.95	0.23	0.065	0.084
Land use	0.98	0.15	0.95	0.23	0.152	0.175
Farmsize hectares	1.49	1.14	1.51	1.13	0.743	0.772
Farming profitable	0.62	1.14	0.56	0.88	0.869	0.915
Without food	0.91	0.29	0.92	0.28	0.831	0.835
Butsotso Central	0.58	0.50	0.36	0.48	0.000	0.000
Esumeiya	0.46	0.50	0.64	0.48	0.003	0.004
Nonfarm business	0.60	0.49	0.54	0.50	0.251	0.269
Extension visit	0.50	0.50	0.36	0.48	0.011	0.014
Market information	0.49	0.50	0.42	0.88	0.065	0.038
Farming decisions	0.64	0.48	0.71	0.45	0.189	0.215
Food safety storage	38.80	26.54	31.20	21.07	0.043	0.044
Electricity access	0.44	0.50	0.31	0.46	0.012	0.016
Membership years	5.35	3.31			5.38	3.31
% change in yield	85.42	141.66			85.42	141.66
Info family plan	0.50	0.33	0.37	0.34	0.001	0.001

[1] Land ownership in this study is at household level data, because a majority of the women interviewed affirmed that they had land in the sense that they were allocated a small portion of the land by their husbands to farm. However, they have no control over the land, they cannot use it as collateral to get credit.

[2] Std. Dev. = standard deviation.

in a farmer group and women owning land increases women's effective participation in agriculture, while women's limited power in decision-making in farming issues and lack of access to credit decreases women's effective participation in agriculture.

The results suggest that farmer groups with easy access to credit largely influence women's decisions in joining farmer groups. Conversely, sociocultural factors, including women not owning land and limited decision-making power, mostly dissuades women from participating in farmer groups. Location fixed effects also influence farmers' decisions to participate in farmer groups. Empirical results indicate that female farmers' membership years in a farmer group have a positive significant effect on the percentage change in yields. Furthermore, possession of a mobile phone enables money transfers, access to crop prices and other essential information, thereby contributing to increased crop yields. The theme of the critical role of access to credit has been shown in it significantly affecting female farmers' effective participation in agriculture, in its influencing female farmers' decisions to participate in agriculture and in determining changes in crop yields.

Some policy implications and agrobusiness management implications can be drawn from the findings of this study. The results revealed that membership years had a positive impact on crop yields, Awal and Abdulai (2018) had similar findings. Members of farmer groups incur reduced transaction costs due to having access to extension services including training and market information leading to better input and output prices, these benefits boost agrobusiness management. Getnet *et al.* (2018) are of the same opinion. The results suggest that farmer groups are particularly effective platforms to improve crop yields and other multiple constraints confronting female farmers, Ingutia (in press) had similar conclusions. If farmer groups get support from the government, they can: (a) give credit to women to facilitate women's access to land and other productive resources; (b) develop input supplying and product collecting and marketing cooperatives thereby upgrading agrobusiness management.

The situation of female farmers as described in Section 2.1 is likely to diminish through effective and efficient farmer groups because the latter is a common platform for female farmers as beneficiaries and governments, donor agencies and agribusiness companies as benefactors targeting the promotion of smallholder productivity. Surprisingly, the farmer group platform is largely under-utilised, particularly in rural Kenya, evidenced by only 31% of the female farmers participating in farmer groups (Table 2) as well as the multiple constraints female farmers face, and yet the literature indicates the potential of farmer groups in reducing these constraints.

It is through farmer groups that illiterate women can, for example, receive adult education, obtain essential information on family planning and nutrition education, become empowered in decision-making, receive extension services. Most farmer groups in rural areas do not offer any of these services to their members because of unskilled management, lack of capital, corrupt practices and lack of commitment from both members and the management. It is worth noting that the few agricultural cooperatives available in rural Kenya have similar challenges as farmer groups. The only notable differences are cooperatives' legal status, size of membership and being mostly commercial farming. The empirical results support the transformation of farmer groups from being mainly associated with access to credit to needs-based community-related services (education, family planning, gender equality). Policymakers should invest in the human, financial and physical capital of farmer groups because it is a pathway to rural development, improvement of rural livelihoods and reducing poverty.

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Conflict of interest

The authors have no conflict of interest.

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