Do Grassroots Institutions Promote Household Food Security? Evidence from Cooperative Membership in the Southern Highland Regions of Tanzania

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Abstract

This study investigated the impact of Agricultural Marketing Cooperative Society (AMCOS) membership on household food security. The Propensity Score Matching (PSM) and Endogenous Switching Regression (ESR) models were used to evaluate whether changes in the treated group attributed to their membership. The study used cross-section data collected in 2016 from 1400 households in the southern highland regions of Mbeya and Songwe in Tanzania. The outcome variable of interest was the Household Food Insecurity Access Scale (HFIAS). The logit estimates indicated that age of the household head, total land owned, land cultivated, and whether a household head accessed credit from microfinance institutions significantly predicted the likelihood of joining a cooperative membership. Results of PSM show that ATT was negative (-0.039) implying that being treated cooperative members were likely to improve household food security. On the contrary, the result from ESR suggested that being treated cooperative membership a had negative impact on reducing household food insecurity status. The differences in ATT from PSM and that from ESR models suggest that both observed and unobserved factors influence the decision to join cooperative membership and household food security outcome given the joining decisions. However, the Transitional Heterogeneity effect was negative (TH= -0.486) implying that the impact on reducing food insecurity was much higher to rural farm household that did receive intervention compared to untreated cooperative members. The study recommends the need to promote policies that aim to strengthen cooperatives and their functioning for the rural farming households to boost their income and improve household food security.

Keywords: AMCOS, Farming Household, Food Security, Southern Highlands, Tanzania

Introduction

In the last decade, collective action in the context of rural livelihoods improvement has received substantial attention (Andersson and Gabrielsson, 2012). Cooperatives have been promoted as potential policy instruments for smallholder farmers in improving livelihoods and adopting agricultural technologies, boosting crop productivity and reducing poverty in transition economies (Chagwiza *et al.,* 2016; Hao *et al.,* 2018; Ma *et al.,* 2018; Mojo *et al.,* 2017; Wossen *et al.,* 2017). Cooperatives are associated with collective action thus can reduce transaction costs by creating economies of scale in input supply, technology transfer and market integration among small-scale farmers (Chauvin *et al.,* 2017). Cooperatives incentivize smallholder farmers to participate in markets and have a strong voice in negotiation for their economic and social benefits (Barrett, 2008). This may result in an increase in household food security among crop-producing households from own production and income from crop sales.

Food insecurity and poverty remain serious problems in Africa (Abdul Mumin and Abdulai, 2020). Africa has almost 233 million people accounting for about 20 percent of the African population who live in hunger despite several interventions to improve food and nutrition

security (Abdul Mumin and Abdulai, 2020; FAO, 2020). Food insecurity is strongly evident in sub-Saharan African countries including Tanzania (Otsuka, 2013; Schindler *et al.,* 2017). Agricultural development in these countries provides a direct link with an improvement in food security and poverty alleviation (FAO, 2013). Evidence has shown that most food-insecure and undernourished people are smallholder farmers living in rural areas of developing countries (Dethier and Effenberger, 2011; Sibhatu and Qaim, 2017). The estimates show that smallholder farmers do 90 percent of all agricultural production activities, where the average farm size is about one hectare (IFAD and UNEP, 2013). In addition, these smallholder farmers represent the poorest and most food-insecure population (Dethier and Effenberger, 2011; IFAD, 2013).

Food security exists when all people at all times have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2009). Food security combines multiple concepts supported by four pillars: availability, access, utilization and stability of foods resulting in food sufficiency in quantity and quality (Becquey *et al.,* 2010). Several factors contribute to food insecurity and among them, poverty is a core. Poverty restrains the ability of farming households to invest in productive assets and agricultural technologies leading to low agricultural productivity. Natural disasters such as drought (Welderufael, 2014), population growth, insufficient productive or financial resources and barriers of access to the market because of poor market infrastructure (Magrini and Vigani, 2016) increase transaction costs and contribute to household food insecurity. Data from the 2015 Tanzania Demographic and Health Survey (TDHS) show that nationwide only 57 percent of the households were able to satisfy their food requirements in 2015. Food insecurity was severe among rural households than it was among urban households. About 55 and 77 percent of rural and urban households respectively consume three (3) meals per day. These statistics suggest that food insecurity existed among 45 percent of rural households and 33 percent of urban households (URT, 2016).

An extensive literature review suggests increasing evidence that agricultural cooperatives in developing countries play a fundamental role in technology adoption in the context where there are high transaction costs and low bargaining power (Abebaw and Haile, 2013; Abdoulaye *et al.,* 2013; Ma and Abdulai, 2016). Some studies show that cooperative membership facilitates access to input credit (Meier zu Selhausen, 2016) and the adoption of yield-enhancing technologies especially the use of improved seed varieties, fertilizers and pesticides (Abebaw and Haile, 2013; Chagwiza *et al.,* 2016; Ma *et al.,* 2018; Michalek *et al.,* 2018; Shiferaw *et al.,* 2009). In the Sub-Saharan Africa, cooperatives are widely argued as potential instruments to boost agricultural sector performance in rural areas of developing countries (Ahmed and Mesfin, 2017; Hazell *et al.,* 2010) and increasing market bargaining power potential (Shiferaw and Hellin, 2011; Abdoulaye *et al.,* 2013; Latynskiy and Berger, 2016). The literature demonstrates the importance of cooperatives in strengthening smallholder farmers linkage to markets (Barham and Chitemi, 2009; Hazell *et al.,* 2010), increasing household income (Bernard and Spielman, 2009; Bernard *et al.,* 2008; Birchall, 2003; Fischer and Qaim, 2012; Ito *et al.,* 2012; Ma and Abdulai, 2016; Michalek *et al.,* 2018; Mujawamariya *et al.,* 2013; Vandeplas *et al.,* 2013) and improving household consumption expenditures (Ma and Abdulai, 2016). Collective action has often been viewed as a potential mechanism of addressing market-oriented production towards poverty reduction and ensuring food security (Chauvin *et al.,* 2017; Nugusse *et al.,* 2013). Some empirical studies have examined the impact of cooperative membership on technical efficiency (Abate, 2014; Abdul-Rahaman, 2018) and revealed that cooperative membership yields a positive and significant impact on technical efficiency.

In Tanzania, the agricultural sector remains the potential productive sector in the economy and hence its good performance may have a significant contribution to food and nutrition security and poverty reduction (Schindler *et al.,*

2017). Over 75 percent of the Tanzanians live in the rural areas employed in the agricultural sector. Therefore, the sector plays a substantial role in household food and income contributing to about 27 percent of the Gross Domestic Product (GDP). However, periodic drought is among the factors that reduce harvests subjecting the country to chronic food insecurity (Cochrane and D'Souza, 2015). According to USDA's Economic Research Service (ERS), almost 5 million out of 48 million people, were food insecure in 2014 and this number is expected to rise to 14 million by 2024 (Rosen *et al.,* 2014).

The development of agricultural cooperatives in Tanzania is traced back to 1932 when the Kilimanjaro Native Cooperative Union (KNCU) was established as a coffee cooperative in the Kilimanjaro Region, aiming to promote coffee production and marketing (Mruma, 2014). After independence in 1961, the government made a cooperative movement as a vital instrument to transform agricultural production for economic development. From the mid-1990s, the Government of Tanzania has been implementing institutional reforms aiming at eradicating poverty. The reforms include the formulation of the agricultural and livestock policy of 1997 which aimed to increase investment in the agriculture sector, marketing, value addition, and provision of support services. One of the potential initiatives was the establishment of the Cooperative Act of 2003. The main objectives of AMCOS were to solve production and marketing constraints. These includes supplying inputs for agricultural crop production, purchasing, processing, and marketing agricultural products to meet the economic needs of members and share the profit according to the number of shares. Moreover, AMCOS intended to deal with collective marketing, improve negotiation power of the members to fetch better crop prices, reduce transaction costs and improve their livelihoods.

In Tanzania, smallholder agriculture is a key driver of food security, employment, and poverty reduction among rural farming households (Kissoly *et al.,* 2017). By joining producer organizations, farming households can form their strategies out of poverty and make their voices heard. A well-functioning grassroot organization such as the Agricultural and Marketing Cooperative Society (AMCOS) is crucial among farming households. (AMCOS[1]) as a form of collective action can enable members to attain economies of scale through timely and better access to quality inputs and increase sales volume (Chambo, 2009; Sizya, 2001). Since cooperatives are owned and controlled by the members, there are good reasons to believe that through AMCOS, members could tap opportunities and address their economic challenges. These challenges include lack of access to input, barriers to improving agricultural productivity, high transaction costs of accessing output markets where they could market their produce, overcoming asymmetric information, lack of training and lack of access to financial services.

On the one hand, AMCOS members are expected to have better access to input credits, training, and ultimately higher returns and thus become food secure through availability from their production. On the other hand, since AMCOS are registered to deal with collective marketing, the bargaining power of its members is expected to rise. The income earned through selling the surplus may increase allocation to household consumption expenditure such as accessing food. As a benchmark for evaluating the outcome, we model AMCOS members' choice to join the cooperative society as a selection process where the expected benefits of the treated members drive the decision to belong to the treatment group.

Although cooperatives are potential policy instruments in improving livelihoods and poverty reduction among smallholder farmers, there is no empirical evidence of whether being a cooperative member specifically, AMCOS affects household food security in Tanzania. This study investigated the impact of Agricultural Marketing Cooperative Society (AMCOS) membership on household food security. The southern highland regions of Mbeya and Songwe were an interesting case since the regions are among the leading food

[1] *AMCOS is a form of cooperative registered and regulated under the legal framework specifically to deal with collective marketing.*

crop producers in the country, and have many cooperatives and farmer organizations (FOs). The high rate of malnutrition in the regions about 36% (Orchieng *et al.,* 2017) also motivated the undertaking of this study. The study used Propensity Score Matching (PSM) and the Endogenous Switching Regression (ESR) models to evaluate whether changes in the treated group are attributed to their membership. It is hypothesized that the treated cooperative (AMCOS) members had access to the market through collective marketing, higher returns necessary to increase household income, and therefore were more food secure than was the case with the control group. The paper contributes knowledge to the existing literature in twofold: First, the findings provide insights regarding the determinants of joining cooperative membership to draw implications for rural farm households welfare. Second, the use of mixed methods to derive treatment effects of cooperative membership in reducing household food insecurity yield robust results. The fact that the decision to join cooperative membership is non-random, endogeneity problems could affect the results. PSM estimation technique controls the heterogeneity effects due to observed covariates. To assess the robustness of the results, the ESR model was used to control both selection bias and unobserved heterogeneity. The findings of the study may benefit rural households, academicians and inform policymakers regarding marketing cooperatives. The rest of the sections of the paper are organized as follows; Section Two describes material and methods, Section Three presents data analysis, and Section Four presents results and discusses the impact of cooperative membership on household food security. The last section presents the conclusion and policy recommendations.

Theoretical framework

Ideally, cooperative members self-selected themselves to join AMCOS. As a result, it is difficult to compare the food security indicator (HFIAS) of the treated (AMCOS members) and non-treated (members of other cooperatives) because of the selection bias attributed to observed and unobserved characteristics (Di Falco *et al.,* 2011). Cooperative membership is a function of the benefits attained from being a member, which could increase either the physical outcome or the utility of the member (Di Falco *et al.,* 2011). Therefore, the decision of whether to join a cooperative or not depends on the expected utility of either decision. The farming household can join a cooperative when expecting greater utility from joining than not joining (Debertin, 2012). In this study, farming households' direct expectation of being a member of AMCOS is the reduction of food insecurity. If the expected utility of being an AMCOS member were lower than the expected utility from not joining the decision would be not to join. The utility is likely not only dependent on household food security but also on other factors such as socio-economic, demographic and institutional factors that affect household food security (Di Falco *et al.,* 2011). The expected utility theory guided this study. Utility theory was a theoretical basis for the adoption decision among farming households that were in the treatment group as opposed to the utility of non-treated members (status quo) in terms of receiving the benefits (the new state). In this study the utility for the status quo is denoted as follows;-

$$U_{0j} = u\left(Y_j, Z_j, \mathrm{q}^0\, \varepsilon_{0j}\right) \quad \text{.....(1)}$$

The utility for the new state is denoted as:

$$U_{1j} = u\left(Y_j, Z_j, \mathrm{q}^1\, \varepsilon_{1j}\right) \quad \text{.....(2)}$$

In this model, the farming household j can be a member of AMCOS if the utility of receiving the benefits exceeds the utility of not receiving.

$$U_1\left(Y_j, Z_j, \mathrm{q}^1\, \varepsilon_{1j}\right) > U_0\left(Y_j, Z_j, \mathrm{q}^0\, \varepsilon_{0j}\right) \text{.(3)}$$

U_0 Indicates the utility function of the farming households without benefits (status quo), U_1 indicates the farming households that receive membership benefits, Y stands for food security indicator (HFIAS), q^0 and q^1 represent the alternative levels of the good indexes for farming households with and without AMCOS membership respectively. If $q^1 > q^0$, then q^1 refers to improved food security of the farming household after receiving benefits. Z_j denotes

a vector of exogenous variables. Assuming the farming households maximize utility, the decision by farm household j to receive the intervention (treated member = 1) or not to receive the intervention (non-treated member = 0) is grounded through a comparison of expected utilities of both situations. The difference in the expected utilities can be expressed by the following decision rule:

$$Cooperative\ member = \begin{cases} 1, if E\left[U_j^1 - U_j^0 \middle| Z_j\right] > 0 \\ 0, if E\left[U_j^1 - U_j^0 \middle| Z_j\right] \leq 0 \end{cases} .(4)$$

Here, E denotes the expectation operator. Based on their different characteristics, farming households also differ in their expectations of the utility levels of both choices. The vector Zj stands for variables impacting utilities of both choices and how the expectations are formed on these utilities.

In theory, food security has four distinct pillars: food availability, access, utilization, and food stability (Nsiah and Fayissa, 2019), implying that the absence of these pillars leads to increased food insecurity. Food availability and access can directly be impacted by the production performance of the crop sector (Nsiah and Fayissa, 2019). Availability suggests the supply side of the household food security determined by the level of household food production and stock (Muzari, 2016). Access to food is certain when all members or individuals within the household have adequate resources of obtaining an appropriate and nutritious diet. It is worth mentioning that since farmer organizations in the area comprise crop producers who have access to farm inputs and may improve productivity for both household consumption and as a source of income, we expect them to reduce food insecurity. The linkage between AMCOS members and household food security is through availability and access. As agricultural productivity increases, poverty level and food insecurity tend to decline (Muzari, 2016).

Material and methods

The study area

This study was conducted in Mbeya and Songwe Regions in Tanzania (Fig. 1). Songwe was created on January 2016 from the Western part of Mbeya Region. Geographically, the two regions are located in the South western part of the Southern Highlands of Tanzania, laying between latitude 7° and 9° South of the Equator and between longitude 32° and 35° East of the Greenwich. Mbeya region comprises of five districts: Mbeya Rural, Mbarali, Rungwe, Kyela, and Busokelo. Songwe region is divided into four districts: Songwe, Ileje, Mbozi, and Momba. Mbeya and Songwe Regions are estimated to have a population of 2,070,412 (NBS, 2018). The annual rainfall in both regions ranges from 650mm to 2,600mm. The selection of the study area was based on two reasons; first, the food crops production potential (maize, paddy, common beans, and soya beans), the two regions are among the big seven (7) food basket-producing regions in the country (AGRA, 2020) with many cooperatives and Farmer Organizations (FO). According to NBS (2018) Mbeya and Songwe Regions had a total of 180 registered AMCOS and 315 registered Saving And Credit Cooperative Societies (SACCOS). Second, the Integrated Project of Increasing Agricultural Productivity (IPIAP) in Tanzania led by the Wageningen University of the Netherlands and the Sokoine University of Agriculture in Tanzania intended to strengthen capacity of farmer organizations, increase smallholder market-led agricultural production and to enhance smallholder farmers' access to structured produce markets. Through income earned, members would improve household nutritional security. In terms of food security situation, these regions are food surplus-producing areas, with maize from these region supplied to other regions as well as neighboring countries. Other crops include rice, beans, groundnuts, sorghum and potatoes (Cochrane and D'Souza, 2015).

Sampling strategies and data collection

The study used cross-section data collected in 2016 from 1400 households in Mbeya and Songwe Regions. A multistage sampling procedure was used to collect data. First, two regions of Mbeya and Songwe were purposively selected. Purposive sampling technique was also used to select four country-

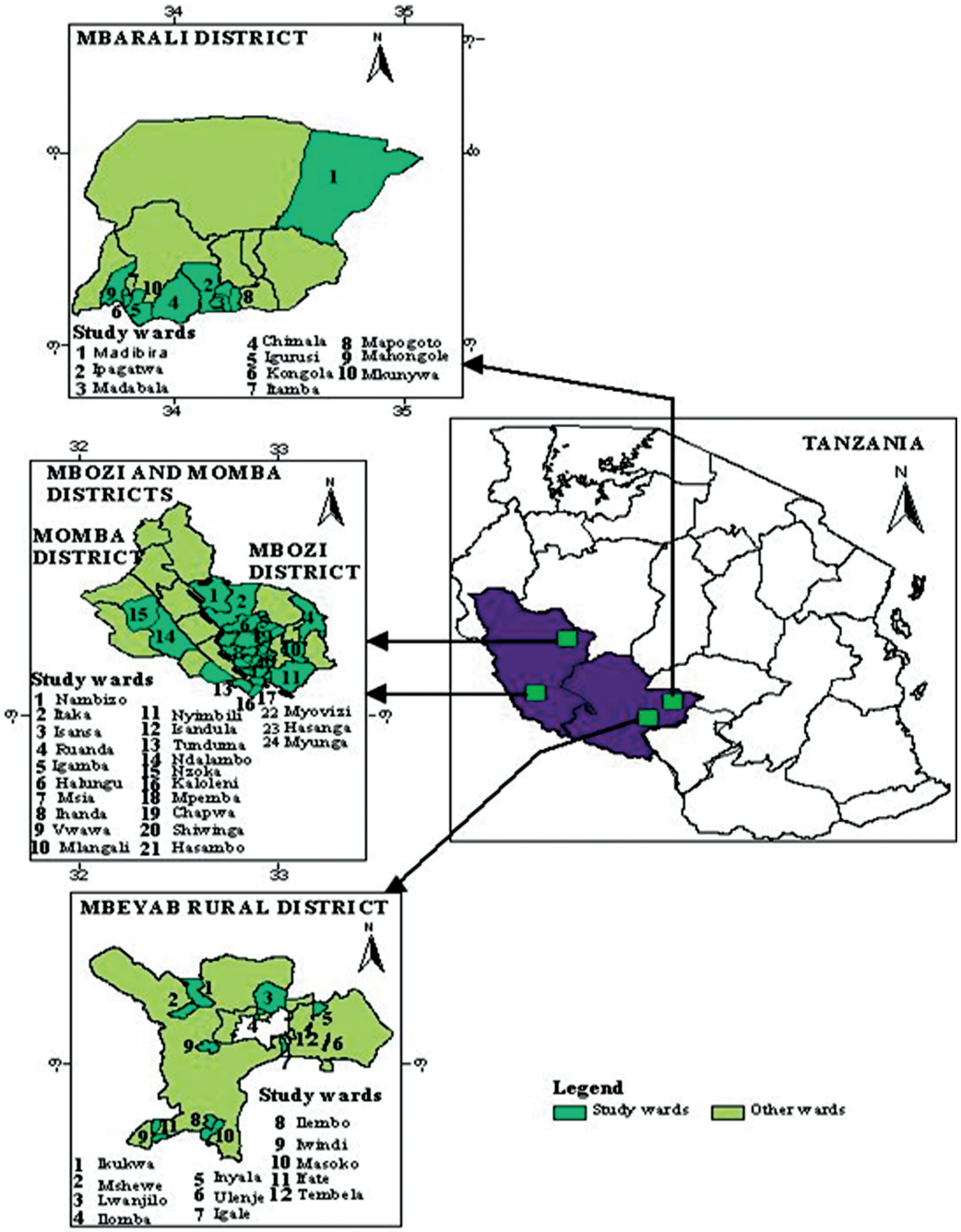

Fig. 1: A map of Tanzania showing the study areas

level districts: Mbeya Rural and Mbarali from Mbeya region and Mbozi, and Momba from Songwe region. These districts are among the leading producers where food crop such as maize, rice, beans and soya beans are grown, which were strategic crops of IPIAP project. A simple random sampling technique was employed to select farmer organizations from the list acquired from the District Agriculture Irrigation and Cooperative departments. Fifty-one (51) farmer organizations were selected. These organizations operated in 51 out of 92

wards. Out of these organizations, 19 were AMCOS, five (5) were SACCOS and 27 were other FOs. One of the IPIAP project objectives was to link farmers with financial institutions hence SACCOS were sampled because these were financial co-operatives that aimed at meeting the financial needs of all members by encouraging savings and granting loans to the members. A simple random sampling was used to select households for an interview because all the cooperative members were eligible to participate in the survey. In the analysis, we used 687 households as the treatment group (AMCOS members), and 713 as the control group (SACCOS members and members of other FOs). Structured questionnaires were the main tool for data collection using the tablet-based application (Open Data Kit) to complete questionnaires. Enumerators worked in pairs where a male enumerator interviewed the male head of the household collecting information related to crop production and marketing. A female enumerator interviewed the wife and information collected included socio-economic characteristics, asset ownership and household food insecurity status.

In the case of a female-headed household, a female enumerator interviewed the head using both questionnaires. In absence of spouse, an informed person in the household responsible for cooking was interviewed. Key informant interviews were used to collect qualitative information from National Food Reserve Agency (NFRA) AMCOS leaders regarding food crop marketing issues.

Data analysis

Propensity score matching

Propensity Score Matching (PSM) was used to evaluate whether changes in the household food security attributed to AMCOS membership. The PSM was suitable to deal with the problem of selection bias on the observables (Heckman *et al.,* 1997; Rosenbaum and Rubin, 1983). The decision to join AMCOS is not exogenous, and hence the likelihood of self-selecting into the treatment group creates bias. As a result, the treatment and control groups may not be comparable based on initial characteristics. We used PSM to construct a counterfactual, that is, what would have happened to the AMCOS members if the members had not joined. A propensity score is based on the conditional probability of the assignment to a particular treatment given the observed covariates (Rosenbaum and Rubin, 1983). The propensity score matching technique is the probability of a unit being assigned to a specific treatment conditional on the observed baseline covariates (Austin, 2011). It is a balancing score where the distribution of observed baseline covariates is likely to be similar between treated and untreated subjects. Two assumptions hold in PSM, the first is the conditional independence assumption (CIA) stating that the selection to treatment depends on observable characteristics. The second is a common support or overlap condition presented as $0<P(D=1|X<1)$. It is a region where the scores have a positive density for both the treatment and comparison group and therefore, subjects have a probability of receiving either treatment (Rosenbaum and Rubin, 1983). The probability of an assignment is bounded between 0 and 1.

We then estimated the logit model of the treated group to predict the propensity scores for each observation. The dependent variable used in this choice model is dummy variable that takes the value of 1 if a cooperative member belonged to a treatment group, and 0 if a cooperative member was in a control group. This is important as the average treatment on the treated should only be defined in this region (Caliendo and Kopeinig, 2008). The second is the balancing property that must be satisfied before matching. Following Heckman *et al.* (1997) and Austin (2011), the potential confounders are associated with treatment assignment and the outcome variables. In our model, Di is a binary variable that takes the value of 1 if household i is treated and 0 if otherwise. The outcome variable HFIAS is denoted as Yi (Di) where i = 1;.....N and N indicate the total number of cooperative members. The average treatment effect on the treated is specified as follows,

$$T_{ATT} = E(T\left|D=1\right.) = E\left[Y(1)\middle|D=1\right] - E\left[Y(0)\middle|D=1\right] \quad ..(5)$$

Where ATT is the average treatment effect on the treated, E[Y(1)|D=1] is an expected

HFIAS for a treated member of cooperative and E[Y(0)|D=1] is the expected HFIAS for the counterfactual.

We performed our analysis by using the nearest neighbour matching technique with replacement. Practically, the algorithm matches treated with non-treated individuals based on the proximity of the propensity score (Kassie *et al.,* 2013). The algorithm reduces bias in matching because the untreated subjects can be matched to more than one treatment individual (Dehejia and Wahba, 1999). After matching, we performed the balancing test to check for similarities in covariates between treated and control members. The test enabled us to determine whether the balancing requirements of the propensity scores were satisfied (Austin, 2011; Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983). Following the weakness of PSM to control only observable variables, the use of ESR controls both observable and unobservable heterogeneity.

Endogenous switching regression

As a robustness check to PSM we used the counterfactual analysis to evaluate the outcome variable if a farming household would not be AMCOS members. The outcome variable of interest was the Household Food Insecurity Access Scale (HFIAS). To account for the possible endogeneity for the decision to receive an intervention, the ESR model was employed to estimate the impact of being treated on HFIAS. The main advantage of ESR is that the technique controls both observed and unobserved characteristics of farming households and achieves unbiased estimates. The endogenous switching model involves a separate estimation of sub-groups of the treated and control members. The function of the treated is defined as

$$D_i = \delta Z_i + \mu_i \quad \text{.....(6)}$$

With i=1 for AMCOS members in the treatment group and 0 for non-treated members. Z_i is a vector of household, farm and institutional characteristics influencing the decision to become an AMCOS member.

The identification of the ESR model necessitates at least one additional variable in the choice model. An empirical study by Krishnan and Patnam (2014) is evident that extension services are the primary source of information regarding adoption of new technology. Some studies (Di Falco *et al.,* 2011; Shiferaw *et al.,* 2014) used information sources such as the government extension, farmer-to-farmer extension, radio information, and distance to inputs markets as additional variables. Extension agents play crucial roles in transferring modern technologies (for example, improved seeds) to smallholder farmers. Through training on proper farming and management practices, farming households become exposed to new technologies (Anderson and Feder, 2007; Wossen *et al.,* 2015). Following the literature Wossen *et al.* (2017) and Shiferaw *et al.* (2014), the current study used the age of cooperative, the regional dummy and age difference between spouses.

Following Equation (6), the outcomes are observed for the two groups of farming households (Asfaw *et al.,* 2012):

Regime 1: $Y_{1i} = \alpha_1 X_{1i} + v_{1i}$ for cooperative members that are treated .....(7)

Regime 2: $Y_{2i} = \alpha_2 X_{2i} + v_{2i}$ for cooperative members: the control .....(8)

Y(i) denotes HFIAS while X(i) is a vector of exogenous variables affecting the HFIAS, and vi are residuals. There is a probability that some unobserved characteristics such as motivation and managerial skills that affect the probability of receiving intervention could also affect the HFIAS. Therefore, the error term in Equation (6) and the error terms in the outcome functions (7) and (8) may be correlated. This problem is solved by estimating equations 5–7 simultaneously using a Full Information Maximum Likelihood (FIML) that remains the most efficient approach. According to Lokshin and Sajaia (2004) the "movestay" command in STATA provides consistent estimates of the endogenous switching model.

We used ESR model to compare the expected HFIAS of the treated members (a) with respect to the non-treated members (b) to investigate the expected HFIAS in the counterfactual cases (c)

that the treated members if did not receive the intervention, and (d) that the control members did adopt (Asfaw *et al.,* 2012; Di Falco *et al.,* 2011). The measure is important to explain the differences in the HFIAS between the two groups and suggest possible responses to a change in the policy. The conditional expectation for HFIAS in cases (a), (b), (c), and (d) are reported in Table 1. Cases (a) and (b) indicate the actual expectation while counterfactual expected outcomes are presented in cases (c) and (d). The impact of receiving intervention "the treatment effect on the treated" (TT) (Asfaw *et al.,* 2012), which is the difference between cases (a) and (c) is expressed in equation (9)

$$TT = E\left(y_{1i} \middle| D_i = 1\right) - E\left(y_{2i} \middle| D_i = 1\right) \quad \text{.....(9)}$$

the heterogeneity effects. For example, the HFIAS for treated members may be high or low compared to the non-treated members regardless of whether they received interventions, but rather because of the unobservable characteristics that affect the HFIAS. The base heterogeneity effect is expressed in equation (11) as the difference between cases (a) and (d) for the treated group members (Asfaw *et al.,* 2012; Di Falco *et al.,* 2011)":

$$BH_1 = E\left(y_{1i} \middle| D_i = 1\right) - E\left(y_{1i} \middle| D_i = 0\right) \text{....(11)}$$

The base heterogeneity effect of non-treated members is given by Equation (12) as the difference between cases (c) and (b):

$$BH_2 = E\left(y_{2i} \middle| D_i = 1\right) - E\left(y_{2i} \middle| D_i = 0\right) \text{....(12)}$$

Table 1: Average expected HFIAS for treated and control members of cooperatives

Sub-sample	Decision stage		
	Adopt	**Not adopt**	**Treatments effect**
Treated cooperative members	(a) $E(y_{1i}\|D_{1i}=1)$	(c) $E(y_{2i} \mid D_{1i}=1)$	TT
Non-treated cooperative members	(d) $E(y_{1i}\|D_{1i}=0)$	(b) $E(y_{2i} \mid D_{1i}=0)$	TU
Heterogeneity Effect	BH_1	BH_2	TH

Note: *(a) and (b) are the observed expected score per adult equivalent unit.*
(c) and (d) are the counterfactual expected food variety score per adult equivalent unit.

Di=1 if farming households are treated members;
Di=0 if farming households are non-treated members
y_{1i} : HFIAS if treated cooperative member
y_{2i} : HFAS if non-treated member
TT : Effect of the treatment on the treated
TU : Effect of the treatment on the untreated
BHi : Base heterogeneity effect for treated members i =1, and non-treated members (i=1)
TH = (TT-TU): Transitional heterogeneity
Source: Adapted from Asfaw *et al.* (2012); Di Falco *et al.* (2011)

Similarly, the difference between cases (d) and (b) is the treatment effect on the untreated (TU) for the control members. This is expressed by equation (10) as:

$$TU = E\left(y_{1i} \middle| D_i = 0\right) - E\left(y_{2i} \middle| D_i = 0\right) \text{....(10)}$$

Our treatment effects were differentiated from

Moreover, the study investigated whether the effect of being a treated member is greater or smaller for treated members or non-treated members if they did receive project interventions "the transitional heterogeneity effect" was calculated as,
TH=TT-TU

Food security status of households

As stated earlier, we interviewed a person responsible for meal preparation to gain information related to adjustments made by a household regarding food consumption patterns. Our outcome variable food security was measured using the Household Food Insecurity Access Scale (HFIAS). The HFIAS was calculated as responses from the standard questionnaire consisting of nine (9) items (Becquey *et al.,* 2010). The HFIAS is a continuous measure of the degree of food insecurity (access) that occurred in the household for the past 30 days. According to Ballard *et al.* (2011) the HFIAS

reflects three universal domains of household food insecurity: (1) the anxiety about household food insecurity, (2) inadequate quality and (3) insufficient quantity of food supplied. Based on the literature, our reference period was 30 days before the survey date (Coates *et al.,* 2007). The questionnaire consisted of nine questions covering three themes (i) households that were worried that they would not have enough food supply, (ii) varying quality of the food, and (iii) reducing the quantity of food consumed. In each of the nine questions of the HFIAS, we established a frequency of occurrence score over the past 30 days. A score of 0 was recorded if the household never experienced any of the nine items of the HFIAS, 1 if rarely occurred (once or twice in the past 4 weeks), and 2 if it sometimes occurred (three to ten times in the past 4 weeks). A score of 3 was assigned if it often occurred (more than 10 times in the past 4 weeks). The sum of HFIAS points ranged from 0 for food-secure to 27 for maximum food-insecure households (Coates *et al.,* 2007). The FAO cut-off points summarize that 0-2 indicate less food insecurity, 3-10 imply moderate food insecurity, and 11-27 denote severe food-insecure household (Coates *et al.,* 2007). The strength of the tool is that HFIAS captures conditions ranging from slight food insecurity to very severe food insecurity. The food insecurity situation may affect both health and household wellbeing (Ballard *et al.,* 2011).

Results

Summary statistics of the variables

Table 2 presents the summary statistics of the key variables used in the analysis. Based on the two-sample t-test, the treated and non-treated members of the cooperatives were similar in most of the socio-economic characteristics except for few variables. These variables include the age of the household head, gender of the respondents, whether the head requested a loan from a microfinance institution, age of cooperative and the regional dummy. The difference in these variables may be attributed to the non-randomness of the treated sample. We employed the PSM to control for variables, which were not balanced between the two groups.

Propensity scores matching

Our first step was to generate propensity scores. The logit estimates indicated that the age of the household head, total land owned, land cultivated and whether a household head had access to credit from microfinance institutions significantly predicted the likelihood of a cooperative member being treated. It was evident that the total land owned by the head and whether the household head requested a loan from the microfinance institutions significantly reduced the chances of a cooperative member receiving project intervention (Table 3).

Considering that PSM depends on the CIA, the region of common support [.29177534, .92502903] is identified and the balancing property is satisfied. The results indicate that 706 out of 713 treated and 687 non-treated cooperative members were within the region of common support. The results are evident that seven (7) treated households were off support Table 4.

We used the nearest neighbour matching algorithm to match the covariates. We matched only households found in the region of common support with HFIAS as our outcome variable. Results of PSM shows that the average treatment effect on the treated (ATT) was negative implying that being treated cooperative members were likely to improve household food security by 0.039. The standard error is 0.390 and the p-value is 0.920. However, the effect was not statistically significant (Table 5). The distribution of propensity scores on the region of common support after matching is presented in Figure 2.

Since we conditioned only on propensity scores, we checked for covariate balance between treated and control groups. A two-sample t-test is used to check whether there is a significant difference in the covariate means for both groups (Rosenbaum and Rubin, 1985). The test aims to investigate each observable for treatment and control. Before matching, a significant difference in covariates means is likely while after matching the covariates should be balanced (Caliendo and Kopeinig, 2008). Table 6 presents the mean of all covariates for the treated and non-treated before and after matching. The findings show that before

Table 2: Summary statistics of variables used in analysis

Variable	(treatment group) N=687	(control group) N=713	diff	Pr (|T|t)
Age of household head (years)	51.100 (13.206)	49.225 (13.143)	-1.675	0.017
Dummy=1 if Male head of household	0.866 (0.340)	0.834 (0.371)	-0.031	0.098
Household head completed secondary school (12 years of schooling)	0. 681 (2.778)	0.824 (3.037)	0.143	0.357
Total adult equivalent unit[2]	5.156 (2.210)	5.032 (0.205)	-0.123	0.295
Number of household members with secondary education	0.482 (0.830)	0.524 (0.893)	0.042	0.354
Total land owned (acres)	5.075 (4.752)	5.758 (14.677)	0.683	0.244
Total land cultivated (acres)	5.857 (4.897)	5.530 (5.743)	-0.114	0.755
Dummy =1 if head requested loan from financial institution	0.187 (0.390)	0.235 (0.424)	0.047	0.028
Total livestock owned (TLU)[3]	1.752 (2.330)	1.702 (3.728)	-0.051	0.760
Distance to market	25.122 (30.328)	22.657 (28.465)	-2.465	0.117
Age difference between head and spouse	9.863 (8.457)	8.372 (8.441)	0.028	0.954
Age of cooperative	15.441 (11.356)	7.760 (6.114)	-7.680	0.000
Household Food Insecurity Access scale	5.876 (5.435)	5.559 (5.882)	-0.316	0.296
Dummy=1 if Songwe region, 0 if Mbeya	0.637 (0.481)	0.348 (0.476)	-0.288	0.000

[2] *he adult equivalent scale is commonly used in household consumption analysis because it is more meaningful in expressing food consumption profiles in households with different size and composition by age and sex*

[3] *Total livestock calculated based on the tropical livestock unit (TLU) conversion factors (2005) cattle= 0.7, goat = 0.1, pig =0.2, chicken =0.01, rabbit=0.01*

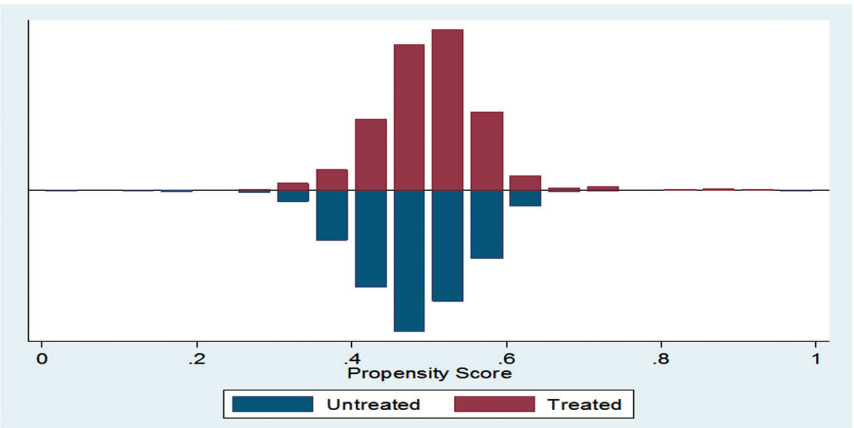

Figure 2: A histogram showing the distribution of propensity scores on the region of common support after matching

Table 3: Estimation of logit model (standard errors are in parenthesis)

	(1)
VARIABLES	**AMCOS members**
Age of household head	0.012*** (0.004)
Dummy=1 if Male head of household, 0 if female headed household	0.223 (0.159)
Dummy =1 if household head completed secondary school education (12 years of schooling)	-0.007 (0.021)
Total adult equivalent unit	0.036 (0.028)
Number of household members with education above primary school (>7 years)	-0.100 (0.074)
Total land owned by the household (acres)	-0.076*** (0.026)
Total land cultivated by the household (acres)	0.075*** (0.027)
Total livestock owned by the household (number)	0.001 (0.018)
Dummy =1, if household accessed loan from microfinance institutions	-0.318** (0.135)
Distance from farm to agricultural output markets (km)	0.003 (0.002)
Constant	-0.971*** (0.281)
Observations	1,400

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Table 4: Number of households with the nearest neighbour matching on the common support region

psmatch2:			
Treatment assignment	**Off support**	**common support on support**	**Total**
Control household	0	687	687
Treated household	7	706	713
Total	**7**	**1393**	**1400**

Table 5: Average treatment effect: Nearest neighbour matching

Variable	**ATT**	**Bootstrap standard error**	**P>|Z|**
Household Food insecurity access scale (HFIAS)	-0.039	0.390	0.928

Table 6: T-test for equality of means for individual variables before and after matching in the pooled sample

Variable	description	Mean treated	Mean control	percent reduction bias	t-test P>(|t|)
Age of household head (years)	Unmatched	51.100	49.225		0.017
	Matched	51.10	51.309	-1.6	0.774
Dummy=1 if Male head of household	Unmatched	0.866	0.834		0.098
	Matched	0.866	0.870	-1.2	0.811
Dummy=1 if head completed secondary school education	Unmatched	0.681	0.824		0.357
	Matched	0.681	0.637	1.5	0.767
Total adult equivalent	Unmatched	5.156	5.032		0.292
	Matched	5.156	5.237	-3.7	0.502
Number of household members with secondary education	Unmatched	0. 481	0.524		0.354
	Matched	0.482	0.486	-0.5	0.919
Total land owned	Unmatched	5.075	5.100		0.244
	Matched	5.616	5.419	-2.2	0.939
Total land cultivated (acres)	Unmatched	5.857	5.530		0.755
	Matched	5.857	5.711	2.1	0.667
Dummy=1 If head requested loan from financial institution	Unmatched	0.187	0.235		0.028
	Matched	0.188	0.168	4.7	0.351
Distance to the market	Unmatched	25.122	22.657		0.117
	Matched	25.123	23.716	1.7	0.384
Total livestock owned (TLU)	Unmatched	1. 752	1.702		0.760
	Matched	1.752	1.685	2.2	0.678
	Matched	9.677	9.662	0.2	0.976

matching some variables indicate statistically significant difference, implying that, not all variables were balanced, while after matching all the variables were balanced.

After identifying the covariance balance indicators for before and after matches, Sianesi (2004) suggests the importance of re-estimating propensity scores on a matched sample, and compare the two pseudo R^2s of before and after matching. The results of the Pseudo R^2: the test for the joint significance show that before matching our Pseudo R^2 was 0.0152 while after matching it was fairly low 0.002 (Table 7). The test suggests how well the regresses explain

Table 7: Covariance balance indicators before and after matching

Before matching	
Pseudo R^2	0.0152
Kernel-based matching	
Pseudo R^2	0.002
LR χ^2 (P-value)	3.73 (0.959)

the probability of cooperative member being treated. After matching our Chi-square is 0.959.

Endogenous switching regression results

Factors affecting cooperative membership

Table 8 presents the results of the Full Information Maximum Likelihood estimation (FIML) of the endogenous switching regression model. Some variables such as the age of the AMCOS, dummy=1 if the member was a resident of Songwe Region and zero for members resided in Mbeya Region and the age difference between the head and a spouse were included in the adoption equation to meet the

Table 8: Estimates of the impact of AMCOS membership on food security

Variable Dependent Variable: HFIAS	Adoption Model		Outcome Model			
			Treated cooperative members		Non-treated cooperative members	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Age of household head (years)	0.005	0.004	0.052***	0.018	0.058***	0.018
Dummy=1 if male head of household	-0.391*	0.226	-0.531	0.994	-1.780	1.575
Education dummy=1 if household head completed secondary school education, 0= otherwise	0.005	0.015	0.066	0.084	-0.173**	0.080
Total adult equivalent unit	0.042*	0.022	0.295**	0.116	0.157	0.123
Number of household members with education above primary (> 7years)	-0.164***	0.059	-0.840**	0.332	-0.749**	0.300
Total land owned (acres)	-0.050***	0.016	0.236**	0.109	-0.001	0.020
Total land cultivated (acres)	0.037**	0.016	-0.303***	0.109	-0.116***	0.041
Total livestock owned (number)	-0.010	0.015	-0.333***	0.101	-0.159**	0.064
Distance from farm to market	-0.002	0.001	-0.008	0.008	0.034***	0.008
Dummy=1, if head of household requested loan from microfinance institution,						
0= otherwise	0.008	0.106	-0.500	0.574	1.026*	0.547
Dummy=1 if household head a resident of Songwe Region, 0=Mbeya region	0.886***	0.092				
Age of cooperative (years)	0.069***	0.006				
Age difference between head and spouse	0.002	0.005				
Constant	-0. 724**	0.303	4.523***	1.442	4.413**	1.900
Observations	1128		1128		1128	
Rho_1	0.0958454					
Rho_2	0.1222125					

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

Table 9: Impact of cooperatives on food security

	Decision Stage		
Sub-samples effects	**To adopt**	**Not to adopt**	**Treatment effect**
Treated cooperative members	(a) 5.775	(c) 5.181	TT= 0.594 ***
Non-treated cooperative member	(d) 6.476	(b) 5.396	TU = 1.08***
Heterogeneity	BH1 = -0.701	BH2 = -0.215	TH = -0.486

condition of the model identification (Nonvide, 2017). Theoretically, these variables affected the probability of receiving treatment but did not affect HFIAS as a food security indicator. The study found that the coefficient of correlation (Rho_1) between the choice equation and outcome equation was statistically insignificant. This implies that the decision to join the treatment group is unaffected by observable and unobservable characteristics. The endogenous switching model presents the results of both the choice and the outcomes. The results regarding the adoption model were briefly discussed since the main objective was to evaluate the impacts of AMCOS membership on household food security measured by HFIAS.

The impact of cooperative membership on household food security

Table 9 shows the expected HFIAS under the counterfactual analysis for treated and non-treated members of a cooperative. Cases (a) and (b) are the observed expected HFIAS that were 5.775 for the treated and 5.396 for the control-farming households. The study showed that the treated members had significantly higher HFIAS with a difference of 0.38. However, this cannot be attributed to being a treated member only. Similarly Table 9 presents the treatment effects of being a treated cooperative member. Unlike the PSM results which compares the treated cooperative members and control members based on observable variables, the result from ESR suggests that the interventions had a negative impact on reducing household food insecurity status. It clearly shows that the counterfactual case (c), the HFIAS for treated members would be 0.594 less if they had not received interventions. If the non-treated had received interventions (case (d)), the HFIAS would be 1.08 higher (i.e. they would be more food insecure). The last column of Table 1 shows that the transitional heterogeneity effect was negative (TH= -0.486) that is the impact of being treated was significantly higher for the farm households that received treatment than for the control members. The heterogeneity effects suggest that the treated cooperative members would have HFIAS less than the non-treated cooperative members in the counterfactual case (c) while having more in case (d).

Discussion

The analysis of the determinants that guide the decision to join cooperative membership has generated interesting results. Age of the household head, total land owned, land cultivated and whether a household head had access to credit from microfinance institutions were identified as primary factors affecting cooperative member being treated. The PSM estimates revealed a negative ATT (-0.039) implying that, on average the project intervention increased the likelihood of reducing food insecurity to treated cooperative members (Table 5). Despite that the effect was not statistically significant the negative coefficient translates that AMCOS are crucial instruments in reducing food insecurity to rural farm household. Unllike the findings of the PSM, the effect of the Treatment on the Treated (TT) of the ESR was 0.594 while the effect of the Treatment on the Untreated (TU) was 1.08. The effects of both TT and TU were positive and statistically significant at $p<0.01$. These results imply that AMCOS members were less likely to reduce household food insecurity by 0.594 to treated and by 1.08 to untreated groups. The differences in treatment effect from PSM and that from ESR model suggests that both

observed and unobserved factors influence the decision to join cooperative membership and household food security outcome given the joining decisions.

However, the Transitional Heterogeneity effect was negative (TH= -0.486) implying that the impact on reducing food insecurity was much higher to rural farm household that did receive intervention compared to untreated cooperative members.

Theoretically, one would expect treated cooperative members to be food secure than non-treated cooperative members did because AMCOS were established mainly to engage in collective marketing and hence improve household income. The income earned may increase the purchasing power of the households to access food through purchases to contribute to household food security. A possible explanation for a lesser impact of AMCOS membership on reducing food insecurity is that marketing of food crops specifically maize AMCOS trades with an institutional buyer particularly the National Food Reserve Authority (NFRA). Results from the key informant interviews indicated that NFRA had limited capacity to buy all maize collected by AMCOS thus impeding AMCOS members to enjoy the benefits of collective marketing. More evidence suggests that despite the fact that NFRA bought a small share of the collected maize, delayed payment affected the AMCOS members not only to receive income for purchasing agricultural inputs but also to access other foods resulting in increased household food insecurity. The findings are consistent with the findings of others scholars (Fischer and Qaim, 2012) who argues that being a member of farmer organizations does not guarantee benefits but rather, the member's participation in certain economic activities matters. The findings of the study are also consistent with Zeweld Nugusse *et al.* (2013) and Asfaw *et al.* (2012) who found that cooperatives played a substantial role in food security in Ethiopia. Further, our results are inconsistent with the results of a study by Gebremichael (2014) who revealed that interventions improved the standard of living of the members of the cooperative in Ethiopia. This could be attributed to the fact that members participated in various economic activities for income that increased access to food to improved household food security through purchases, as access is the second pillar of food security.

Conclusion and recommendations

This study investigated the impact of cooperative membership who received intervention on integrated technologies on household food security. The study used PSM and ESR models that take into account the endogeneity problems. The findings from PSM have shown that the average treatment effect on the treated (ATT) was negative but statistically insignificant. The result implies that being a treated member of the cooperative increased the likelihood of being food secure. On the contrary, an ATT from ESR was positive and statistically significant, implying that the intervention increased the chances of being more food-insecure households. Based on the information from key informants, cooperatives have not worked well specifically in the collective marketing of food crops in the regions. Receiving intervention on integrated technologies should go hand in hand with members'participation in various economic activities such as collective marketing that may increase households' income. Through income, the purchasing power of its members may improve hence more access to food through purchases. For significant impact in improving rural household food security, we still see the importance of strengthening cooperatives to boost the economy of the rural farming households. The high value of TU Table 90 is evident that if non-treated members would get interventions, food insecurity would be 1.08.

This study recommends (1), the need to promote policies that aim to strengthen cooperatives, and their functioning for the rural farming households to boost their income and improve household food security. (2), NFRA should be capacitated to increase the purchased volumes and ensure timely payment. (3), the government should creating an enabling environment for AMCOS to engage in collective marketing within and outside the country for increased income and improved household food security.

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