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Effect of market access provided by farmer organizations on smallholder vegetable farmer's income in Tanzania

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Abstract: Limited market information and market access are two major obstacles to increased smallholder farmers' income in Tanzania. Formation of a farmer organization is one way to overcome these challenges by improving access to markets while reducing transaction costs. This paper evaluates the effect of market accessed through farmer organizations on household income in Babati District, Tanzania. Multi-stage sampling technique was employed to elicit information from 250 smallholder vegetable farmers using a structured questionnaire. Propensity score matching was used to estimate the effect of market accessed through farmer organizations on smallholder vegetable farmer's income. Except for gender of the household head, average farm size owned, distance to the market, and transportation cost, there were no statistically significant differences between vegetable growers who belonged to a farmer organization and those who do not. Market access has a significant positive and robust effect on farm income. Smallholder vegetable farmers with an average farm size of 0.5 acre who had access to the market provided by farmer organization have more income per season (USD 220.11) than vegetable farmers who did not belong to the group membership (USD 177.90). Also, the cost incurred for transporting vegetables to the market and the distance was different between farmers who belonged to a group USD 0.22 and those who were not members USD 0.68. A government supported policy environment that will facilitate establishing and/or strengthening of farmer organizations be supported in sourcing, disseminating market information market accessibility to enhance smallholder livelihoods. This will assist in sustainably transforming smallholder vegetable farming as a viable business venture through increased productivity and incomes.

Subjects: Environment & Agriculture; Food Science & Technology; Development Studies

Keywords: market information systems; farmer organization; social capital; group dynamics; Tanzania; Babati district

PUBLIC INTEREST STATEMENT

Continuous supply of vegetables to retail outlets can be sustainably achieved through mobilizing farmer marketing groups to produce and meet the market demands in rural and urban areas. This is highly possible because farmers will be encouraged to form organized producer groups to access markets if the expected benefits are higher. Therefore, this study investigates the effect of market opportunities provided by farmer-based organizations on smallholder vegetable farmers' income. The findings show that vegetable farmers with access to the market information provided by farmer organization have more income per season. Supporting the formation and strengthening of farmer organizations is a viable option for transforming smallholder vegetable farming to enhance smallholder livelihoods in terms of increased productivity and incomes.

1. Introduction

The horticultural subsector is one of the upcoming subsectors in Tanzania. The growth of this subsector is a result of the increased health awareness of populace in terms of the benefits of eating fruits and vegetables (Dolan & Humphrey, 2000). Consequently, there is an increased demand and market opportunity for horticultural produce in urban centers of both developing and developed countries. Due to this, smallholder farmers have an enormous opportunity to invest more in sustaining horticultural production system, especially vegetables. Vegetable production has received considerable attention in recent times. Vegetables are of great importance in terms of nutrition improvement, income generation, food security, and improving resource use efficiency in agriculture (Ebert, 2014). Despite the importance of vegetables, their production is associated with high risk and uncertainty because it is highly perishable produce. The perishable nature of vegetables necessitates effective marketing channels (Xaba & Masuku, 2012). According to Antwi and Seahlodi (2011), the success of vegetable growers (operation and decision) depend on market availability, accessibility, and affordability.

To this end, most smallholders receive asymmetrical and incomplete market information. This is due to the fact that information is scattered across a variety of agencies, government departments and private sector organizations, which limits the chances of smallholder farmers accessing the information (Tschirley, Diskin, Molla, & Clay, 1995). In order to overcome asymmetrical and inadequate information problem, Market Information System (MIS) needs to be enhanced so as to encourage a more competitive economic environment by reducing informational asymmetry between buyers and sellers of agricultural commodities. In most parts of Africa, farmers rely on the information from traders despite the likelihood of such information being inaccurate compared those obtained from other sources such as government, NGOs, and processing companies (Ochieng, Niyuhire, Ruraduma, Birachi, & Ouma, 2014). Smallholder farmers need better access to market information on prices, quality, quantities, where to sell, and production technologies which can be done through the establishment of MIS by government and development partners in agricultural development.

Furthermore, Dorward, Kydd, Morrison, and Urey (2004) and Ton (2008) revealed that smallholder-led economy is obstructed by a lack of market access. Market access is crucial in smallholders' development because it creates the necessary demand and offers remunerative prices, thereby increasing smallholder incomes (Al-Hassan et al., 2006). The proponents of this thought strongly argue that effective market access can lead to sustainable increases in household incomes and food security, increased rural employment, and sustained agricultural growth. Another study by Hugo et al. (2006) supports the enhancement of market access by contending that greater agricultural markets mean increased trade and ultimately increased income growth. Hence, there is an urgent need to improve market access of perishable crops, particularly, horticultural produce such as vegetable production to ensure sustainability.

One such option of enhancing market access involves through the provision of market information to smallholder vegetable producers through the formation of farmer organizations. Mobilizing producers into groups and establishment of contractual arrangements between farmers and buyers can be an important entry point to link farmers with buyers hence a market assurance to farmers and sufficient supply to buyers (HODECT, 2010). Kaganzi et al. (2009) and Ochieng, Knerr, Owuor, and Ouma (2018) indicated that farmer groups through collective action help meet basic market requirements for minimum quantities, quality, and frequency of supply which they cannot achieve as individuals. However, most rural-based farmer organizations face various challenges; for example, a study by Ochieng et al. (2018) reported that most of the members of these organizations are poor (67%) and few are considered rich (2%) or middle class (28%), while the rest are connoted as destitute who are often excluded from the designated groups due to their own passivity and inability to contribute financial resources for joint activities. Kaganzi et al. (2009) found that collective action in Uganda had failed to increase farmers' net profits due to

overwhelming transaction costs and time demands and that some individually managed sales sometimes emerged as the most profitable option.

In addition, farmer organizations establish contacts between farmers themselves, traders, and processors, thereby improving the social capital. Such sustainable interventions will help farmers to benefit both directly and indirectly, through better access to the market or improved market opportunities. However, when assessing the role of farmer organizations in market development, it is important to take several issues into account: sustainability, the need, and challenge to get different players such as government, private sector, and others working effectively together. According to Stockbridge (2003), farmer organizations build up internal and external relationship of trust during market access linkages, thereby defending farmer interest and improving their market participation. Therefore, market access needs to be improved by upgrading the value chain through strengthening market linkages and information access between established farmer groups and other value chain actors while taking advantage of the latter's ability to coordinate information among members.

In Babati District-Tanzania the Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project funded by USAID has come up with sustainable initiatives of integrating vegetables into maize-based systems for improved nutrition and income of smallholder farmers. This initiative has been implemented by World vegetable Center (WorldVeg), Eastern and Southern Africa. The project has devoted much effort in encouraging the establishment of vegetable farmer organizations, while also strengthening existing ones as a source of information and linkage to potential markets to allow the coordinated produce to meet the demands of large volume regional markets. However, the extent to which this has been achieved has not been evaluated in the study locale. Therefore, there is a need for exploring the influence of farmer organizations toward achieving sustainable production and marketing of vegetables. This is important because farmer organizations have the potential to contribute to the adoption of sustainable and productive management practices (Meinzen-Dick, Pandolfelli, Dohrn, & Athens, 2004) and increase the incomes of the members and more specifically active members who participate in collective marketing (Ochieng et al., 2018). However, market failures often limit smallholders' ability to be linked to markets even if they are organized into farmer organizations.

2. Methods

2.1. Theoretical framework

Collective action and social capital theoretical frameworks are applied to assess the rationale for farmer organizations in improving farmer's access to information and implications on incomes. Collective action has become an important strategy for smallholders in developing countries to remain competitive in rapidly changing markets (Ochieng et al., 2018). Collective action is defined as "action taken by a group (either directly or on its behalf by an organisation) in pursuit of members' shared interests" (Marshall, 1998). Social capital is the resource inherent in the social relations which facilitate collective action and trust, norms and networks of associations representing any group which gather consistently for a common purpose (Pretty & Ward, 2001).

Social capital can be achieved through bonding, bridging and linking; and influenced by depends on several factors such as easy access to market information considered in econometric modeling in this paper. Farmer organization is often seen as key factors in enhancing farmers' access to markets. Often, too little attention is directed at whether farmer organization makes less or more sense in the case of provision of market information and market access. The benefits of farmer organization are more evident in the vegetable sector, characterized by high transaction costs associated with market access. Based on these theories, the current analyses of farmer organizations as a market information system facilitates access to agriculture market information and link vegetable farmers to sustainable markets. From the theory, it is expected that farmers acting collectively will minimize different challenges incurred in vegetable production and marketing such

as the transportation cost, searching cost for market information and trader exploitation. Therefore, it implies that acting collectively helps farmers in making production decisions and enhances market access, get better prices, reduce marketing risks, and subsequently improve their income.

2.2. Research design

This study was conducted in Babati District, located in Manyara region of Tanzania. Babati District is situated in Northern Zone of Tanzania, between latitude 3° and 4° south and the longitude 35° and 36°. The district is one of five districts in Manyara Region of the country. It consists of four divisions, 21 wards, and 82 villages. The population of the district in 2012 was 405,500 (312,392 for Babati District Council and 93,108 for Babati Town Council) (URT, 2013). The district has a total land area of 4969 km² and endowed with about 180,000 ha (36%) of arable land. Different crops are grown in Babati ranging from maize, pigeon peas, cotton, wheat, Irish potatoes, vegetable and rice and fruit, and leafy vegetables.

The study employed a multi-stage sampling technique where the first stage involved purposive selection of Babati district from Manyara region due to agro-ecological conditions that favor production of a diverse number of crops including vegetables and existence of initiatives to promote vegetable production for income and nutrition. At the second stage, four villages namely: Matufa, Seloto, Bermi, and Gallapo, where the World Vegetable Center (WorldVeg), through the Africa Research in Sustainable Intensification for the Next Generation (Africa RISING)¹ project was implemented. The farmers were stratified by farmer organization membership: non-members and members of the organizations. Using a cross-sectional survey design, smallholder's vegetable farmers were randomly selected from a given source list to make a sample of 250 farm households. Data were collected using structured questionnaires. STATA version 12 was used to process the elicited data.

2.3. Estimation strategy

Conventional approaches to assess the impact of an intervention using with and without method have been hampered by a problem of missing data. Due to this, the effect of the intervention could not be accurately estimated by simply comparing the outcome of the treatment groups with the outcomes of control groups. One of the alternative techniques followed to assess the effect of discrete treatment on an outcome is the propensity score matches developed by Rosenbaum and Rubin in 1983. Thus, to estimate the effect of market access through farmer organizations on farmer's income, Propensity Score Matching (PSM) was used for this paper. PSM method improves on the ability of the regression to generate accurate causal estimates by the virtue of its non-parametric approach to the balancing of covariates between the "treatment" and "control" group (Conniffe, Gash, & O Connell, 2000).

PSM was used, employing nearest neighbor, radius, and kernel algorithms for robustness. The observations outside the common support were eliminated from the overall average treatment effect on the treated (ATT). In view of the limitation that PSM controls for selection bias only on the observable covariates, Rosenbaum tests were conducted to gauge the sensitivity of the estimated treatment effects to hidden bias (Rosenbaum, 2002).

The study's interest is the average effect of market access on the income of smallholder vegetable farmers who are in group income, or the average effect on the "treated" (ATT), which can be written as $E(Y_{i1} - Y_{i0})$, where $M_i = 1$ if i^{th} farmer has market access and 0 if otherwise. Observing the outcome for the i^{th} farmer (Y_{i1}) if it accesses market through farmer organizations, but not the outcome (Y_{i0}) if it does not. Likewise, non-members were observed only when they do not access the market. Thus, the counterfactual state is observed for neither group.

Estimated average effect of market access through farmer organizations on income was done by comparing the outcome (income) between group members and non-members, but there may be systematic differences among farmers that explain why some choose to sell in groups and others do not. Systematic difference would generate a “selection biases” in our estimates of the effects of market accessibility.

Propensity score was obtained using a logit model to predict the probability of farmers’ market access. Logit model was used to estimate propensity scores using vegetable smallholder farmers’ characteristics (Rosenbaum and Robin, 1983) and matching was then performed using propensity scores of each observable characteristics. These characteristics include covariates variables that influence the market access and income as the outcome of interest. The coefficients are used to calculate a propensity score, and group members matched with non-members.

$$P_i = \frac{e^{z_i}}{1 + e^{z_i}} \tag{1}$$

where P_i is the probability of market access for the i^{th} vegetable farmer and it ranges from 0 to 1.

Z_i is a function of N-explanatory variables which is also expressed as

$$Z_i = \beta_0 + \sum \beta_j x_{ij} + \mu_i \tag{2}$$

where $i = 1, 2, 3... n$, β_0 = intercept, β_j = regression coefficients to be estimated or probit parameter, μ_i = a disturbance term, and x_{ij} = determinants of market access. The probability that a farmer belongs to non-member group is

$$1 - P_i = \frac{1}{1 + e^{z_i}} \tag{3}$$

Therefore, the odds ratio can be written as

$$\frac{P_i}{1 - P_i} = \frac{1 + e^z}{1 + e^{-z}} = e^z \tag{4}$$

Now $\frac{P_i}{1 - P_i}$ is simply the odds ratio in favor of market access. It is the ratio of the probability that the farmer would access market to the probability that he/she would not access the market. Finally, by taking the natural log of Equation (3) the log of odds ratio can be written as

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = \ln \left(e^{\beta_0 + \sum_{j=1}^n \beta_j x_{ji}} \right) = Z_i = \beta_0 + \sum_{j=1}^n \beta_j x_{ji} \tag{5}$$

where P_i was probability of market access provided by farmer organization and it ranges from 0 to 1, Z_i was a function of n explanatory variables (X_i) which is expressed as

$$Z_i = \beta_0 + \beta_1 + X_1 + \dots + \beta_n + X_n + \mu_i \tag{5}$$

The study further estimated the effect of market access through farmer organizations on income by letting Y_{i1} and Y_{i0} be the amount of income for participants and non-participants, respectively. As such, the difference in outcome between treated and control groups can be seen from the following mathematical equation:

$$\partial = Y_{i1} - Y_{i0} \tag{6}$$

Y_{i1} = Outcome of treatment (income of i^{th} household, when he or she access market provided by farmer organizations).

Y_{i0} = Outcome of the untreated individuals (income of i^{th} household, when he or she does not access market provided by farmer organization).

Table 1. Description of variables used in the logistic regression model

Code variables	Variable description	Units of measurement	Expected sign
Dependent variable			
Market access	Market access through farmer organizations	1 = Yes, 0 = No (dummy)	±
Independent variables			
Gd	Gender of household head	1 = male, 0 = female (dummy)	±
Educ	Education level of vegetable farmers	Number of years in schooling (continuous)	+
Hhsize	Farmer's household size	Number of family members (continuous)	+
Fsize	Farm size	Farm size in acres (continuous)	+
Ext	Extension services	Number of contacts with extension	±
PriceT	Market price of Tomato	Tomato market price in USD (continuous)	+
PriceA	Market price of Amaranth	Amaranth market price in USD (continuous)	+
PriceAF	Market price of African eggplant	African eggplant market price in USD (continuous)	+
TransfreqT	Frequency of transaction for tomato	Number of times a farmer sales tomato to the market (continuous)	+
TransfreqA	Frequency of transaction for amaranth	Number of times a farmer sales amaranth to the market (continuous)	+
TransfreqAF	Frequency of transaction for african eggplant	Number of times a farmer sales african eggplant to the market (continuous)	+
Transpcost	Cost incurred when transporting the produce	Actual amount of money (USD) used during transportation (continuous)	+
Dism	Distance from farm to the nearest market	Distance from the farm to the nearest market.	+
QuantsT	Quantity of tomatoes supplied	Amount of tomatoes supplied to the market in kilograms	+
QuantsA	Quantity of amaranth supplied	Amount of amaranth supplied to the market in kilograms	+
QuantsAF	Quantity of African eggplant supplied	Amount of African eggplant supplied to the market in kilograms	+
MrktI	Access to market information	1 = Household access to market information, 0 = otherwise (dummy)	±

∂ = Change in outcome as a result of treatment

Equation (6) is then expressed in causal effect notational form, by assigning $D_i = 1$ as a treatment variable taking the value 1 if an individual received the treatment and 0 otherwise. Then, the average treatment effect of an individual i can be written as

$$ATE = E(Y_{i1} | D = 1) - E(Y_{i0} | D = 0) \tag{7}$$

where ATE , average treatment effect, is the effect of treatment on farm income. $E(Y_{i1} | D = 1)$: Average outcomes for the individual with treatment, if he or she access market through farmer organizations, ($D_i = 1$). $E(Y_{i0} | D = 0)$: average outcome of untreated individual, when he or she does not access the market through farmer organizations ($D_i = 0$). Furthermore, the ATT for the sample can be measured as

$$ATT = E(Y_{i1} - Y_{i0} | D = 1) = E(Y_{i1} | D = 1) - E(Y_{i0} | D = 1) \tag{8}$$

Since PSM controls for selection bias only on the basis of observable covariates, following Dillon (2011) and Asfaw, Kassie, Simtowe, and Lipper (2012), Rosenbaum test (Rosenbaum, 2002) was conducted to gauge the sensitivity of the estimated effect of market access to hidden bias. The goal of the sensitivity analysis is to provide a sense of how large an effect on omitted variable or variables would have to have in order to invalidate a finding. That is, sensitivity analysis provides a quantitative statement that in order to explain away a particular association, one would need a hidden or unobserved bias of a certain size (Rosenbaum, 2002).

3. Results and discussion

3.1. Descriptive statistics

The descriptive statistics for the variables used in the econometric analysis are presented in Tables 1 and 2. The results (Table 1) show that vegetable growers who belonged to a farmer organization and those who do not belong to a farmer organization were not significantly different except for the gender of the household head, average farm size owned, distance to the market, and transportation cost. More men are in vegetable growers group compared to women. Same applies to those who did not belong to a group. This indicates that vegetable production is dominated by men. The results are in line with that of Korir, Lagat, Mutai, and Ali (2015) who observed that in Kenya male-headed households participated much (63%) in French beans marketing compared to female-headed households (37%).

Table 2. Mean of the variables used in propensity score matching regression model

Characteristics	Mean			
	Group member	Non member	t-Test	p-Value
Gender	0.65	0.71	4.06**	0.03
Education	7.01	6.13	-0.65	0.52
Household size	5.33	5.57	0.73	0.47
Farm size	0.60	0.46	-2.88***	0.00
Extension contacts	84.02	79.30	1.00	0.31
Price of tomato (USD)	0.19	0.16	-0.83	0.41
Price of amaranth (USD)	0.02	0.03	0.23	0.81
Price of African eggplant (USD)	0.03	0.02	-0.64	0.51
Market information	0.75	0.73	0.27	0.79
Frequency of transaction for tomato	3.78	3.82	0.8	0.78
Frequency of transaction for amaranth	4.09	4.08	-0.01	0.99
Frequency of transaction of African eggplant	4.42	4.54	1.02	0.31
Distance	1.08	0.59	-1.84*	0.07
Transportation cost (USD)	0.22	0.68	5.66***	0.00
Quantity of tomato supplied	777.197	760	-0.07	0.94
Quantity of amaranth supplied	341.73	514.75	0.41	0.68
Quantity of African eggplant supplied	262.04	72.148	-1.77	0.08
Tomato grower	0.68	0.65	-0.44	0.15
Amaranth grower	0.56	0.52	-0.62	0.53
African eggplant grower	0.42	0.25	-2.84	0.66

Notes: *, **, *** represent significance levels at 10%, 5%, and 1%, respectively.

Vegetable production practices varied greatly among men and women due to the fact that men are responsible for providing household income. Farm size under vegetables showed vegetable growers who belonged to a group had 0.60 acres and 0.46 acres for non-member. This indicates that the vegetable farmers who belonged to a group had larger farm sizes than non-members. Non-members own larger farm size for other crops and not vegetable farming. In addition, most studies indicate that the smallness of landholding is one of the characteristics of small-scale farmers. The results show vegetable members have a significantly higher mean score on farm size than non-members ($p < 0.01$).

The cost incurred for transporting vegetables to the market and the distance was different between farmers who belonged to a group USD 0.22 and those who were not members USD 0.68. Besides, group members traveled 1.08 km longer in search of markets. These findings imply that being a member of a group helped in reducing transaction costs by reducing the cost of transport and were able to access markets much better than non-members. These findings are also in line to Korir et al. (2015) who reported that the distance to the market for farmers in groups covered an average of 0.85 km, and non-members 0.48 km in Kenya. This explains why farmers who are located further from the marketplace are more likely to be in farmers group in order to reduce challenges encountered when marketing their produce. Therefore, as the distance to the market increases, the cost of transport increases and the tendency for collective action among the farmers improves. In addition, the study done by Key, Sadoulet, and Janvry (2000) and Makhura, Kirsten, and Delgado (2001) found that distance to the market influences both the decision to participate in markets and the proportion of output sold.

3.2. Factors influencing smallholder vegetable farmers' access to markets

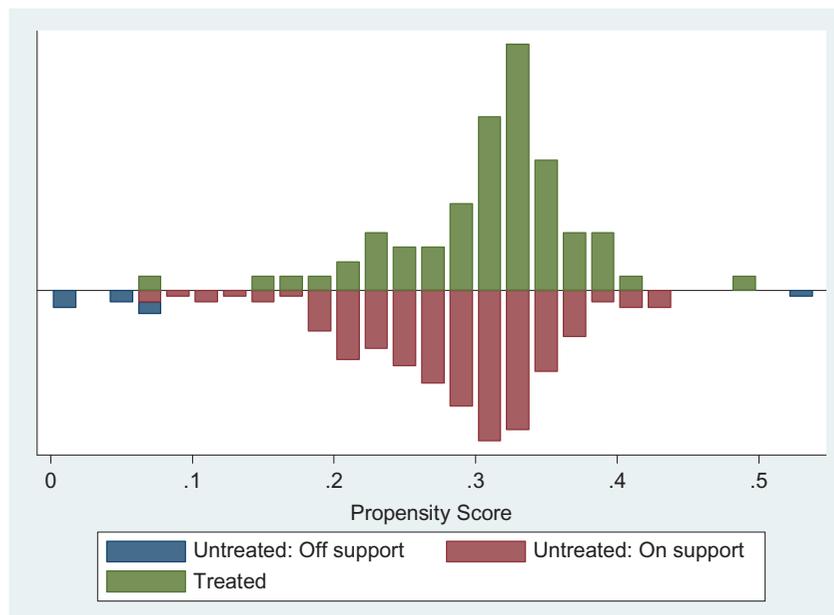
To generate the propensity scores for the matching process, the probability of vegetable smallholder farmer to access a market through farmer organization was estimated using the logit model. The results indicate that smallholder vegetable farmer market access is strongly associated with socio-economic characteristics (see Appendix A). Gender significantly affects the likelihood of market access. Male-headed households had a higher probability of market access than female, and this is mainly because for most cases it is the man in a family who make the decisions on whether to sell vegetables or not. However, when farm size increases the probability for market access also increases. Larger farm size often implies more output and this can positively affect farm income leading to higher household income (Mahmudul, Ishida, & Taniguchi, 2003; Parvin & Akteruzzaman, 2012). Vegetable farmers who have access to better market information are likely to access the market. Perhaps this might be because access to market information helps in planning the marketing process of any farm business (Magesa, Michael, & Ko, 2014). From the fact that most of the farms are distant from the place where goods and services are exchanged, it was expected that households far from the market are less likely to produce vegetables for sale and more likely to produce vegetables for their own consumption. The longer the distance to the marketplace from a farmer's premises, the more difficult and costly it will be to access the market.

3.3. Impact of market access provided by farmer organization on income

Before assessing the impact of market accessed through farmer organization, we tested the quality of matches to check for the fulfillment of common support conditions, and to ensure that the balancing requirement of PSM is satisfied. The density distribution of estimated propensity scores for the two groups of farmers is presented in Figure 1. The overlap of the distribution of the propensity scores across treatment and comparison groups found the extent of overlap to be satisfactory. The households' off-support regions were not included in the matching processes. The exemption of these households has minimal effect on the reliability of the matching results. In fact, the common support provides an adequate sample for estimating the PSM effect parameter.

Furthermore, the matching quality tests were estimated where kernel matching with a band width of 0.50 is the best estimator for the data at hand. This is because kernel matching has an advantage of a lower pseudo R^2 (0.006) and 7 sample size which is large compared to other

Figure 1. Distribution of estimated propensity scores and common support for the treated and control groups.



matching methods (see Appendix B). Moreover, other balancing of propensity score and covariate was tested based on kernel matching for all the covariates (see Appendix C). The balancing powers of the estimations are ascertained by considering different test methods such as the reduction in the mean standardized bias between the matched and unmatched farmers, equality of means using *t*-test, and chi-square test for joint significance for the variables used.

In the present matching models, the standardized difference (% bias) before matching is in the range of 0.6% and 7.3% in absolute value (see Appendix C). After matching, the remaining standardized difference for almost all covariates lie between 0.1% and 5.5%, which is below the critical level of 20% suggested by Rosenbaum and Rubin (1983). In all cases, it is evident that sample differences in the unmatched data significantly exceed those in the samples of matched cases. The process of matching thus creates a high degree of covariate balance between the treatment and control samples that are ready to use in the estimation procedure.

The effect of market accessed through farmer organization on vegetable farmers' income was estimated using average treatment effect. To compute the ATT, three alternative matching methods (nearest neighbor matching, radius matching, and kernel matching) were used (see Table 3). The focus is on the effect of farmer organization members' income. Analysis was based on implementation of common support so that the distributions of treated and non-treated units were located in the same domain. The results show that there is a significant positive treatment

Table 3. Average treatment effect for smallholder vegetable farmers' income (USD)					
Matching algorithm	Treated	Control	Difference	Standard error ^a	t-Statistic
Nearest neighbour matching (NN)	204.29	168.62	35.6679	46.1727	0.57
Radius matching	220.11	176.65	43.5580	36.6476	1.11*
Kernel matching	220.11	177.90	42.2203	36.5760	1.15*

Note: * represent significance level at 10%.

effect on the treated USD 42.22. That is, income for vegetable farmers who belonged in a group is higher than those who did not belong to a group. Farmers who had access to market through farmer organizations had more income per season (USD 220.11) than those who did not belong to a group (USD 177.90).

Therefore, market access has a positive effect on farm income of the study area. This could be due to the fact that farmers who belonged to farmer organizations received higher prices for their produce in the market. This could therefore enable farmers to produce more due to market assurance. These results are similar to Bachke (2009) who found that farmer organizations contribute significantly toward higher income. Thus, the formation of functional farmer organizations is a viable option to enhance small-scale farmers' welfare. In addition, Tolno, Kobanashi, Lehizen, Esham, and Balde (2015) report that, group membership has the potential to benefit farmers by increasing their incomes and that farmer organization provide a good platform for provision of farm production inputs and marketing of output; this can immensely enhance farm productivity and increase farmers' income.

3.3.1. Robustness checks

The estimated results were tested for robustness with respect to possible hidden bias. PSM does control for selection bias in impact/outcome assessment that is caused by observed heterogeneity between treated and control groups. Mhbounds was used to compute Mantel-Haenszel bounds to check the sensitivity of estimated average treatment effects and critical hidden bias (Appendix D). These results show positive selection bias where the market participants tend to have higher income. This bias was however not significant at different bound levels both for likely underestimation of the treatment effects and for overestimation of the treatment effects (Appendix D). This implies that the impact was insensitive to unobserved selection bias that will double or triple the odds of change in vegetable farm income. Thus, we conclude that the effect estimates (ATT) are free from endogeneity problems.

4. Conclusion and recommendations

Agricultural market access is crucial for agricultural development and has been reported by several researchers. However, market access challenges faced by smallholder farmers are a common phenomenon in Tanzania. Therefore, to link smallholder vegetable farmers to markets and to enhance smallholder livelihoods, there is a need to emphasize on the formation of farmer organizations. The study found out that farmers can easily access markets if they belong to farmer organization, although other factors such as distance to the market, farm size, gender, and market information have a great influence on farmers' market access. Vegetable farmers in farmers' organization were benefiting more in vegetable farming since they can access market hence higher farm income. Despite the fact that vegetable farmers' who belonged to a group were fewer than those who did not, results from our study indicates that vegetable farmers who belong to a group earn a better income than those who did not.

Farmer organizations can benefit farmers by increasing their incomes and providing a good platform for the provision of farm inputs and marketing of produce, which can immensely enhance farm productivity and increase farmers' incomes. Thus, to successfully increase market access and farmers' incomes through active participation in farmer organizations, there is need to enact enabling policies that will strengthen these farmer organizations' capacity in sourcing, disseminating market information and searching for produce markets. This is important because strong farmer organizations will effectively bridge farmers towards market access, thereby improving their access to high-value markets and improving their livelihoods through increased incomes and enhanced nutrition.

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Competing Interest

The authors declare no competing interests.

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Note

1. The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program consists of three agricultural research-for-development (AR4D) projects supported by the United States Agency for International Development (USAID) as part of the U.S. Government's Feed the Future (FTF) initiative. For more information, visit the program website: <http://africa-rising.net>.

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Appendices

Appendix A. Factor influencing smallholder vegetable farmers' access to markets

Variable	Marginal effect (dy/dx)	Standard error	p-Value
Gender	0.029*	0.056	0.091
Education	0.035	0.010	0.603
Household size	-0.001	0.000	0.760
Farm size	0.241***	0.097	0.012
Extension services	0.652	0.080	0.930
Price of tomato	-0.021	0.018	0.228
Price of amaranth	-1.311	0.000	0.944
Price of African eggplant	9.206	0.000	0.527
Market information	0.041*	0.000	0.082
Frequency of transaction for tomato	0.024	0.203	0.723
Frequency of transaction for amaranth	-0.011	0.012	0.381
Frequency of transaction for African eggplant	-0.05	0.078	0.488
Distance	0.078***	0.070	0.047
Transportation cost	0.116	0.058	0.267
Quantity of tomato supplied	0.049	0.063	0.438
Quantity of amaranth supplied	0.044	0.014	0.145
Quantity of african eggplant supplied	0.003	0.000	0.723
Tomato growers	0.071	0.034	0.281
Amaranth growers	0.182	-0.320	0.488
African eggplant growers	0.062	0.283	0.426

Notes: *, **, *** represent significance levels at 10%, 5%, and 1%, respectively.



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