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Impact of Combined Rural Initiatives for Participatory Agricultural Transformation and Farmer Market School Approaches on Income and Food Security

Katılımcı Tarımsal Dönüşüm ve Çiftçi Piyasası Okulu Yaklaşımlarına Yönelik Kombine Kırsal Girişimlerin Gelir ve Gıda Güvenliğine Etkisi

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ABSTRACT

Interventions to increase agricultural production have always been biased toward production without much consideration of market strategies. It is against this background, several development agents initiated a project that combines rural initiatives for participatory agricultural transformation and farmer market school approaches with the aim of transforming smallholder farmers' agricultural production and marketing, respectively. The objective of this study is to examine the impact of combined rural initiatives for participatory agricultural transformation and farmer market school approaches on income and food security. The present study applied a cross-sectional research design, and the data used were gathered from a sample of 321 farming households, selected using a multi-stage random sampling procedure. Of the 321 respondents, 93 were farmers who participated in rural initiatives for participatory agricultural transformation and farmer market school, and 100 and 128 were farmers who participated in rural initiatives for participatory agricultural transformation interventions and non-participants, respectively. Data were analyzed using descriptive statistics and propensity score matching for quantitative data, while content analysis was applied for analyzing qualitative information. The results indicate that, across farmers enrolled in rural initiatives for participatory agricultural transformation and farmer market school and rural initiatives for participatory agricultural transformation only, and non-participants, there was no significant difference in levels of income and food diversity, although there was a positive difference. The results of rural initiatives for participatory agricultural transformation and farmer market school and rural initiatives for participatory agricultural transformation-only interventions were Tanzania Shilling (TZS) 73,947 and TZS 51,796, respectively, with food diversity scores of 7.454 and 7.418. The drought faced by farmers during piloting was found to be the main challenge for the insignificance impact of the approaches. The results of our study suggest that the adoption of combined rural initiatives for participatory agricultural transformation and farmer market school in agricultural interventions is likely to improve smallholder farmers' income and food security. The two approaches should be promoted to produce additional benefits in terms of productivity and land use efficiency.

Keywords: Rural initiatives for participatory agricultural transformation, farmer market school, propensity score matching, income, food security

ÖZ

Tarımsal üretimi artırmaya yönelik müdahaleler her zaman piyasa stratejilerini fazla dikkate almadan üretime yönelik olmuştur. Bu arka plana karşı, çeşitli kalkınma kuruluşları, sırasıyla küçük çiftçilerin tarımsal üretim ve pazarlamasını dönüştürmek amacıyla katılımcı tarımsal dönüşüme yönelik kırsal girişimleri ve çiftçi pazarı okulu yaklaşımlarını birleştiren bir proje başlattı. Bu çalışmanın amacı, katılımcı tarımsal dönüşüme yönelik birleşik kırsal girişimler ile çiftçi

pazarı okulu yaklaşımlarının gelir ve gıda güvenliği üzerindeki etkisini incelemektir. Bu çalışmada kesitsel bir araştırma tasarımı uygulanmış ve kullanılan veriler, çok aşamalı rastgele örnekleme prosedürü kullanılarak seçilen 321 çiftçi hanesinden oluşan bir örneklemden toplanmıştır. 321 katılımcının 93'ü katılımcı tarımsal dönüşüm ve çiftçi pazarı okulu için kırsal girişimlere katılan çiftçilerdi ve sırasıyla 100 ve 128'i katılımcı tarımsal dönüşüm müdahaleleri için kırsal girişimlere katılan ve katılımcı olmayan çiftçilerdi. Veriler, niceliksel veriler için tanımlayıcı istatistikler ve eğilim puanı eşleştirme kullanılarak analiz edilirken, nitel bilgilerin analizinde içerik analizi uygulandı. Sonuçlar, katılımcı tarımsal dönüşüm için kırsal girişimlere çiftçi pazarı okulu ve yalnızca katılımcı tarımsal dönüşüm için kırsal girişimlere kayıtlı çiftçiler ile katılmayanlar arasında, gelir ve gıda çeşitliliği düzeylerinde anlamlı bir fark olmadığını, ancak olumlu bir fark olduğunu göstermektedir. fark. Katılımcı tarımsal dönüşüme yönelik kırsal girişimler ve çiftçi pazarı okulu ve yalnızca katılımcı tarımsal dönüşüme yönelik kırsal girişimler müdahalelerinin sonuçları sırasıyla Tanzanya Şilini (TZS) 73.947 ve TZS 51.796 oldu ve gıda çeşitliliği puanları 7.454 ve 7.418 oldu. Çiftçilerin pilot uygulama sırasında karşılaştığı kuraklığın, yaklaşımların etkisinin önemsiz olmasındaki temel zorluk olduğu görüldü. Çalışmamızın sonuçları, katılımcı tarımsal dönüşüm için birleşik kırsal girişimlerin ve tarımsal müdahalelerde çiftçi pazarı okulunun benimsenmesinin, küçük çiftçilerin gelirini ve gıda güvenliğini iyileştirebileceğini göstermektedir. Verimlilik ve arazi kullanım verimliliği açısından ek faydalar üretmek için iki yaklaşımın desteklenmesi gerekmektedir.

Anahtar Kelimeler: Katılımcı tarımsal dönüşüm için kırsal girişimler, çiftçi pazarı okulu, eğilim puanı uyumu, gelir, gıda güvenliği

Introduction

Agriculture has remained the main source of livelihoods in Africa, and is characterized by smallholder farm households. Smallholder farmers are main actors on income and food systems in developing countries (IFAD, 2022). According to NEPAD (2013), more so than in other continents, Africa is dominated by smallholder farmers, who rely mainly on family labor, characterized by less than 2 ha and accounting for 80 percent of all farms globally. The importance of agriculture cannot be over-emphasized in Africa, including Tanzania; however, its productivity is low and lags behind other developing regions (African Development Bank Group, 2016) Hence, the continent has the highest incidence of undernourishment, estimated at almost one in four persons (African Development Bank Group, 2016; Christiaensen, 2017; FAO, 2017).

Agriculture is an important sector for Tanzanian inclusive economic growth and poverty reduction. The sector employs over 65% of Tanzanian workforce and contributes 100% of food in the country to make Tanzania a food-sufficient economy. Agriculture in Tanzania contributes 27.7% of GDP and 24.1% of export earnings as well as 60% of industrial raw materials (URT, 2021). As it is in Africa, about 80% of agricultural produces in Tanzania come from smallholder farmers who depend on local and manual cultivation and rainfed, and they are prone to weather shocks (IFAD, 2022). The growth rate of agriculture for the past several years (4–5%/year) has failed to achieve the national target (6–10% /year), and poverty reduction is also lagging behind (IFAD, 2022). Failure to achieve the growth target is rooted in several challenges facing the sector which require an integrated approach to reduce them for improved production and productivity. Addressing challenges facing agriculture, adoption of farming techniques, input use and the application of available technologies, and policy actions have been instrumental for alleviating poverty in rural Africa.

There are numerous interventions that have been implemented for improving production, productivity, and hence reducing both food insecurity and income poverty. Stewart et al. (2015) pinpoint that these interventions are meant to reduce income poverty and food insecurity among smallholders. Accordingly, skills development and adoption of available technologies are main approaches to achieve the objectives of these interventions. For improving income and food security from agriculture resulting from productivity, scholars (e.g., Bravo-Ureta et al., 2012; Nakano et al., 2017; Triebs & Kumbhakar, 2013) consider managerial skills to use the best existing technologies, and marketing-oriented production as major aspects to be promoted by intervention aimed at supporting farmers.

In practice, we see more interventions that are biased to either production or marketing than those focusing on both. While such efforts are useful, it is noteworthy that some of the interventions on farming are liable to failure due to lack of business orientation among the target group. According to Ferris et al. (2014), lack of market-based agricultural production has consistently locked millions of smallholder farmers in poverty. It is against this background that Sokoine University of Agriculture (SUA), Adventist Development and Relief Agency (ADRA) Tanzania, Research, Community and Organizational Development Associates (RECODA), and ADRA Denmark initiated a project that combines rural initiatives for participatory agricultural transformation (RIPAT) and farmer market school (FMS) approaches with the aim of transforming smallholder farmers' agricultural production and marketing, respectively. The project, which is known as '*Kilimo na Masoko*-Farming for the Market, was implemented as a pilot project for 2 years (October 2020–September 2022) with the aim of assessing the complementarity and synergy of the RIPAT approach with the FMS approach (RIPAT-SUA ", 2020).

The RIPAT approach is among agricultural interventions for which donors have invested substantial amounts of resources with the aim to support the efforts to bridge agricultural technology gaps for increased productivity. On the other hand, the FMS approach focuses on enabling smallholder farmers to explore and analyze the market to better understand the dynamics that determine the market and the value chains (ADRA Denmark, 2021). While the merits of combining the production and marketing aspects are well acknowledged, there is paucity of information regarding the effect of this combination on smallholder farmers' livelihood. Therefore, the study examined the impact of the RIPAT-FMS combination on the farming households' income and food security measured in terms of food diversity.

Methods

Data Collection

Data used in this study were collected in Mvomero district and Morogoro district in Morogoro region, Tanzania. Mvomero

Table 1.
Number of Respondents by Group/Category

District	Village	Group Name	FMS and RIPAT Group Members	RIPAT Group Members	Non-Group Members
Morogoro	Mgambazi	Faraja	12	-	5
	Magadu	Maendeleo	12	-	12
	Kauzeni	Mshikamano	12	-	10
Mvomero	Tangeni	Tupendane	12	-	12
	Mkuyuni	Uchumi	12	-	12
		Tukaleghoya	13	-	
	Changarawe	Nuru	-	19	18
		Amani	-	18	
	Peko	Tukalehamwe	-	22	20
	Kipera	Mashujaa	15	-	16
	Mlali	Umoja	12	-	10
	Mnyanza	Twikindem	-	15	13
		Chikena	-	19	
Total			100	93	128

Note: FMS = farmer market school; RIPAT = rural initiatives for participatory agricultural transformation.

District is located at latitude 06°26" south and longitude 37°32" east. Morogoro Municipal is located in North-East of Morogoro Region between 6°00" and 8°00" Latitudes South of Equator, also between Longitudes 36°00" and 38°00" East of Greenwich. Accordingly, Population and Housing Census, Morogoro Municipal had 56,723 households and Mvomero 58,314 households with a total population of 286,248 and 312,109 respectively (URT, 2022). The study employed a cross-sectional research design. Data were collected using a multi-method research approach, which comprised of quantitative and qualitative research methods namely household survey, focus group discussion, in-depth interviews with farmers and key informant interviews with village leaders and extension officers as well as FMS facilitators. For the quantitative data, selection of respondents was done randomly from 8 farmer groups that participated in RIPAT and FMS interventions, 5 farmer groups that participated in RIPAT only interventions[1] and farmers who did not benefit from any of the interventions but are in the villages/streets in which the interventions were introduced. As for the qualitative data, participants were selected purposively, criteria being participation in combined RIPAT and FMS interventions, participation in RIPAT intervention only, participation as FMS trainer, and village/street leadership or extension officer position in the project area.

Both purposive and random sampling were applied to select wards, villages, and participants. Purposive sampling was applied to select wards and villages based on the criterion of being RIPAT program intervention. The second stage involved random selection of farmers to participate in the programs. A total of 193 farmers were selected from 13 farmer groups (8 under both Farming for the Market and RIPAT-SUA projects, and 5 under RIPAT-SUA project only) whereas 128 non-group members were randomly selected from the list of farmers who were not members of any farmer group (Table 1). Both categories had respondents from each project village/ward for participating in the household survey. For the groups, at least 12 farmers (about 50% of the group members) were randomly selected from each group. A questionnaire was administered to the respondents with the aim to solicit their socio-demographic information, physical characteristics of the study area, income and food security statuses, and information regarding crop and livestock production and marketing.

In-depth interviews and focus group discussions were chosen as qualitative methods. During in-depth interviews, two farmers were selected from each of the 13 farmer groups under the FMS project not on the basis of representation but rather on the assumption that all the group participants possessed the investigated characteristics. However, an attempt was made to make sure that one of the participants was male and the other was female. The aim was to examine the determinants of an effective combination of RIPAT and FMS approaches. Farmers were interviewed at their households or at convenient places where they were found. From each group, seven to eight members were purposively selected for participation in focus group discussions (FGDs). The selection process ensured the inclusion of male and female members and group leaders. Thus, a total of 13 FGDs were conducted. Among other things, the FGDs were meant to obtain farmers' views regarding the combination of RIPAT and FMS approaches in terms of factors seen as enhancing and those seen as constraining the effective integration and the modalities with which the approaches were introduced.

Construction of Important Variables

Participation in the RIPAT training, RIPAT-FMS, and/or non-participating program is a dichotomous variable taking the value 1 if the farming household participated in the project, 0 otherwise. As explained earlier, farmers were grouped into three subgroups: non-participants, farmers participating in RIPAT, and the third

[1] RIPAT-SUA project, which used the RIPAT approach, was implemented in the area with 16 initial groups between February 2018 and June 2021, whereas *Kilimo na Masoko* project, which used the FMS approach, was implemented with 8 of the RIPAT-SUA project"s initial groups from October 2020 to September 2022. Five (5) of the groups which were not involved in the *Kilimo na Masoko* project have been selected randomly and treated as RIPAT only groups (RIPAT-SUA project"s final report, 2021; *Kilimo na Masoko* project proposal, 2020).

group was farmers participating in RIPAT-FMS. To achieve analysis of the combination, first analysis involved non-participants (0) and those participated in RIPAT only (1) and then non-participants (0) and RIPAT-FMS participants (1). The non-group members served as a non-participants group—for comparison purposes as indicated in Table 1 below.

Household income is the sum of all sources of income accrued from all sources. The present paper identified about nine potential sources of income in the questionnaire: retail business, farming, livestock, remittances, and other income. Income from farming was computed using information on the price and quantity of the harvest for each agricultural produce and then was aggregated. Agricultural products include maize, vegetables, fruits, beans, peas, cassava, sweet potatoes, and bananas. On the other hand, animals included chickens, pigs, goats, and rabbits. Income was computed by multiplying the total quantity of the crops/animals sold and the respective unit price.

The present research applied dietary diversity in measuring food security. Dietary diversity scores index is developed by counting food groups consumed over a given period, usually a 24-hour period or a week (Bizimana & Richardson, 2017; Carletto et al., 2013). A questionnaire with specific questions based on identified sixteen food groups, whereby each group scores one regardless of the number of food items consumed (Kennedy et al., 2011). Literature review revealed the following dietary diversity indicators developed, namely household dietary diversity score (HDDS), the Infant and Young Child Dietary Diversity Score, the Women Dietary Diversity Score (WDDS), and the Food Variety Score (Leroy et al., 2015; FAO, 2013; Rathnayake, 2012). Household dietary diversity score is used frequently and has been proposed over the years as an alternative means of capturing food access (Bizimana & Richardson, 2017; FANTA, 2006, Leroy et al., 2015). The present paper is enlightened and hence applies the HDDS in measuring food security.

Data Analysis

The study applied Propensity Score Matching (PSM) in analyzing the impact of training initiatives on income and food security. Like any other observational studies, the present one is plagued by lack of randomization to apply Randomized Control Trials (RCT). Relating to the present study, key issues that made randomization hardly applicable include (i) RCT requires a stable process and must not be in its early stages, (ii) the enrollment demand is minimal, (iii) it requires an extensive management process, and (iv) results from RCT for this study cannot be generalized to the population (Ozminkowski, 1998; Rossi & Freeman, 1993). Based on the conditions stated, the PSM technique was found relevant for data analysis. Propensity-score matching uses the probability of being a member in the group of interest or not (e.g., participants vs. non-participants group) based on homogeneity in covariates such as demographic and socio-economic to then be used in logistic regression to create a counterfactual group (Johnson et al., 2018; Smith, 1997). Propensity score matching does not require randomization nor a baseline for impact analysis and requires a large sample to make precise outcomes (Adeyanju et al., 2019; Benedetto, 2018; Olounlade et al., 2020). The main advantage of the PSM is its reduction in dimensions, which solves the problem of an insufficient number of sample cases (Guo et al., 2020).

The average treatment effect on the treated (ATT) generated using PSM is equal to the expected difference in the outcomes between participants and non-participants after being matched based on socio economic characteristics (Frölich & Sperlich, 2019). The uniqueness of this technique over other approaches (correlated random effects—CRE), Tobit, local average treatment effect parameter (LATE) is that PSM builds with common supports. It needs good quality data, otherwise common support can be a problem if two groups are very different. Accordingly, PSM is a powerful analytical tool for adjusting confounding variables and reducing selection bias since it accounts for the outcomes of the participant and non-participant groups, which provides an unbiased estimate by non-participants of observable factors and reduces matching problems (Hotmaida & Purba, 2018; Olounlade et al., 2020). The main basis of the PSM is its common support that identifies subgroups with similar socio-economic characteristics and these groups differ because of intervention/treatment only (Hotmaida & Purba, 2018). Accordingly, the model assumes unconfoundedness; all variables that influence treatment assignment and potential outcomes to be observed by the researcher, and the second is common support or overlap implying that all covariates have a positive probability of being assigned to treatment or not (Caliendo & Kopeinig, 2005; Lin, 2015; Morgan, 2018; Smith, 2000). According to Imbens and Wooldridge (2009), propensity score sub-classification, propensity score weighting, and matching estimators are robust in most data situations. Thus, using the PSM model follows two stages. Firstly, a logit model and the second stage entails estimating the ATT.

The RIPAT participants were matched and compared with non-participants and RIPAT-FMS versus non-participants on all similar observable characteristics except the treatment (Schulte & Mascha, 2018; Taylor, 2018). The estimation of propensity scores used for the matching exercise was analyzed as follows**.**

Participation in the program (participants = 1, non-participants = 0) at first was between participants in RIPAT and non-participants and the second was between participants in RIPAT and FMS and non-participants.

$$Y = {}^{2}_{0} + {}^{2}_{1}X_1 + \varepsilon_i \quad (1)$$

such that

$$Y = {}^{2}_{0} + {}^{2}_{1}X_1 + \varepsilon_{Cov} + \varepsilon_i \quad (2)$$

The outcome model is specified in the following equation

$$Y = {}^{2}_{0} + {}^{2}_{1}X_1 + {}^{2}_{2}X_2 + {}^{2}_{3}X_3 + {}^{2}_{4}X_4 + {}^{2}_{5}X_5 + {}^{2}_{6}X_6 + {}^{2}_{7}X_7 + {}^{2}_{8}X_8 + {}^{2}_{9}X_9 + {}^{2}_{10}X_{10} + {}^{2}_{11}X_{11} + {}^{2}_{12}X_{12} + \varepsilon_i \quad (3)$$

Whereby

Y = outcome variable (Income in Tanzanian shillings)

β_0 = Regression constant

β_i = Regression coefficient

X_1 = participation in the program (participants = 1, non-participants = 0) at first was between participants in RIPAT and non-participants and the second was between participants in RIPAT and FMS and non-participants. Other variables X_2 to X_{12} are covariates that can also affect the outcome variable but are not of interest for this paper.

X_2 = marital status

X_3 = age of the respondent

X_4 = education level of the respondent

X_5 = farming experience

X_6 = land ownership

X_7 = off-firm income

X_8 = source of finance for farming

X_9 = wealth in ownership of assets

X_{10} = distance to market

X_{11} = household size

X_{12} = capital used/farming investment

ε_i = error term.

Stage two involves participants and non-participants to be matched by using propensity score values from stage one. PSM fits into the data to evaluate the effect of participating in the RIPAT-FMS program on improving income and food security. The model is explained as follows.

Let Y_i^T and Y_i^C be the outcome variable for the participants and non-participants, respectively. The difference in outcome of the two groups is expressed in Equation (4) below:

$$\Delta_I = Y_i^T - Y_i^C \quad (4)$$

Whereby,

Y_i^T outcome of participants (i.e., youth female seaweed farmers' income, when she participates in the program)

Y_i^C outcome of the non-participating seaweed farmers

Δ_I difference between the outcomes of the two groups.

whereby, the causal effect notational form of this model, assigning by (D_i =1) as the experimental variable which takes the value of 1 for participants and 0 for non-participants, then the average treatment effect of youth females, can be written as follows:

$$\text{ATE}=\text{E}(Y_i^T \mid D_i = 1) - \text{E}(Y_i^C \mid D_i = 1) \quad (5)$$

whereby,

$\text{E}(Y_i^T \mid D_i = 1)$ = average outcome for participants (D_i =1)

$\text{E}(Y_i^C \mid D_i = 0)$ Average outcome for non-participants (D_i = 0).

The ATT for the sample is as follows:

$$\text{ATT}=\text{E}(Y_i^T - Y_i^C \mid D_i = 1) - \text{E}\left(Y_i^T \mid D_i = 1\right) - \text{E}(Y_i^C \mid D_i = 1) \quad (6)$$

The equations (1)–(6) are repeated and modeled for food security to determine the impact of RIPAT and FMS on food security.

Results, Discussion, and Conclusion and Recommendations

Technology Uptake Among Farmers

In supporting farmers to increase their income and food security, the projects (RIPAT-SUA and Kilimo na Masoko), which applied RIPAT and/or RIPAT and FMS approaches, introduced/promoted about nine technologies (Table 2). These were village savings and loan associations (VSLA), agricultural produces value addition, new crops, vaccination in poultry, improved feed, improved seeds, irrigation practices, and collective marketing and soil conservation practices. While 67% of the farmers reported full participation in VSLA, 13% only had adopted value addition practices. About 19%, 20%, and 56% of farmers adopted new crops as a result of market search under FMS, vaccination of chickens based on proper dosage and directives, and use of improved feeds respectively. About 62% of the participants were found using improved seeds, 24% consistently irrigated their crops, while about 14% were conducting collective marketing in their groups. The program put emphasis on soil conservation practices to reduce land degradation and improve production and productivity. Nearly a quarter (23%) of the trained farmers applied the promoted soil conservation practices (Table 2).

Table 2.
Uptake of Technologies Promoted Through RIPAT and FMS Approaches Among Farmers

Technologies Promoted Through RIPAT and FMS Approaches	Percent
Village Savings and Loan Association (VSLA)	67
Value addition and microprocessing	13
New crops	19
Poultry vaccination	20
Use of improved feed	56
Use of improved seeds	52
Irrigation practices	24
Collective marketing	14
Soil conservation practices	23

Note: FMS = farmer market school; RIPAT = rural initiatives for participatory agricultural transformation.

Income distribution

The results (Table 3) reveal that the overall average household income pooled from all sources was TZS 993,813. Specific to non-program participants, the household incomes from all sources were found to be Tanzania Shilling (TZS) 918,171, TZS 993,813, and TZS 1,026,381 for non-participants, RIPAT-only participants, and RIPAT and FMS participants, respectively. On the other hand, maximum incomes from all sources in the program areas were TZS 3,375,000, TZS 3,682,750, and TZS 3,910,443 for non-participants, farmers participating in RIPAT only, and farmers participating in both RIPAT and FMS, respectively (Table 3).

It should be noted that income level (Table 3) did not include the value of crops and animals consumed by a household member throughout the year and some sales which were made by the

Table 3.
Income Distribution

Statistics	Non-Participants	RIPAT Participants	RIPAT and FMS Participants
Mean	918,171	993,813	1,026,381
Minimum	100,000	158,000	254,838
Maximum	3,375,000	3,682,750	3,910,443
n	129	95	99

Note: FMS = farmer market school; RIPAT = rural initiatives for participatory agricultural transformation.

Table 4.
Descriptive Statistics of Covariates

Variables	Coef.	Std. Error	*Z*	*p*>z	95%CI	
(a) RIPAT- FMS farmers and non-participants						
Sex	−0.184	0.179	−1.030	0.303	−0.534	0.166
Age	0.014	0.007	1.890	0.059	−0.001	0.028
Marital status	0.049	0.142	0.350	0.729	−0.229	0.327
Education level	0.503	0.180	2.790	0.005	0.150	0.856
Household size	0.058	0.050	1.160	0.245	−0.039	0.155
Total plot size	0.081	0.047	1.710	0.087	−0.012	0.174
Constant	−2.369	0.679	−3.490	0.000	−3.699	−1.039
(a) RIPAT-only farmers and non-participants						
Sex	−0.211	0.183	−1.150	0.248	−0.571	0.148
Age	0.016	0.007	2.170	0.030	0.002	0.031
Marital status	0.093	0.146	0.630	0.526	−0.194	0.379
Education	0.398	0.189	2.110	0.035	0.028	0.768
Household size	0.048	0.048	1.020	0.310	−0.045	0.142
Total plot size	0.076	0.045	1.690	0.091	−0.012	0.165
Constant	−2.306	0.680	−3.390	0.001	−3.639	−0.973

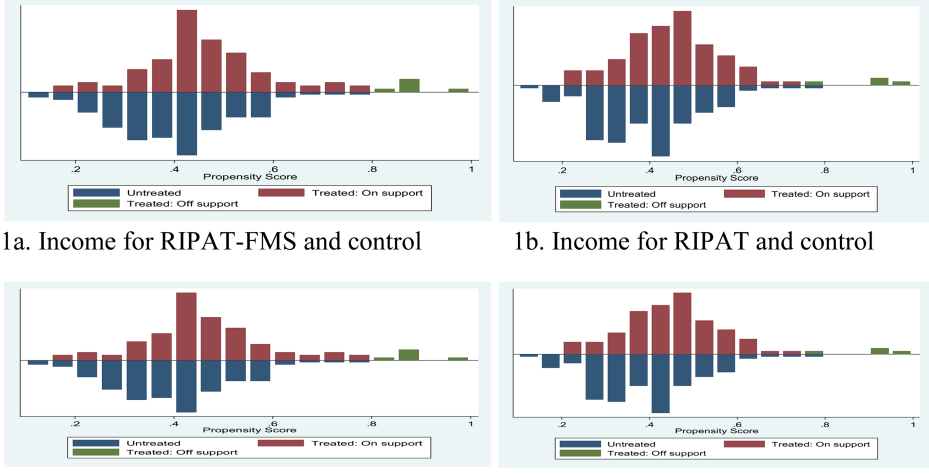
Note: RIPAT-FMS = rural initiatives for participatory agricultural transformation and farmer market school.

household purposely for buying other foodstuffs. For example, in most cases, surveyed households produced largely for consumption. During in-depth interviews with farmers and focus group discussions, it was revealed that farmers in the program areas spent about 70% of their produce for household consumption.

Propensity Score Matching Analysis Results

The nearest neighbor matching technique was applied to balance the covariates between the trainees and non-trainees. Table 4 reports the descriptive statistics of explanatory variables for: (a) farmers who participated in a project which applied both RIPAT and FMS approaches (RIPAT-FMS intervention); and (b) farmers who participated in a project which applied the RIPAT approach (RIPAT intervention), relative to non-participants. The main advantage of PSM is matching whereby group members whose characteristics cause statistical differences are dropped so that the remaining ones are those with comparable groups through common support method.

Propensity score distribution and common support (Figure 1) for propensity score estimation with a kernel matching technique: (a) income outcome variable between farmers participating in RIPAT-FMS intervention versus non-participants; (b) income outcome variable between farmers participating in RIPAT intervention versus non-participants; (c) food security outcome variable between farmers participating in RIPAT-FMS intervention versus non-participants; (d) food security outcome variable between farmers participating in RIPAT intervention versus non-participants.



1a. Income for RIPAT-FMS and control

1b. Income for RIPAT and control

1c. Food security for RIPAT -FMS and control

1d. Food security for RIPAT and control

Figure 1.
Propensity score distribution and common support for income and food security.

Table 5.
Impact of RIPAT Approach and Combined RIPAT and FMS Approaches on Household Income

Description	Treated	Non-participants	Difference	T-stat
RIPAT-FSM/non-participants				
Income unmatched	1,090,000	918,000	174,000	1.890
ATT	1,090,000	1,020,000	73,947	0.540
RIPAT/non-participants				
Income unmatched	1,070,000	918,000	152,000	1.660
ATT	1,070,000	1,020,000	51,796	0.380
RIPAT and FMS/RIPAT				
Income unmatched	1,210,000	1,090,000	122,000	1.110
ATT	1,090,000	1,060,000	33,664	0.220

Note: ATT = average treatment effect on the treated; FMS = farmer market school; RIPAT = rural initiatives for participatory agricultural transformation.

Impact of Participation in Combined Rural Initiatives for Participatory Agricultural Transformation and Farmer Market School on Income

Results in Table 5 indicate that across farmers enrolled in RIPAT, RIPAT and FMS and non-participants, there is no significant difference in levels of income between participants and non-participants, albeit there is a positive difference. Based on the matching process, the average income from all sources in the project areas is TZS 1,090,000, TZS 1,070,000, and TZS 1,020,000 for farmers participating in both RIPAT and FMS intervention, farmers participating in RIPAT intervention only, and non-participants, respectively. The results (Table 5) show that the farmers who participated in RIPAT-FMS intervention scored the ATT of TZS 73,947 relative to non-participants. On the other hand, the ATT for farmers who participated in RIPAT intervention only is TZS 51,796 relative to non-participants. In addition, a regression model based on the PSM approach was run to determine the relative impact of participating in RIPAT-FMS intervention relative to participating in RIPAT only. The results indicate an ATT of TZS 33,664. However, in both interventions, the coefficients for the income are not statistically significant at standard levels.

The results suggest that there was no statistically significant difference in income gaining between farmers who had been exposed to combined RIPAT and FMS approaches or RIPAT only and those that had not been exposed to the approaches. However, the positive income gained is an indicator that there is a positive direction with regard to the impact of the approaches toward increasing income among the farming households in the project area.

Table 6.
Consumption of Various Food Groups Among Households in Program Areas

Food Groups	Food Types Reported	Percent of Consumers (Pooled)
Cereals	Rice, maize-meals, millet, bananas, wheat products, porridge, or paste	100
White roots and tubers	Sweet potatoes, white cassava	95
Vitamin A rich vegetables and tubers	carrot,	58
Dark green leafy vegetables	Dark green leafy vegetables, including wild forms and locally available vitamin A-rich leaves such as amaranth, cassava leaves, and spinach	79
Other vegetables	Other vegetables (i.e. tomato, onion, eggplant) + other locally available vegetables	100
Vitamin A rich fruits	Ripe papaya and avocado	32
Other fruits	Other fruits: ripe bananas and watermelon	72
Organ meat	Liver, kidney, heart, or other organ meats, or blood-based foods	0
Flesh meats	Beef, pork, lamb, goat, rabbit, chicken, duck, other birds, insects	27
Eggs	Eggs from chicken, duck, guinea fowls, or any other egg	08
Fish and seafood	Fresh or dried fish or shellfish	13
Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, seeds, or foods made from these (e.g., hummus, peanut butter)	100
Milk and milk products	Milk, cheese, yogurt, or other milk products	09
Oils and fats	Oil, fats or butter added to food or used for cooking	100
Sweets	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies, and cakes	48
Spices, condiments, beverages	Spices (black pepper), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	29

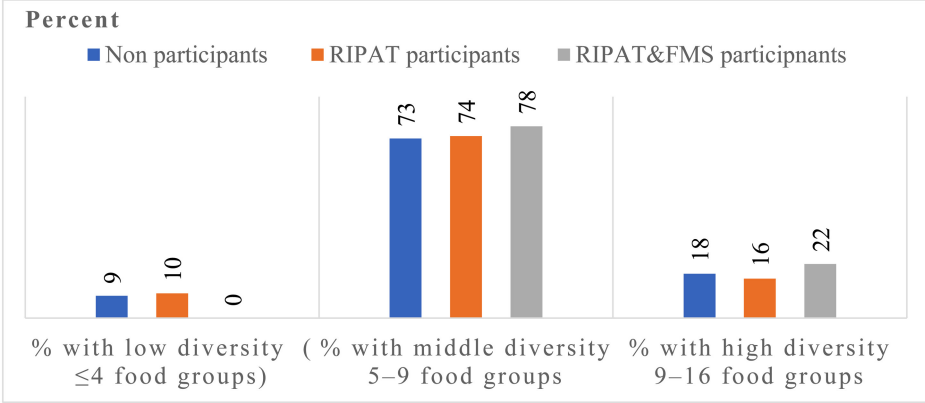


Figure 2.
Distribution of household dietary diversity score in the program area.

During the field work, it was revealed that farmers experienced drought in 2021–2022 cropping season, and hence the learned farming methods and marketing approaches would not work effectively. *"…I cannot say much because farmers are yet to practice the FMS training in full…"*—EO cum FMS facilitator. Further, it was observed that some farmers did not do well in transferring the practices and newly introduced crop varieties like bananas and maize, or livestock and poultry, namely goats, pigs, and chicken, to their own farms. They participated well at the demonstration plot and in group activities in general but did not do well in taking the practices home. Accordingly, adoption rate at farm level in Tanzania has remained low, and hence the impact of interventions is unlikely to be observed (Andrew et al., 2019).

Since it had been only about 1 year since the project applying the RIPAT approach phased out, it is logical to attribute the lack of statistical significance to it being too early to realize a significant contribution of the intervention to income. Studies conducted in areas where the RIPAT approach had been introduced 5 years past the data collection period showed no evidence of an increase in income as a result of the projects. For instance, Lilleør and Lund-Sørensen (2013) showed that there were no measurable effects of the projects on poverty, but there were indications of a shift in the sources and uses of agricultural income.

Dietary Diversity of Farming Households

Food security was measured in terms of households with low dietary diversity for recall for the past seven days. A household to be defined as food insecure had to have consumed less than 4 food groups, hereafter referred to as minimum dietary diversity (MDD) (WHO, 2008) that are required for a productive and healthy life. The sixteen food groups are recommended for healthy consumption according to food groups (FANTA, 2006; International Dietary Data, 2022). Table 6 indicates the proportion of 16 food groups households consumed in the study area. Figure 2 indicates that the majority of the farmers (73%, 74%, and 78% of non-participants, RIPAT-only participants, and RIPAT-FMS participants, respectively) scored mid-level of the food diversity.

In the context of dietary diversity, a household consumed about four groups or less is termed as the household with low dietary diversity. The study conforms to the study by Nithya and Bhavani (2018) who found that the majority of farming households with good climatic conditions had middle food diversity score. Accordingly, the results by Minja et al. (2021) found that a majority (80%) of the households in South-eastern Tanzania have medium dietary diversity, comprised of cereals, fats and oils, and proteins.

Impact of Participation in Combined Rural Initiatives for Participatory Agricultural Transformation and Farmer Market School Interventions on Food Diversity

Table 7 presents estimates of the average impact of participation in the combined RIPAT–FMS intervention and in RIPAT-only intervention. The results indicate that matched average food diversity per day in the program areas are 6.22, 7.418, and 7.454 for non-participant farming households, those involved in RIPAT-only

Table 7.
Impact of Combined RIPAT- FMS and RIPAT-Only Interventions on Food Diversity

Description	Treated	Non-participants	Difference	*T*-stat
RIPAT-FMS/non-participants				
Food diversity unmatched	7.455	6.557	0.898	0.400
ATT	7.454	6.134	1.316	0.960
RIPAT/non-participants				
Food diversity unmatched	7.495	6.899	0.596	0.249
ATT	7.418	6.220	1.198	0.640
RIPAT-FMS/RIPAT				
Food diversity unmatched	7.455	7.557	−0.102	0.259
ATT	7.454	7.134	0.320	0.960

Note: ATT = average treatment effect on the treated; FMS = farmer market school; RIPAT = rural initiatives for participatory agricultural transformation.

intervention, and farming households involved in combined RIPAT-FMS intervention, respectively. Overall, matching estimates show that both the combined RIPAT–FMS and RIPAT-only interventions have a positive but not robust effect on households' food security. The findings indicate that the combined RIPAT and FMS intervention improved households' food diversity by about 1.316 per day. This means that households that participated in combined RIPAT and FMS intervention ate one more food type compared to non-participants households. On the other hand, farming households that participated in RIPAT-only intervention had food diversity of about 1.19 more relative to non-participants households.

Comparing farming households that participated in combined RIPAT–FMS and RIPAT-only interventions, there is no sign of positive differences in food diversity score as both scored 7 out of 16 scale of food diversity score. This suggests that both programs have no causal influence on total food consumption when individuals are matched according to relevant socio-demographics, assets, and other covariates. Accordingly, in a population made up of low-income households and which is largely dependent on agriculture, if productivity is low, food intake based on both production and entitlement remains low too.

The respondents indicated that drought was the main cause of food insecurity in the households. Another possible reason for the lack of statistical significance in terms of the contribution of the interventions (combined RIPAT-FMS and RIPAT only) on food security is the fact that uptake of the introduced technologies and marketing techniques was not widespread among the participants. The low uptake of agricultural technologies has been reported by a number of scholars, including Teka and Lee (2020) and Andrew et al. (2019). Adoption of many seemingly beneficial technologies remains low (Ruzzante et al., 2021).

The results indicate that, across farmers enrolled in combined RIPAT–FMS intervention, those under RIPAT-only intervention, and non-participants, there is no statistically significant difference in levels of income and food diversity, albeit there is a positive difference which connotes a positive direction toward a significant impact. The depicted trend can be explained by the fact that an extended drought prevailed in the area during the 2021–2022 crop season. Also, adoption of the introduced agricultural technologies and marketing techniques was not widespread among the participants.

Although both single approach and combined approaches have not brought significant impact in terms of income and food security, the positive changes on the level of income and food diversity relative to non-participant farming households suggest that the introduced farming technologies and marketing techniques can cause significant impact in the long run. While this suggests the adoption of combined RIPAT and FMS in agricultural interventions aimed at improving smallholder farmers' income and food security, future efforts should have been beyond the demonstration plots/group training. This could include awareness of farmers to transfer knowledge and practices at their farms.

Study Limitations and Areas for Further Research

As this study used cross-sectional data, it is limited in terms of showing the time effect of participating in program on household income and food security. In addition, the extended drought that prevailed during the period 2021–2022 might have contributed to the impact of the interventions being insignificant. Future research is recommended for examining the impact using panel data.

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