RI

Tanzania (United Republic of)

Marketing Infrastructure, Value Addition and Rural Finance Support Programme (MIVARF)

Authors:

Sedi-Anne Boukaka, Beliyou Haile, Rawane Yasser, Carlo Azzarri, Adriana Paolantonio, and Athur Mabiso

IFAD

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Acknowledgements

List of acronyms

ADF	African Development Fund
AfDB	African Development Bank
AMSDP	Agricultural Marketing Systems Development Programme
ASDP II	Agriculture Sector Development Programme Phase II
ATET	Average Treatment Effect on the Treated
CAPI	Computer Assisted Personal Interviews
CGIAR	Consultative Group for International Agricultural Research
FAO	Food and Agriculture Organization
FIES	Food Insecurity Experience Scale
GDP	Gross Domestic Product
IA	Impact Assessment
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPW	Inverse Probability Weighting
IPWRA	Inverse Probability Weighting with Regression Adjustment
LGA	Local Government Area
MIVARF	Marketing Infrastructure, Value Addition and Rural Finance Support
MT	Mainstreaming Themes
NPS	National Panel Survey
PCA	Principal Component Analysis
PEML	Producer Empowerment and Market Linkages
PSM	Propensity score matching
RFSP	Rural Finance Services Programme
SHPG	Smallholder Producer Group
SHPO	Smallholder Producer Organizations
SO	Strategic Objectives
TOC	Theory Of Change
TZS	Tanzanian Shillings
UPS	Unequal Probability Sampling
VA	Value Addition
WEAI	Women's Empowerment in Agriculture Index
WRS	Warehouse Receipt Systems

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Executive summary

Efforts to transform the agricultural sector in Tanzania have been at the center stage of the government's strategy to achieve socioeconomic development. While there were improvements in agricultural labor productivity, technology adoption, market linkages, and overall farm income following the 2008 food crisis, they were mostly driven by the expansion of medium scale farms as opposed to small scale farmers (World Bank 2019a, Wineman et al 2020). The second phase of the Tanzania's Agriculture Sector Development Programme II (ASDP II) (2017/2018–2027/2028) is set to "transform gradually subsistence smallholders into sustainable commercial farmers by enhancing and activating sector drivers and supporting smallholder farmers to increase productivity […] and forge sustainable market linkages for competitive surplus commercialization and value chain development." (The United Republic of Tanzania 2017).

The Marketing Infrastructure, Value Addition and Rural Finance Support (MIVARF) programme funded by the International Fund for Agricultural Development (IFAD) and the African Development Bank (AfDB) supports the objectives of ASDP II through improved access to markets, agricultural income, food security, and resilience. Implemented between 2011 and 2020, MIVARF aimed at enhancing the income and food security of smallholders through increased access to financial services and markets. The programme enhanced access to a wider range of financial services to promote adoption of productivity-increasing sustainable agricultural technologies and access to output markets.

This report presents results from the Impact Assessment (IA) of MIVARF, which was conducted as part of the IFAD11 replenishment agenda, through which IFAD is analyzing the impacts of a sample of projects to generate evidence on the overall effect of its portfolio as well as on lessons learned for improving the design of future projects. The IA was implemented between September and October 2021 by the International Food Policy Research Institute (IFPRI) in collaboration with the Research and Impact Assessment (RIA) Division of IFAD. Using primary household survey data, the impacts of MIVARF interventions were estimated on program-related indicators as well as other indicators of economic mobility, productive capacity, resilience, food security, and women's empowerment. Average treatment effects were estimated by comparing average outcomes of MIVARF participants with average potential outcomes of MIVARF non-beneficiaries using statistical non-experimental matching techniques.

The evidence suggests that MIVARF achieved most of its development objectives through the successful upgrading of the agricultural value chain. It improved engagement with formal financial services and technology adoption that subsequently enhanced farmers' productive capacity. MIVARF beneficiaries were 7 percentage points more likely to engage with a formal bank to secure loans, with the value of loans secured being 45% higher than that of the control group. Loans received were used to purchase farm inputs and equipment as evidenced by 7% growth in the productive asset among beneficiaries. MIVARF also fostered adoption of improved seeds and irrigation, especially in the rice value chain, as shown by rice growing beneficiaries being 7 and 28 percentage points more likely to use improved seeds and irrigation, respectively, relative to the control group.

These improvements, accompanied by strengthened output market linkages, were associated with an increase in crop sales and market participation. Beneficiaries' crop sales were 18% higher, while the share of harvest they sold was 6.2 and 4.6 percentage points higher in quantity and value, respectively, relative to the control group. The rate of commercialization (share of value of crop sold over total value of crop harvested) among rice and maize growing beneficiaries was 42 and 50 percentage points higher, respectively, relative to that of rice and maize growing households in the control group.

Consequently, farm income, household food security, and nutrition all increased among MIVARF beneficiaries. Beneficiary gross income and dietary diversity score were 16% and 4% higher,

respectively, and food insecurity experience scale (FIES) was 11% lower than the corresponding values in the control group.

Finally, MIVARF had moderate impact on women's empowerment where improvements in joint (male and female) participation in crop activities (increased number of fields and crops under joint decision making, higher value of harvest and sales from crops controlled by both men and women, greater joint participation in decisions about earnings from crop sales) were observed. Moreover, the women's empowerment score among beneficiaries was 5% higher than in the control group. While there was no improvement in intra-household inequality due to MIVARF interventions, programme participation was associated with moderate gain in several indicators of intrinsic, instrumental, and collective agency among women beneficiaries.

1. Introduction

Agriculture is instrumental in achieving Tanzania's socioeconomic development goals. About 65% of the country's population resides in rural areas where agricultural labour accounts for a similar share of total employment[1]. While improvements in poverty reduction over the last decade has been beneficial to rural households, the divide between rural and urban living standards remains considerable with one third of the rural population living below the poverty line (World Bank 2019b). Agriculture growth is central in achieving faster poverty reduction at the national level but it is hindered by several factors including "(i) poor production techniques; (ii) underdeveloped markets, market infrastructure and farm-level value addition; (iii) poor rural infrastructure, including rural roads, telecommunications, and electricity; and (iv) inadequate agricultural finance" (The United Republic of Tanzania 2017).

The Marketing Infrastructure, Value Addition and Rural Finance Support (MIVARF) programme, developed by the central Government of Tanzania, the International Fund for Agricultural Development (IFAD), and the African Development Bank (AfDB), was designed to sustainably enhance income and food security by enhancing market linkages and facilitating access to financial services. The programme was built upon the lessons learned from the Agricultural Marketing Systems Development Programme (AMSDP) and the Rural Finance Services Programme (RFSP). It was implemented nationwide between 2011 and 2020 covering 72 Local Government Authority (LGAs)/districts across the mainland and Zanzibar.

To achieve its objectives, MIVARF invested in improving marketing infrastructure, creating value-addition, empowering producers, and building market linkages for specific value chains, while strengthening grassroots financial services to increase outreach in rural communities. The programme targeted smallholder producers and small rural-based entrepreneurs as well as grassroots finance institutions and farmers' associations involved in processing and marketing. The main objectives of MIVARF were to increase sales and profitability margins at producer group's levels through greater productivity, improve the quality of agricultural production and sales revenue, and reduce production and transaction costs as well as post-harvest losses to increase household wealth and food security among smallholders.

According to programme documents, almost 1.5 million rural households, corresponding to about 3 million individuals, were reached by MIVARF for a total cost of USD 154.5 million. The largest share of beneficiaries (88%) were individuals who have accessed financial services through the programme. The remaining part (12%) included members of Smallholder Producer Organizations (SHPOs) who benefited from investments aimed at strengthening market linkages and building their capacity. The latter interventions targeted 14 different value chains with paddy, maize, sunflower, and cassava being the main ones. MIVARF strongly encouraged women's inclusion, with women's participation in programme's activities reaching an estimated 45%.

The remainder of the report is structured as follows. Section 2 describes MIVARF (e.g., program components, target population, and theory of change) and outlines the main research questions answered by the IA. Section 3 describes the IA design, data, and identification strategy used. Section 4 describes the profile of the project area and study sample. Section 5 discusses the implications of COVID-19 for the IA and presents descriptive statistics on the effects of COVID-19 outbreak. Section 6 presents and discusses IA results on intermediate program outcomes and core economic indicators. Section 7 concludes with recommendations and lessons learned for future program design.

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[1] World Bank WDI accessed on April 2022: https://data.worldbank.org/country/tanzania

2. Theory of change and main research questions

2.1 MIVARF theory of change

MIVARF was designed to scale up some of the successful activities implemented under the Rural Financial Services programme (RFSP, 2000-2010) and the Agricultural Marketing Systems Development programme (AMSDP, 2001-2009). Specifically, it aimed to achieve a higher degree of integration of rural finance and marketing and value addition activities, recognizing the important synergies that could arise from this approach in terms of a larger and more sustainable impact on rural poverty. MIVARF's interventions were expected to help rural smallholder producers overcome some of the main financial, technological, and trading barriers they traditionally face that prevent them from obtaining profitable margins from agricultural activities. Limited access to credit and timely inputs, absence of functioning post-harvest storage facilities; difficult and costly (both in terms of time and financial resources) access to markets; and scarce and inadequate processing equipment and machineries coupled with low capacity in using available technology were some of the main production and marketing bottlenecks MIVARF intended to address.

Around the start of the programme, the agricultural sector provided jobs to 76% of adults 15 years or more (Tanzania Household Budget Survey 2011-2012) and contributed 25% of the GDP[2]. According to the same data source, the incidence of poverty, based on the basic needs' poverty line, was around 28% and even higher in rural areas (33%). Rightly so, the National Strategy for Growth and Reduction of Poverty for the Mainland and Zanzibar as well as the Development Vision 2025 for the Mainland and the Vision 2020 for Zanzibar considered agriculture as the driving force in country's efforts to promote economic growth and reduce poverty. The transition from subsistence and semi-subsistence farming to commercial farming is a critical step in achieving these goals while generating employment opportunities.

Figure 1 shows the Theory of Change (TOC) of MIVARF. The programme was structured around two main components and several sub-components that aim at closely aligning market infrastructure, value addition and rural finance interventions to achieve a broader impact on rural poverty. The first component (Component 1) is the Marketing Infrastructure and Systems Development that aims to improve marketing infrastructure, value addition, producer empowerment and market linkages. Investments under this component were expected to contribute to agricultural development by improving rural roads and other priority marketing infrastructure; by building the capacity of public, private sector and community actors for the provision and maintenance of the infrastructure; by strengthening agro-processing (such as cold storage facilities, grading and packing facilities, and agro-processing plants); by enhancing the capacity of private sector agents and producer groups to provide and operate the facilities for warehouse receipt systems (WRS); by building production and marketing decision making capacity of producers and traders; and by strengthening agricultural market information systems.

The second component (Component 2) is Rural Finance with investments under this component contributing to agricultural development by enhancing the capacity of rural microfinance institutions and community banks and linking them with the formal banking sector; increasing access to credit and matching grant for farmers, processors, cooperatives, and small and medium entrepreneurs with promising business plan but without collateral.

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[2] Source: World Bank national accounts data, and OECD National Accounts data files.

Figure 1. MIVARF's theory of change

INPUTS AND ACTIVITIES	OUTPUTS	OUTCOMES	IMPACTS
Marketing infrastructure development: • Upgrade of gravel feeder roads • Construction of markets and warehouses • Training on infrastructure maintenance **Value-addition:** • Rehabilitation of post-harvest training centers • Matching grants for buying machines • Training on machine use & crop processing **Producer empowerment & market linkages:** • Official registration of Producer Groups • Business plan development • Financial literacy • Support in building relationship with buyers **Rural finance:** • Support in strengthening rural financial institutions & services • Development of new approaches & tools	• Rural roads are upgraded and their usage is increased • Markets and warehouses are established, functioning and well-maintained • Post-harvest training centers are rehabilitated and put into use with upgraded technology • Producer Groups members are trained on technology use and processing techniques • Access to markets, processing & storage facilities is improved • Producer Groups are formally registered and have better skilled members • Formal relationships with buyers are established and maintained • Outreach of rural financial institutions is increased • Adequate financial tools are available, accessible and used by rural clients	**Household Level** • Increased productivity • Improved quality & prices • Increased market participation • Increased sales • Reduced production & transaction costs • Reduced post-harvest losses • Increased sale margins • Improved access to financial services **Producer Group Level** • Increased and more stable formal market participation • Sustained management structure • Increased involvement of women	**Household Level** • Increased income & assets ownership • Increased food security & nutrition • Increased resilience • Empowerment of women **Producer Group Level** • Ability to mobilize additional resources • Ability to expand activities & enter new contractual arrangements

ASSUMPTION

• MIVARF team is able to identify priority needs for SHPOs in terms of marketing infrastructures and value addition facilities • Technical trainings and technologies are appropriate and relevant to local conditions • There is room to improve profitability margins of SHPOs involved in supported value chains • SHPOs members are willing to use new/renewed infrastructures and facilities and receive training • Rural financial institutions are receptive and proactive • Rural communities need and are willing to take up loans for their production activities	• Marketing infrastructures and value addition facilities are accessible to all potential users • Training is sufficient to ensure good maintenance of new/renewed infrastructures and facilities and to make proper use of new technologies • Trainees and service providers are competent • Trainers improve farmer competencies • Credit is sufficient and disbursed on time	**Household Level** • Profits obtained by agricultural activity substantially contribute to the formation of household income • There is adequate supply of inputs and labor locally • There is adequate demand of agricultural products • Gender issues are successfully addressed within the household for both men and women **Producer group Level** • SHPOs ensure maintenance of value addition facilities and keep up with technological progress • SHPOs ensure continuity in the commercial agreements established • Profits obtained by SHPOs members are partially reinvested to keep upgrading the value chain • External funds can be obtained after the project • Gender issues are successfully addressed within the organization for both men and women

2.2 Project coverage and targeting

Four target groups were identified for MIVARF across the nation: (i) smallholder farmers, herders, and fishers, (ii) small rural-based entrepreneurs, traders, and artisans, (iii) primary societies/associations involved in processing and marketing for Component 1; and (iv) grassroots FIs and their clients for Component 2. The geographical targeting was nationwide for Component 1 except for sub-component 1.3 (Producer Empowerment and Market Linkages) where the programme adopted a demand-driven approach and competition for resources to ensure responding to the priorities and needs of the target population. In this approach, resource allocation to the LGAs/districts is transparent and based on meeting several pre-determined eligibility criteria thus encouraging healthy competition among the LGAs/districts for limited programme funds (MIVARF Annual Progress Report 2018-2019). The two overall eligibility criteria set by MIVARF consisted in:

- prioritizing regions, LGAs/districts, and wards with a high incidence of poverty and food insecurity; and
- the existence of smallholder farmers and small entrepreneurs willing to be supported to increase their livelihood incomes.

Additional eligibility criteria included participation of women (at least 45%), the choice of a value chain that involves a sufficiently large share of the smallholder producer population active in the area, and willingness to contribute to the cost of priority activities for the LGAs/districts.

2.3 Research questions

Based on the MIVARF TOC, the IA was designed to answer the following questions:

1. Did MIVARF contribute to improving forward and backward market linkages including access to financial services?
2. Did MIVARF improve households' productive capacity and agricultural productivity?
3. Did MIVARF improve beneficiaries' livelihoods including income, resilience, food security and overall wealth?
4. Did MIVARF help empower women?
5. To what extent were the impacts of MIVARF interventions heterogenous (e.g., value chain)?

Table 1 shows how key research questions relate to IFAD's strategic objectives (SOs), the overarching goal (OG) and mainstreaming themes (MT).

Table 1. Matrix of research questions and IFAD's goal, strategic objectives (SOs) and mainstreaming themes

Research question	OG Economic mobility	SO1 Productive capacity	SO2 Market access	SO3 Resilience	MT Gender, Youth, Nutrition, Climate
Did the MIVARF contribute to improving forward and backward market linkages including access to financial services?			x		x
Has the MIVARF improved households' productive capacity and agricultural productivity?		x			
Has the MIVARF improved beneficiaries' livelihoods including income, resilience, food security and overall wealth?	x			x	x
Has the MIVARF helped empower women?					x
To what extent were the impacts of MIVARF interventions heterogenous (e.g., value chain)?	x	x	x	x	x

3. Impact assessment design: Data and methodology

While the M&E system tracks and examines if and to what extent the programme met the output targets, it can only provide an indication of programme's contribution to fulfilling its expected outcomes. To establish attribution – i.e., if and how the outcomes of MIVARF beneficiaries have changed as a direct consequence of programme's interventions – a rigorous impact assessment is needed. To establish this cause-and-effect link and quantify the changes in outcomes attributable to MIVARF, we would need to answer the question "how would these outcomes have fared for programme's beneficiaries in the absence of the programme?". Since it is impossible to observe this situation (outcomes of MIVARF beneficiaries are observable only in the presence of MIVARF), one needs to establish a credible counterfactual scenario by identifying a group of individuals (control or comparison group) whose (observable and unobservable) characteristics are as similar as possible to programmes' beneficiaries (treatment group) except for not having received any interventions from the programme.

When beneficiaries are randomly selected within the eligible population, as in the case of Randomized Control Trials (RCTs), attribution is straightforward, and programme's impact can be measured by simply comparing the outcomes of those who randomly entered the programme to the outcomes of those who did not. However, participation to MIVARF was not random, but rather demand-driven, which poses several challenges for the evaluation due to possible bias arising from self-selection, endogenous selection, and/or programme placement.

Absent RCTs, a properly designed impact assessment that minimizes these biases is necessary to generate evidence not only on programme's impact, but also to inform similar investments that might be done in the future. In this regard, various non-experimental designs can be explored to construct a plausible counterfactual. For example, if selection determinants are known (or believed to be observable), various regression-based approaches (e.g., matching) can be employed to construct a valid comparison group and mitigate selection bias. If selection determinants are (believed to be) unobserved but are thought to be time invariant, panel data approaches (including simple difference-in-differences) can be employed.

Irrespective of the specific evaluation design, as the internal validity of the causal evidence will depend on the quality of the match between treated and control units, it is crucial to carefully select comparison groups that are statistically similar to treatment groups within specific development domains with similar potential and characteristics. The design of this impact assessment consists of different stages. The first stage entails defining the population of interest for this impact assessment from which the treatment sample will be selected (*i.e.* treatment group).

The second stage involves the identification of a valid counterfactual. This is done using geo-spatial data and other secondary data to identify untreated wards in MIVARF targeted LGAs/districts that are comparable to beneficiary ones based on several observable characteristics and for which the risk of contamination is very minimal or, possibly, null.

Once treatment and control wards are identified, the final step will consist in obtaining the complete lists of producer groups and their members in these wards from where the final sample of households will be randomly drawn. The details of the impact assessment design are described in the section below.

3.1 Data

Identification of the treatment group

The MIVARF programme was implemented nation-wide covering 29 regions in Mainland and Zanzibar. The bulk of MIVARF interventions were targeted at the construction, renovation and rehabilitation of marketing and value-addition infrastructures as well as in capacity building and support in linking smallholder producer groups (SHPGs) to input, output and financial markets. The impact assessment, therefore, focuses on activities implemented under Component 1, namely Marketing Infrastructure, Value Addition, and Producer Empowerment and Market Linkages (PEML), while the effects of rural finance interventions (Component 2) are captured to the extent that they overlap with the PEML sub-component.

Several aspects of the program design were considered in defining the treatment group, based on desk-reviews and discussions with MIVARF implementers as outlined below:

1. **Level of programme involvement**. MIVARF started operating late in certain LGAs/districts which implies that, at programme completion, the level of intervention in these areas will likely have been minimal. With the help of MIVARF staff, these LGAs/districts have been identified and excluded from this impact assessment.
2. **Risk of contamination**. Members of MIVARF supported SHPOs located in Unguja and Pemba were excluded from the universe of beneficiaries for this impact assessment. MIVARF operated extensively in the two islands supporting smallholders involved in fish, horticultural and root crops value chains. This, combined with the relatively small geographic coverage of the two islands and the peculiarity of their economy, would have made the identification of a validate control group challenging. Programme implementers also confirmed that spillover effects were

expected to be large which, if not properly known and accounted for, would produce biased impact estimates.

3. **Logistical and organizational limitations**. Given the nationwide coverage of the programme, logistical, budgetary, time, and organizational challenges were encountered. Based on these constraints, and in consultation with MIVARF staff, it was decided to exclude particularly remote areas or areas that would be difficult to access for field operations. This led to the exclusion of three regions (Kigoma, Kagera and Mara) corresponding to a total of six LGAs/districts.

The targeting approach developed by the programme led to channel investments into the upgrading of specific value chains that are particularly relevant for the local economy both in terms of number people involved and contribution to poverty reduction. The value chains supported by the programme include paddy (one third alone), maize, sunflower, cassava, cashew nuts, sesame, green grams, avocado, garlic, onion, various fruit and vegetables (apple, citrus, banana, pineapple) fish, livestock, and dairy. Looking at our redefined universe of MIVARF beneficiaries, we found a slightly lower number of value chains involved due to fish, livestock and dairy being concentrated in LGAs/districts that have been excluded from the present evaluation for the reasons explained above.

For sampling purposes, value chains with enough degree of similarity were merged by product group. A special case is that of paddy, where it was felt necessary to distinguish between two value chains characterized by very different features in terms of production inputs, costs, and output market. The first paddy value chain comprises production areas around Lake Victoria while the second covers all other paddy production zones (mainly the Southern Highlands). Figure 2 shows the distribution of the value chains by region.

Figure 2. Map of the main value chains (targeted areas)
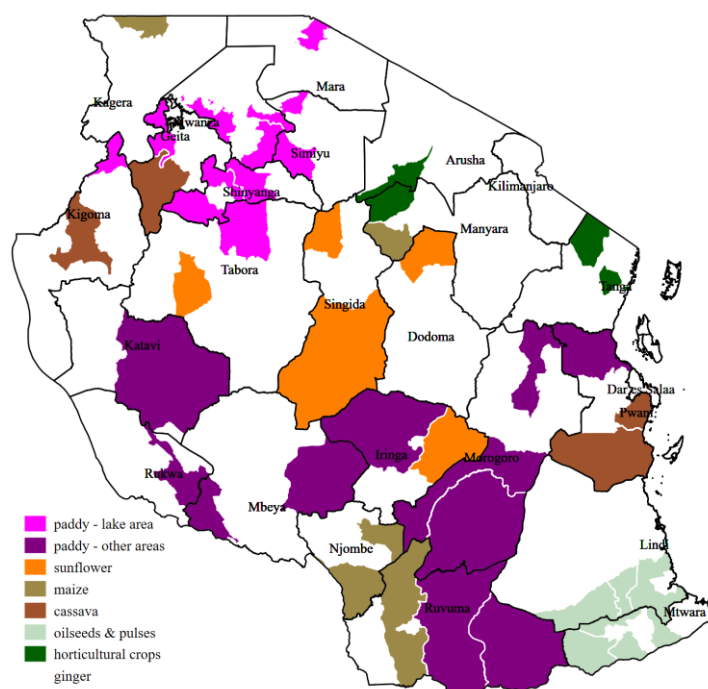
Source: own elaboration

**Identification of the control group**

Finding a valid control group to compare with MIVARF beneficiaries was particularly challenging due to both its nation-wide coverage and the adoption of a demand-driven approach regarding participation of LGAs/districts in the programme. Nonetheless, MIVARF introduced some overall eligibility criteria (see sub-section 2.2) that delimited the area of intervention for the PEML sub-component to regions and LGAs/districts with high incidence of poverty and food insecurity and sufficiently large presence of smallholder farmers (especially women) involved in value chains with potential for improvement. For this reason, using non-targeted LGAs/districts to identify potential controls was not recommended, as these LGAs/districts were likely to be associated to systematically distinct "pre-treatment" characteristics (especially regarding the value chain aspect), which would have caused pre-programme differences in the characteristics of rural population.

Based on the above considerations, the starting point of the proposed identification strategy was to look at untreated wards within MIVARF targeted LGAs/districts. This strategy was followed by statistical matching of wards to identify control wards that were comparable with MIVARF wards in terms of key socio-demographic characteristics, market access, agroecology, and suitability for selected agricultural products. Still, investments in marketing infrastructures made by the programme might have produced effects that go beyond the physical borders of a treated ward. Although programme implementers confirmed that MIVARF infrastructure catchment area was usually confined to the village or villages (in the case of rural feeder roads) where the construction was located, in order to avoid any possible risk of contamination, untreated wards bordering any treated ward were excluded from the group of eligible controls within the LGA/district.

In order to mimic the targeting scheme of MIVARF, once the sub-set of comparison wards was determined, an intermediate step of the identification process consisted in looking at producer groups involved in MIVARF-promoted value chains within these wards. The final selection of control units then happened among members of these groups. Figure 3 shows the final distribution of treated and control wards.

Figure 3. Map of the distribution of sampled wards by treatment status
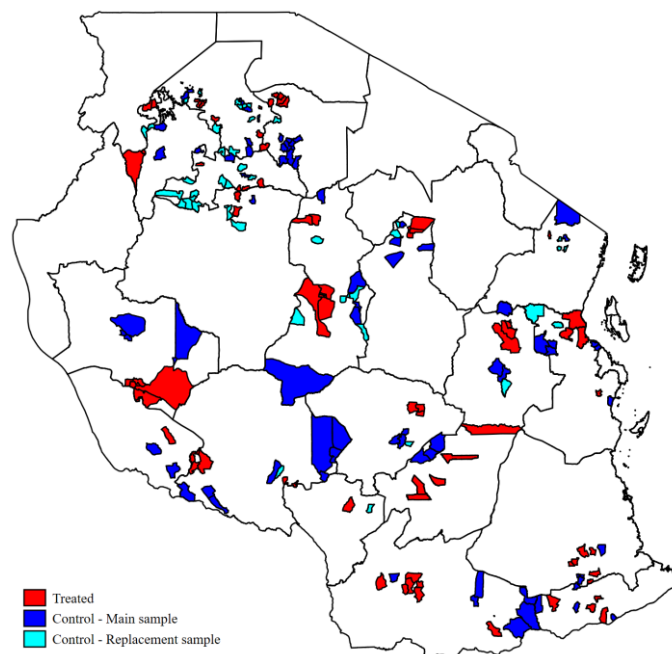
Source: own elaboration

Sample size and sampling strategy

Choosing the right sample size is critical for a successful impact assessment. The unit of analysis for this impact assessment sample is households in treatment and control communities. To determine the optimal number of households (N) to be surveyed, we use statistical power calculations based on the following formula (Winters et al., 2010):

$$N = \left[\frac{4\sigma^2(z_\alpha + z_\beta)^2}{D^2}\right] * [1 + \rho(m-1)]$$

Where D is the minimum expected change in the baseline mean of the outcome variable that the study can detect, σ is the standard deviation of the outcome variable, $z\alpha$ is the critical value of the confidence interval (two tail test=1.96), and $z\beta$ is the critical value of the statistical power (two tail test=1.28). The second part of the formula allows to correct the estimated sample size for intra-class correlation, that is the fact that observables characteristics and associated outcomes of units within the same cluster are potentially correlated independent of the program. Here, ρ is the intra-class correlation of the unit of analysis, and m is the number of units to be sampled in each cluster. In the case of the MIVARF clusters are represented by cooperatives.

The main parameters for the power calculation were estimated using data from the third wave of the Tanzania National Panel Survey (NPS), a nationally representative household survey implemented during the period October 2012 - November 2013 (United Republic of Tanzania, 2014). The sample was restricted to households distributed across districts targeted by MIVARF. Based on data availability and in line with MIVARF logical framework [3], outcome variables were constructed to provide alternatives for income[4] and wealth measures. The results of the power calculation are presented in appendix 1 (Table A 1). Overall, the total number of households to be surveyed equaled approximately **1,800** and the sampling strategy ensured that sampled households were distributed across the 20 regions of mainland Tanzania. The treated sample was obtained by randomly selecting 140 treated communities using unequal probability sampling (UPS), where communities in districts with higher proportion of MIVARF beneficiaries had a higher probability of being sampled. On the other hand, the control sample was randomly drawn from the list of matched control communities in a similar proportion as the treatment sample in the respective region. Since completed and updated lists of households were not available for control communities, a household listing exercise was carried out in sampled control communities. Survey data was collected from 1,828 households (968 treated and 860 control) using a structured questionnaire discussed in Section 3.2 below. Table 2 shows the distribution of households across regions by treatment status.

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[3] The logical framework of the programme has increase in resilience and household income as main programme goals and objectives.

[4] To perform power calculation nominal household consumption expenditure is used instead of household income because the former is considered a more stable measure and a better indicator of permanent income (Hazell & Röell 1983). However, in the sample size calculation for this IA we used household income consistently to the programme's theory of change.

Table 2. MIVARF survey sample distribution (by region and treatment status)

	Treated		Control		Total	
	# obs	%	# obs	%	# obs	%
Dodoma	18	*2*	23	*3*	41	*2*
Geita	13	*1*	0	*0*	13	*1*
Iringa	29	*3*	6	*1*	35	*2*
Katavi	41	*4*	0	*0*	41	*2*
Lindi	224	*23*	198	*23*	422	*23*
Mbeya	62	*6*	102	*12*	164	*9*
Morogoro	56	*6*	5	*1*	61	*3*
Mtwara	15	*2*	8	*1*	23	*1*
Mwanza	21	*2*	107	*12*	128	*7*
Njombe	277	*29*	209	*24*	486	*27*
Rukwa	9	*1*	12	*1*	21	*1*
Ruvuma	35	*4*	104	*12*	139	*8*
Shinyanga	14	*1*	46	*5*	60	*3*
Simiyu	74	*8*	6	*1*	80	*4*
Singida	30	*3*	21	*2*	51	*3*
Songwe	24	*2*	0	*0*	24	*1*
Tabora	6	*1*	13	*2*	19	*1*
Tanga	20	*2*	0	*0*	20	*1*
Total	**968**	*100*	**860**	*100*	**1,828**	*100*

3.2   Questionnaire and impact indicators

The main data collection instruments adapted from the RIA template were administered at the household and community levels. Data were collected using Computer Assisted Personal Interviews (CAPI) through Survey Solutions software. The duration of each household survey was 3.1 hours on average. The community questionnaire, administered to key community informants, aimed at collecting information on access to infrastructure and basic services, economic activities, and social capital.

The main respondent to the household survey was the household member who was more familiar with the topic discussed. In accordance with IFAD11 reporting requirements, the assessment of the MIVARF provided data on IFAD overarching goal (OG) and strategic objectives (SOs), namely: economic mobility, productive capacity (SO1), market participation (SO2), and resilience (SO3). In addition, data collected allowed to report on cross-cutting themes (CT) such as food security and nutrition, the status of individuals with disabilities, youth, and gender. In reference to the latter, the survey had a particular focus on women's empowerment, measured using an integrated version of the project-level Women's Empowerment in Agriculture Index (pro-WEAI) (Malapit et al., 2019). The index was calculated based on 12 equally weighted indicators mapped to three domains: intrinsic agency (power within), instrumental agency (power to), and collective agency (power with).

The integrated-WEAI (i-WEAI) is a first attempt to integrate the 12 pro-WEAI indicators into standard muti-topic household surveys for project evaluation. The aim is to reduce the interview time of the

traditional pro-WEAI approach, while keeping consistency in its 3 domains and 12 indicators. This is done by including as many indicators as possible in the "standard" sections of the household-level instrument leaving out only few original questions asked in add-on modules. The i-WEAI developed for the present impact assessment was also piloting two new modules designed to measure i) collective agency and ii) time-use agency. The pro-WEAI modules were administered to the main adult male and female in the household. Ideally the administration of these modules happened concurrently with a female enumerator interviewing the female respondent and a male enumerator interviewing the male respondent. Whenever this approach could not be adopted (due to logistical or organizational constraints for instance) the same enumerator interviewed consecutively and separately the male and female respondent.

Survey households geo-referenced which allowed the linking of survey data with key geospatial data (*e.g.*, biophysical characteristics of household location, weather and climate conditions, proximity to physical infrastructure and services, etc.) to better assessing possible spatial heterogeneity in the effects of the MIVARF. Following the program Theory of Change presented in Figure 1, additional indicators were also constructed on market linkages, access to and utilization of credit as well as on other dimensions that were important in understanding the specific mechanisms through which the program achieved (or not) its intended impacts. Table 3 presents the list of proposed impact indicators while

Table 4 illustrates the specific components of the i-WEAI.

Table 3. Key indicators of impact

IFAD Reporting	Theme	Indicator
OG	Economic mobility	• **Asset index** and **changes** over time: durables, productive, housing, land, livestock, overall • **Household income**: gross, shares
SO1	Productive capacity	• **Productivity** of agricultural activities • **Value of agricultural production** • **Adoption of production practices/technologies**
SO2	Market participation	• **Value of production sold** • **Market participation** and **marketing** channels
SO3	Resilience	• **Ability to recover** from shocks • **Resilience index** • **Income diversification**
MT	Food security and Nutrition	• **Household Dietary Diversity Score** • **Food Consumption Score**
	Gender	• **Pro-WEAI** Indicators • **Female participation** in decisions in productive activities and **ownership** of production.

Table 4. i-WEAI indicators

Domain	Indicator
Intrinsic agency (from pro-WEAI)	- Autonomy in income - Self-efficacy - Attitudes about domestic violence - Respect among household members
Instrumental agency (from pro-WEAI)	- Input in productive decisions* - Ownership of land and other assets* - Access to and decisions on credit* - Control over use of income* - Work balance - Visiting important locations
Collective agency (from pro-WEAI)	- Group membership* - Membership in influential groups*
Pilot indicators	- Time use agency - Collective agency, as derived from social networks

Source: Adapted from Malapit et al. 2019.
* Denotes indicators that have been adapted from their original form in pro-WEAI.

3.3 Impact estimation

The methodology of this IA can be formalized within the potential outcome framework for a binary treatment case (Rubin, 1974). Let h be an index for household ($\forall\ h = 1, 2, ..., N$); T_h is an indicator such that $T_h = 1$ if h is a beneficiary and $T_h = 0$ otherwise (as defined above); and y_h^1 and y_h^0 represent the outcomes when $T_h = 1$ and $T_h = 0$, respectively. Unit $h's$ observed outcome (y_h) is given by $y_h^0 + \Delta_h T_h$, with $\Delta_h = y_h^1 - y_h^0$ measuring treatment effect on h. Since we only observe either y_h^1 or y_h^0 and not both ($\forall\ h$), we cannot observe Δ_h. The main parameter of interest is the average treatment effect on the treated (ATET) given by $(y_h^1 - y_h^0 | T_h = 1, \boldsymbol{X})$, where E is the expectation operator. While the expected value of an indicator for the treated group, i.e. $E(y^1 | T = 1, \boldsymbol{X})$, can be identified from data from the treated group, assumptions are needed to identify the counterfactual mean, i.e. $E(y^1 | T = 0, \boldsymbol{X})$.

One assumption needed to identify ATET is conditional mean independence of y^0 (Heckman et al., 1998), while a stronger assumption is needed to identify the average treatment effect (i.e. conditional mean independence of both y^0 and y^1). Instead of conditioning treatment selection based on a high-dimensional $\boldsymbol{X}$, Rosenbaum & Rubin (1983) suggest conditioning on the conditional treatment probability given $\boldsymbol{X}$ known as the propensity score: $Pr(T = 1 | \boldsymbol{X} = x)$. The second assumption needed to identify ATET is the existence of control units for each value of x ($x \in \boldsymbol{X}$) or the propensity score (Heckman et al., 1997, 1998; Smith & Todd, 2005), while a stronger assumption is needed to identify the average treatment effect for the whole population (i.e. the need for both treated and control units for each value of x ($x \in \boldsymbol{X}$) or value of the propensity score).

The preferred identification strategy for this IA is the inverse probability weighting with regression adjustment (IPWRA) (Cattaneo, 2010). This estimator allows us to address the endogeneity associated with self-selection into treatment by modelling both treatment selection and outcome variables, which is particularly relevant in the context of non-random treatment assignments as in the case with MIVARF. Let the matrix X represent a vector of observed covariates that may affect MIVARF participation decision and/or subsequent outcomes but are unaffected by MIVARF participation. Our corrections to observable differences are based on Equations 1 and 2 that we estimate using probit (for selection into MIVARF) and ordinary least squares (for outcomes) regressions, respectively.

$$\Pr(T_h = 1) \ = g(X_h; \boldsymbol{\theta}) + \ \varphi_h \qquad (1)$$

$$y_h = f(Z_h; \boldsymbol{\beta}) + \ \varepsilon_h \qquad (2)$$

where $g(\cdot)$ and $f(\cdot)$ are assumed functional forms; Z is a vector of covariates affecting y (and whose elements may overlap with those of X); $\boldsymbol{\beta}$ and $\boldsymbol{\theta}$ are vectors of unknown parameters; φ is selection model error term assumed to have a normal distribution; ε is outcome model error assumed to be independent and identically distributed (i.i.d.) with zero conditional means. Given that survey data were collected at the end of the program, Equation 1 controls for retrospective variables about baseline status or variables captured during the survey but are unlikely to have been affected by the program (see list of variables below). Propensity score matching (PSM) of MIVARF households with households in control group is performed using kernel methods (Epanechnikov kernel and a bandwidth of 0.06).

IPWRA estimator is said to be "doubly robust" meaning that only one of the two models (treatment or outcome) must be correctly specified to consistently estimate treatment effects (Bang & Robins, 2005). IPWRA is consistent if either $f(\cdot)$ or $g(\cdot)$ is correct and is more efficient, especially relative to weighting adjustment, if $f(\cdot)$ is correct (Cattaneo, 2010; Zhao, 2004). On the other hand, IPWRA does not necessarily produce better results if both $f(\cdot)$ and $g(\cdot)$ are misspecified (Kang & Schafer, 2007; Tan, 2010). To verify the robustness of the results, impact estimates from two additional approaches are also computed[5:] propensity score matching based on kernel method (KMATCH), and inverse probability weighting (IPW). While the conditional mean independence is inherently untestable, we assess match quality by examining the balance of covariate distribution between groups using different statistics, which are presented and discussed in Section 6.

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[5] These estimates are not presented in the official appendix, but are available upon request from the authors.

4. Profile of the project area and sample

MIVARF was designed to support Tanzania's effort to develop its small-scale sector by tackling obstacles that hamper production and creation of value addition to thereby contributing to poverty reduction and food security. Given that respondents were randomly sampled, descriptive statistics presented in this section should be representative of the universe of beneficiaries and control households. Table 5 summarizes key socio-demographics characteristics of study households by treatment status. On average, the two groups present a lot of similarities. They are composed of around 5 members, led by a head in its early 50s and have at least one disabled dependent in around 30% of cases. Adult members have completed around 8 years of education (primary school) and present the same level of literacy, with 12% of the household heads speaking English in both groups. Vulnerable groups (youth and female headed households) are also represented in a comparable proportion in both groups. The same similarities are observed when looking at variables related to standards of living (durable asset index, housing and natural capital), shock exposure and financial inclusion as measured by the number of households with a bank account.

Table 5. Socio-demographic characteristics of sampled households

	Nb of obs	Treated (T) Mean	Control (C) Mean	Diff (T-C)	p-value
Household size	1,828	5.3	5.2	0.08	0.55
Age of Household head	1,828	53.4	52.6	0.79	0.21
% of Youth headed households (age of head < 35)	1,828	7.0	8.6	-1.58	0.21
% of Female headed households	1,828	20.8	22.7	-1.91	0.32
Average years of education of adult hh members (15+)	1,674	7.7	7.9	-0.16	0.19
Language: HH head speaks English	1,828	12.0	12.2	-0.23	0.88
At least one member of HH with disability	1,828	31.7	29.7	2.06	0.34
Durable asset index (PCA)	1,828	0.2	0.2	0	0.84
HH has flush toilet	1,828	35.4	34.8	0.67	0.77
HH has electricity	1,828	85.5	82.8	2.75	0.11
HH has water piped into the dwelling	1,828	3.1	4.4	-1.32	0.14
Sum of area of parcels owned in HA	1,687	3.0	2.7	0.23	0.07
Number of parcels per HH	1,691	4.3	4.1	0.19	0.05
HH exp. climate related shocks during the reference period	1,665	38.6	35.3	3.26	0.17
HH exp. non climate related shocks during the reference period	1,665	59.3	60.6	-1.34	0.58
HH has a bank account	1,828	74.0	70.9	3.04	0.15

Source: authors' calculations based on IA household survey data.
Note: HH: household; HA: hectare; PCA: principal component analysis.

Regarding income composition, household livelihoods are based on multiple activities with an important contribution of agriculture and family businesses (Figure 4). Once again, a similar pattern is observed for both treated and control groups where crop and livestock activities account for three fifth of annual gross income while around 23% of income is derived from self-employment in the service

sector. The remaining part of household livelihood comes from wage employment, transfers and other income that make up for 17% (treated) to 20% (control) of the total annual gross income. Overall, in both groups, households draw their subsistence from 3.5 different income sources and have a 0.41 Gini Simpson income diversification index computed using gross income shares. Figure 5 considers income levels conditional on participating in the respective activities and indicates that the average gross income of MIVARF beneficiaries appear substantially higher for the most profitable income generating activities (+15% for crop income and +9% for self-employment).

Figure 4. Gross income shares by treatment status
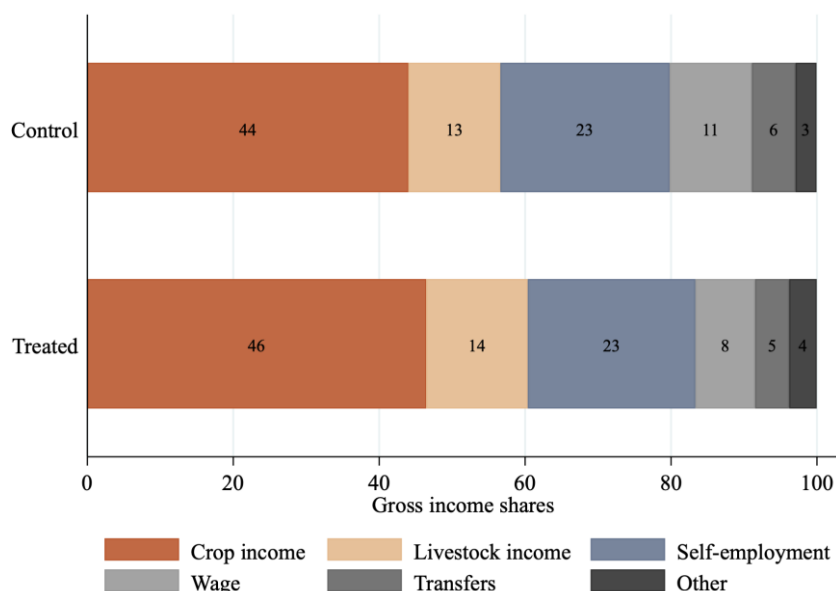
Source: authors' calculations based on IA household survey data

Figure 5. Average annual gross household income, treated vs control
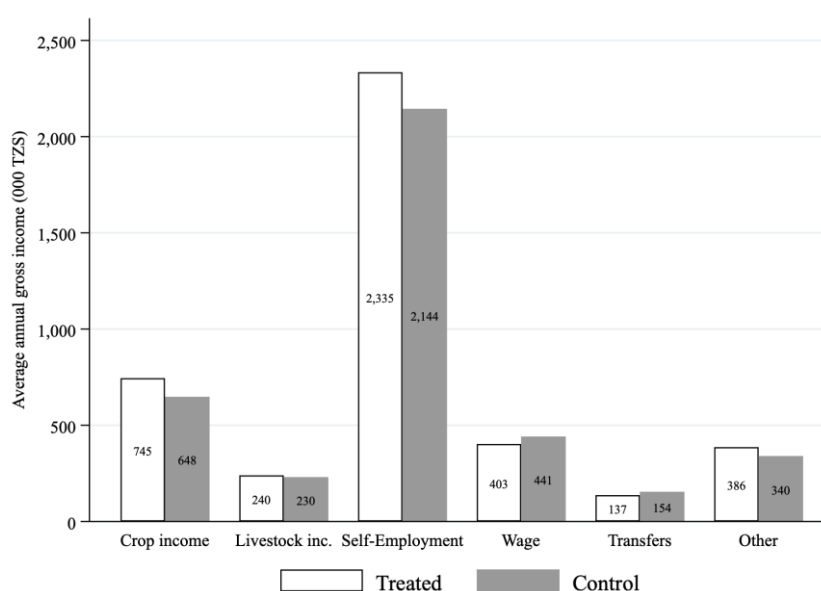
Source: authors' calculations based on IA household survey data

Table 6 gives further insights on households' involvement in agricultural activities. First, harvest decisions are consistent with the choice of the main value chains and show many similarities between treated and control. Maize, which accounts for 46% (treated) to 51% (control) of total harvest unsurprisingly represents the lion's share of crop production given its importance as a staple food in the country. Indeed, in Tanzania, "most maize is produced by small-scale farmers and is grown both for subsistence and as a cash crop but between 65 and 80% of all maize is consumed within the producing household" (Wilson et al 2015). This is consistently reflected by the lower level of maize market participation in survey data. However, higher rates of market participation are observed for MIVARF beneficiaries for almost all crops and especially maize and rice. The latter represents the second main crop harvested by both groups which comes as no surprise considering the importance and rapid expansion of rice production in Tanzania. Indeed, when comparing the 2019/20 to 2007/08 Tanzanian agricultural census, Zhang et al. (2021) find that "paddy production had increased by more than 100%", which explains the greater emphasis placed on maize and rice in the result section 6.

Table 6. Crop production and market participation by treatment status

	Nb of obs	Treated (T) Mean	Control (C) Mean	Diff (T-C)	p-value
Harvest - Share in total harvest (Quantity)					
Maize	1,691	45.9	50.7	-4.85	0.00
Rice	1,691	18.6	17.7	0.92	0.56
Cashew	1,691	5.7	5.5	0.22	0.79
Bean	1,691	6.2	5.2	1.05	0.25
Pigeonpea	1,691	3.2	4.2	-0.92	0.06
Groundnut	1,691	1.9	2.6	-0.75	0.09
Sesame	1,691	3.4	1.3	2.11	0.00
Sunflower	1,691	2.2	1.5	0.69	0.11
Market participation *=1 if HH produces and sells* *=0 if HH produces and does not sell*					
Maize	1,416	26.0	18.5	7.44	0.00
Rice	499	68.4	64.2	4.16	0.33
Cashew	223	98.5	98.9	-0.46	0.77
Bean	327	62.7	59.0	3.7	0.50
Pigeonpea	313	74.8	75.3	-0.47	0.92
Groundnut	201	56.0	52.1	3.82	0.59
Sesame	228	93.9	81.0	12.99	0.00
Sunflower	152	54.4	58.3	-3.99	0.63

Source: authors' calculations based on IA household survey data.
Note: HH: household.

5. COVID-19 Outbreak

Tanzania COVID-19 containment measures in the first year of the pandemic were noticeably less severe than other countries in the region, mainly consisting of school closures, public gathering restrictions, and quickly lifted travel limitations. This unconventional response at times branded as a "business as usual" approach was gradually revised by the new governing authorities in mid-2021 after an expert committee's evaluation of the country's COVID-19 situation (World Bank 2021). As the country's reporting on COVID-19 statistics has been largely inconsistent with no data published for over a year until June 2021, the impact of the pandemic on the country's economy and in particular the agricultural sector, that was already facing the dire consequences of a locust infestation, has been moderately documented. However, as in many other countries, Tanzania's agricultural trade flows were expectedly negatively affected by the pandemic. As of 2020, "growth slowdown in Tanzania's main trade partners has reduced demand and prices for its agricultural commodities" (World Bank 2020). Moreover, focusing on the bean value chain, Nchanji et al. (2021) identify access to rural finance, farm inputs, and labor as the main COVID-19 related challenges for smallholder farmers surveyed in Eastern Africa, leading to higher vulnerability. However, drawing on a series of household and community interviews in Tanzania and South Africa, Tripathi et al (2021) indicates that despite the toll on household income and food security, smallholder farmers with mixed farming systems including both cash and subsistence crops were the less impacted by the pandemic.

The quantitative survey included a set of COVID-19-related questions to appraise the differential impact of the COVID-19 on treated and control. Table 7 summarizes relevant data by treatment status. Overall, the descriptive statistics imply that households were affected by the consequences of the pandemic to a similar extent. Between 7% (treated) to 8% (control) of the families experienced food shortage due to the pandemic. Likewise, 16% of MIVARF beneficiaries and control households alike indicated experiencing both demand and supply shocks in direct relation with the COVID-19 outbreak. Shocks faced included low prices or demand for agricultural outputs paired with the high prices of inputs, potentially implying a critical reduction in farm income of households. While coping mechanisms slightly differ between MIVARF beneficiaries and non-beneficiaries, in most cases, families were not able to adopt corrective measures (they did nothing) or had to reduce food and/or non-food consumption due to COVID-19 negative externalities. A large majority of the households were yet to receive public or private assistance in response to the pandemic, as less than 2% of the respondents indicated benefitting from COVID-19 related transfers. Nonetheless, MIVARF beneficiaries reported a 2% increase in subjective well-being following the outbreak. while non-beneficiaries reported a reduction of well-being by the same magnitude.

Table 7. COVID-19 Outbreak: pre-matching descriptive statistics, Treated vs Control

	Treated (T)		Control (C)		Diff. (T-C)	p-value
	Nobs	mean	Nobs	mean		
Food Insecurity related to COVID-19						
HH experienced food shortage due to the COVID-19 outbreak	968	6.92	860	7.91	-0.99	0.42
Shocks due to COVID-19 outbreak						
HH exp. shocks due to COVID 19 outbreak	968	16.01	860	16.28	-0.27	0.88
COVID related shocks (top 5)						
Low prices/demand for agricultural outputs	968	10.85	860	8.72	2.13	0.13
High prices of agricultural inputs	968	5.68	860	6.40	-0.71	0.52
High prices of major food items	968	3.10	860	2.91	0.19	0.81
High prices of non-agricultural inputs	968	0.93	860	0.81	0.12	0.79
Low prices/demand for non-agricultural outputs	968	0.41	860	0.58	-0.17	0.61
Coping mechanisms (top 5)						
Did nothing	155	37.42	140	41.43	-4.01	0.48
Engaged in additional income gen. activities	155	27.10	140	20.00	7.10	0.15
Reduced food consumption	155	21.29	140	11.43	9.86	0.02**
Relied on savings	155	20.65	140	15.00	5.65	0.21
Reduced non-food consumption	155	12.90	140	5.00	7.90	0.02**
Shock exposure and recovery						
Avg recovery from shocks experienced due to COVID 19 outbreak	154	4.32	135	4.23	0.09	0.37
Avg exposure to shocks due to COVID 19 outbreak (Nb shocks x severity)	155	1.19	140	1.37	-0.18	0.01***
Transfers related to COVID-19						
% of HH with income from COVID related transfers	968	1.65	860	1.05	0.61	0.27
Subjective well-being before/after COVID-19 outbreak						
Step of the ladder on which HH stood just prior to the COVID-19 outbreak	960	4.69	853	4.55	0.14	0.13
Step of the ladder on which HH stands at present after the COVID-19 outbreak	960	4.79	853	4.45	0.33	0.00***
Subjective well-being before/after COVID-19 outbreak: difference	960	0.09	853	-0.10	0.19	0.01**

Note: Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; HH: household;

6. Results

This section presents ATET estimates for key project outcomes and impact indicators. To better contextualize impact estimates, we first consider the potential outcome mean, which represents the base case scenario of what would have happened to MIVARF beneficiaries without the programme. We then focus on the ATET estimates from IPWRA that show the difference between averages for the beneficiary and control groups. As described earlier, outcome and impact indicators are assessed using a matching procedure to ensure comparable baseline and exogenous observed characteristics. The covariates utilized to control for confounding conditions that could influence MIVARF's impact are identified in Table 8 below.

Table 8. Comparison of Covariates, Pre- and Post-Matching

| | Raw | | | Matched T vs C (ATT) | | |
	Treated	Control	StdDif	Treated	Control	StdDif
Household Demographics						
Size of HH	5.33	5.25	0.03	5.33	5.18	0.05
Nb of male HH members of labour age (15-60)	1.37	1.29	0.06	1.37	1.34	0.02
Nb of female HH members of labour age (15-60)	1.44	1.41	0.03	1.44	1.4	0.04
Ratio of children to adults in the HH	0.7	0.71	0	0.7	0.67	0.05
Female headed HH	0.21	0.23	-0.04	0.21	0.21	0
Age of HH head	53.34	52.69	0.05	53.34	53.59	-0.02
Years of education of household-head	7.11	7.12	-0.01	7.11	7.05	0.02
Religion of HH head: Christianity	0.68	0.67	0.03	0.68	0.68	0.01
HH head speaks official language (English)	0.12	0.12	0	0.12	0.11	0.03
Baseline Assets						
Livestock asset index owned at baseline: PCA	0.18	0.15	0.2	0.18	0.18	0.02
Livestock diversification index at baseline: Gini Simpson index	0.32	0.3	0.07	0.32	0.32	0.01
Productive asset index owned at baseline: PCA	0.14	0.12	0.16	0.14	0.14	0.05
Durable asset index at baseline (without land): PCA	0.14	0.13	0.03	0.14	0.13	0.04
Sum of area of parcels owned at baseline (HA)	2.71	2.48	0.09	2.71	2.74	-0.01
Services at baseline						
Average time (minutes) from the homestead to the main source of drinking water at baseline	20.63	23.92	-0.16	20.63	21.03	-0.02
Distance (km) from the community to the nearest motorable road	2.88	2.46	0.2	2.88	2.54	0.15

	Raw			Matched T vs C (ATT)		
	Treated	**Control**	**StdDif**	**Treated**	**Control**	**StdDif**
Distance (km) from the community to the nearest Basic school	1.78	1.61	0.13	1.78	1.72	0.04
Minimum travel distance to urban center (areas with a population between 5,000 and 10,000)	29.68	27.64	0.09	29.68	30.14	-0.02
Bio-Physical						
Log of Average yearly precipitations 1981-2011 (mm)	3.29	3.33	-0.22	3.29	3.26	0.13
Log of Elevation (meters)	6.78	6.81	-0.05	6.78	6.76	0.04

The final specification of the PSM probit model was assessed for each covariate, using the standardized difference in means. The standardized mean differences between the treated and control groups are small, signaling a negligible bias in the distributions of the covariates after matching. A similar finding can be obtained from graphs presented in Appendix 1 (Figure A 1-3). To assess the overall quality of the match, we considered the Rubin's bias (B) and ratio of variances (R) statistics, along with the thresholds outlined in Rubin (2001). Rubin's R refers to the ratio of beneficiary to control variances of the propensity scores while Rubin's B refers to the absolute standardized difference of the means of the propensity score in the beneficiary and control groups. The rule of thumb is that Rubin's R statistic should be below 2 to avoid over-correction of bias and above .5 to prevent under-correction while Rubin's B should be below 25. As shown in Table 9, Rubin's B and R after matching are within the recommended thresholds.

Table 9. Rubin's statistics, matched and unmatched sample

	Rubin's B	**Rubin's R**
Unmatched	52.68	1.03
Matched	21.17	0.70

6.1 Overall impacts of MIVARF[6,7]

Impact on Economic mobility (Overarching Goal: OG)

The primary hypothesis of MIVARF is that giving smallholders farmers and entrepreneurs access to functioning marketing infrastructure, adequate physical and financial capital and technology, together with the right set of skills to sustainably exploit these resources, should lead to higher agricultural income, food and nutrition security, and overall welfare.

Table 10 presents the results of MIVARF impacts on income and wealth and shows that the programme achieved many of its objectives. Overall, we find no impact of MIVARF on total household gross income. However, beneficiaries experienced a 16% increase in gross crop income compared to the

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[6] For all result tables, ATET is estimated using Inverse Probability Weighted Regression Adjustment and impacts are computed based on the log transformed variables for continuous variables other than scores and indices. Detailed results are provided in appendix 3.

[7] We were not able to exhaustively collect data on agricultural expenses as a consequence of an unresolved programming issue during the fieldwork. Therefore the present analysis do not address the impact of MIVARF on potential reduction of production and transaction costs part of the programme's outcomes.

control group. In fact, MIVARF expectedly and effectively impacted agricultural activities, especially rice and maize cultivation. Indeed, when exploring potential differential impacts of the program conditional on cultivating these major crops, we find that the total gross household income of MIVARF beneficiaries increased by 73% for rice growers and 13% for maize growers with respect to the control group. Nevertheless, improvements in farming activities at the intensive margin did not lead to any significant change in beneficiaries' income composition as suggested by the lack of impact on gross income shares disaggregated by main activities. The indices for productive assets and dwelling conditions for MIVARF beneficiaries grew by 7% and 4%, respectively, relative to non-beneficiaries. This implies that the programme has raised the income generating potential of its participants, who are now endowed with relatively more productive inputs, which should enlarge their future productive capacity. In addition, programme participation was also instrumental in improving the dwelling conditions of beneficiaries. Interestingly enough, the programme also had a positive impact on the livestock asset index although its design did not aim at targeting this specific dimension. We do not find a significant impact on the index for durable assets.

Table 10. MIVARF impacts on Economic Goal (OG)

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Income (TZS)			
Total gross household income	5	1,993,561	1,821
Gross income from agricultural activities	16***	665,900	1,691
Gross income from livestock activities	8	230,524	1,389
Gross income from self-employment	2.1	2,051,241	783
Income from wage employment	3.4	414,716	718
Income from transfers	0.4	146,731	684
Income from other sources	1.7	371,160	345
Total gross household income: rice growers	73.4***	1,424,787	501
Total gross household income: maize growers	12.5**	1,976,473	1,416
Income shares **(by income components, over total gross income)**			
Agricultural activities	0.8	45.7	1,821
Livestock activities	1.1	12.8	1,821
Self-employment	-0.1	23.0	1,821
Wage employment	-1.5*	9.8	1,822
Transfers	-1.1*	5.8	1,821
Other sources	0.8	3.0	1,821
Wealth			
Livestock asset index (PCA)	14.6***	0.09	1,821
Productive asset index (PCA)	6.6***	0.19	1,821
Durable asset index (PCA)	1	0.19	1,821
Housing index (MCA)	3.5***	0.5	1,821

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; PCA: Principal Component Analysis; MCA: multiple correspondence analysis; TZS: Tanzanian Shillings.

Impact on Agricultural production and productivity and market access (Strategic Objective 1: SO1 and SO2)

Improving market linkages and market participation "implies the transition by farmers from subsistence farming to a market engagement mode, whereby inputs are increasingly purchased, and outputs sold off the farm to traders. […] The transition from a lower to a higher level of market participation, is influenced by the ability of farmers to produce products which meet market expectations in terms of quality, standards, supply consistency, and ability to deliver products on time for sale at a viable price." (Poole 2017). MIVARF activities span the full range of the process, operating both on forward and backward linkages. In this context, Table 11 presents results related to upstream agricultural activities (inputs and production) while Table 12 shows impact estimates on downstream (commercialization) level.

Rural finance plays a crucial role in the agricultural production process enabling smallholder farmers to "purchase stock, equipment, agricultural inputs; to maintain infrastructure; to contract labour for planting/harvesting; to transport goods to markets; to make/receive payments; to manage peak season incomes to cover expenses in the low season;" among other things (ILO 2019). However, the agricultural sector remains largely unserved by financial institutions in Sub-Saharan Africa. In Tanzania, agricultural loans only represented 10% of total bank credit while rural areas housed 74% of Tanzanians in 2009, and studies show that in many countries most loans classified as "agricultural" were used for purposes other than agricultural production (Jessop et al. 2012). MIVARF specifically addressed rural households' limited engagement with financial institutions and aimed at improving access to financial services. The first part of Table 11 shows that the incidence of households accessing financial services remained unaffected by programme participation. Impact on the proportion of households with a bank account or that obtained a loan since baseline is also not significant. However, MIVARF contributed to a 45% increase in the amount of loan borrowed for farming especially from formal sources. Beneficiaries are 7 percentage-points more likely to engage with a formal bank for loans they sought for purchasing farm inputs, equipment, or animals; to purchase/lease agricultural land; or to cover other agricultural costs.

Technical assistance, capacity building and trainings represent another pillar in MIVARF's ambition to increase agricultural production and productivity of target value chains. Many of the programme intermediate outcomes appeared to have been reached starting with trainings as the proportion of households reported being trained on crops management and soil and natural resources management grew by 5 to 7 percentage-points in beneficiary households relative to the control group. Other evidence of the positive impact of the programme on the strengthening of rural producers' capacity include:

Agricultural technologies

The Tanzanian seed market remains largely untapped. For instance, it is estimated that farmers make use of previous harvest seeds for 80% of maize production although the nation's agriculture would highly benefit from the adoption and development of various maize varieties that could be provided by the more than 100 seed companies[8] serving the seed market (Wilson and Lewis 2015). MIVARF's effort to improve rural finance and engagement with suppliers aimed at stimulating backward linkages including facilitating access to improved seeds and other technologies. Indeed, the latest programme supervision report highlighted that many service providers "have been champions in promoting environment and natural resource management innovations [including] the promotion of quality certified seeds for cash and food crop value chains" (IFAD 2019). Results in Table 11 show that while programme participation did not affect the use of improved seeds for maize it did foster the adoption of

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[8] Access to Seeds Index, Tanzania: https://www.accesstoseeds.org/index/eastern-southern-africa/country-profile/tanzania/

improved seeds for rice among beneficiary households that are 7 percentage-points more likely to utilize such seeds.

Production practices

Better production practices such as efficient irrigation systems make it possible for farmers to sustain agricultural production even during the dry season. While MIVARF activities did not directly target the development of irrigation systems, the provision of trainings on production practices and technologies and the programme's emphasis on rural finance legitimately pushed toward the adoption of methods to sustainably enhance agricultural production. Rice cultivation in particular accounts for 75% of the irrigated land in Tanzania whereas only 12% of the total rice production comes from parcels endowed with irrigation facilities (Zhang et al. 2021). Under MIVARF, the share of households that cultivates irrigated land and the proportion of total cultivated land irrigated increased by 10 and 4 percentage-points respectively. We coherently observed even larger impacts when considering the rice value chain. Rice growers that benefited from MIVARF services are 28 percentage-points more likely to be equipped with irrigation systems compared to control households.

Labour use

Input and output market linkages can induce rising demand for labour in a farming system that is relatively more labour intensive. In the case of MIVARF, we find that programme beneficiaries are 14 percentage-points more likely to hire agricultural labour.

Overall, we found positive and significant impact on several indicators of production capacity and productivity as shown in Table 11. For example, the quantity and value of total annual harvest increased by 20% and 19%, respectively, for MIVARF beneficiaries relative to the control group. Moreover, an even greater impact (+29%) is observed on average crop yields with substantial productivity gains when focusing on rice and maize value chains as yields for these major crops increased by 64% and 35% respectively, for beneficiaries.

Table 11. MIVARF impacts on productive capacity (SO1)

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Productive inputs			
Financial services			
HH has a bank account (0/1)	3.4	70.7	1,821
HH obtained a loan since baseline (0/1)	2.6	64.8	1,821
Source of the loan: bank (0/1)	6.9***	12.4	1,209
Use of the loan: farm inputs, equipment, animals, land, other farm costs (0/1)	6.7**	60.7	1,209
Total amount in loans taken out since baseline (TZS)	45.4***	705,220	1,209
Technical advice and production technologies			
Extension training received on crops management (0/1)	7.3***	68.8	1,359
Extension training received on soil and natural resources management (0/1)	5.4**	25.4	1,359
HH cultivates irrigated land (0/1)	10.4***	9.1	1,697
Share of total cultivated land irrigated	3.6***	5.1	1,697
Rice grower with irrigated land (0/1)	27.5***	4.3	501
HH used improved seeds for cultivating rice (0/1)	1.6**	1.3	1,691

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
HH used improved seeds for cultivating maize (0/1)	1.3	27.3	1,691
HH used hired labor in production process (0/1)	14.4***	59.9	1,691
Agricultural production and productivity			
Total quantity harvested (KG)	19.8***	1,675	1,691
Value of total harvest (TZS)	19.1***	1,015,505	1,691
Yield: KG of crop harvested per HA	28.6***	1,121	1,691
Rice yield: KG harvested per HA	64.2***	1,600	501
Maize yield: KG harvested per HA	35.3***	1,192	1,416

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; HH: household; KG: kilogram; HA: Hectare; TZS: Tanzanian Shillings

Having discussed programme results at the upstream level, we now present impact estimates on commercialization starting with forward linkages and transaction channels that are central to commercialization. Post-harvest trainings were an integral part of MIVARF value-addition component to better help move products to end consumers. Indeed, the role of agricultural extension in improving market participation is not limited to the promotion of production and productivity. Evidence from Ethiopia by Girma and Kurma (2022) show that market participation would largely benefit from a more market oriented agricultural extension system rather than relying on a production oriented agricultural extension system.

As reported at the top of Table 12 the proportion of households who have received trainings on sales, marketing and business management increased by 11 percentage points among MIVARF beneficiaries. Regarding transaction channels, MIVARF moderately increased more formal relationships with buyers and market participation. Specifically, beneficiaries are more likely to sale products at the market rather than on-farm and are more likely to have traders and cooperatives as main buyer. To examine whether the positive impacts on programme outcome indicators (improved rural finance and agricultural extension services, increased technology adoption and strengthening of market linkages), agricultural productive capacity, and productivity translated into improved market access, we examine impact on revenues from crop sales and the share of crops sold of the total harvest both in quantity and value. Results in Table 12 show an increase in sales revenue (+18%) of beneficiaries relative to the control group. Furthermore, MIVARF improved agricultural commercialization as evidenced by the increase in the share of total harvest that was sold by 6.2 percentage points (in quantity) and 4.6 percentage points (in value) while the share of harvest dedicated to own consumption decreased by 6.5 percentage points. Even more telling results arise when focusing on rice and maize growers, for which the rate of commercialization increased by 42 and 50 percentage points for, respectively, rice and maize.

Table 12. MIVARF impacts on market access (SO2)

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Forward production linkages and marketing channels			
Extension training received on sales/marketing and Business mgt. (0/1)	10.5***	29	1,359
Harvest was mainly sold on farm/home (0/1)	-0.7	57	1,691
Harvest was mainly sold at the market (0/1)	3.4*	18	1,691
Harvest main buyer: trader (0/1)	4.9**	59	1,691
Harvest main buyer: cooperatives (0/1)	6.9***	15	1,691
Harvest main buyer: other (0/1)	-3.1*	17	1,691
Revenues from crop sales			
Total revenue from crop sales (TZS)	18.1**	359,113	1,317
Market participation & commercialization			
Share of **quantity** of crop **sales** out of total harvest	6.2***	30.3	1,691
Share of **value** of crop **sales** out of total harvest	4.6***	34.6	1,691
Share of **value** of crop used for **own consumption** out of total harvest	-6.5***	50.2	1,632
Share of value of **rice** sold over total value of rice harvested	41.8**	0.2	499
Share of value of **maize** sold over total value of maize harvested	49.8***	0.1	1,416

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; TZS: Tanzanian Shillings

Impact on Resilience (Strategic Objective 3: SO3)

MIVARF is based on the premise that increased market linkages and producer empowerment will help build resilience among beneficiaries by enabling better production decisions. Table 13 reports impact estimates on households' income and crop diversification indices and their ability to recover from shocks. We find a 13% decrease in households' crop diversification index among MIVARF beneficiaries suggesting reduction in on-farm diversity. Crop diversification can help improve resilience in different ways, by helping farmers adapt to the adverse effects of climate shocks and biotic agents or mitigate the impact of commodity-specific high price fluctuations. For instance, "staple food crops such as maize are more susceptible to expected changes in temperature and water availability, thus reliance on these crops increases the climate vulnerability of poor, non-diversified farm households" (FAO 2017). Therefore, the finding of increased agricultural specialization among MIVARF beneficiaries implies potentially higher vulnerability. We, however, do not find significant impact on ability to recover from climatic and non-climatic shocks among programme beneficiaries.

Table 13. MIVARF impacts on Resilisence (SO3)

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Income/Crop diversification			
Crop diversification index: Gini Simpson index	-12.6***	0.48	1,691
Income diversification index: Gini Simpson index (1)	-1.6	0.41	1,821
Shocks (during the last 12 months)			
Corrected subjective ability to recover from shocks (2)	0	4.1	1,238
Corrected subjective ability to recover from **climate** shocks	-0.1	4.0	601
Corrected subjective ability to recover from **non-climate** shocks	0	4.2	970
Ability to recover from shocks (raw self-reported answer) (3)	2.3	23.7	1,254
Ability to recover from **climate** related shocks (0/1)	0.2	30.8	616
Ability to recover from **non-climate** related shocks (0/1)	2.9	19.2	994

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; (1) calculated with gross income shares; (2) Subjective measure of (perceived) resilience capacity in the aftermath of one or more shocks, developed using the IFAD methodology; (3) Dummy variable =1 if household recovered to same level or better off.

Impact on Nutrition and Food Security (Mainstreaming Theme: MT)

Economic and nutritional trade-offs of increased agricultural commercialization have long been an enduring research topic in agricultural development (Maxwell and Fernando 1989). However, studies show that while increased crop income does not necessarily translate into better nutrition, improved market participation does not generally undermine food security. On the contrary, commercialization should be associated with more food security through increased farm incomes (Wiggins and Keats 2013). In the case of MIVARF, results all point in the direction of high, positive, and significant impacts on both nutrition and food security (Table 14). Household dietary diversity score increased by 3% to 4% depending on the recall period for beneficiaries relative to control households. Moreover, the food insecurity experience scale (FIES) of MIVARF participants decreased by 11% with beneficiaries 6 percentage points more likely to be food secure. This positive impact is associated with a 4-percentage points reduction in food insecure households among beneficiaries. The number of months in which beneficiary households experienced food shortage in the past 12 months also dropped by 17%.

Table 14. MIVARF impacts on Household Nutrition and Food Security (MT)

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
NUTRITION			
Household dietary diversity score based on 7-day recall	3.7***	8.8	1,821
Household dietary diversity score based on 24-hour recall	3.3***	6.8	1,821

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
FOOD SECURITY			
Food insecurity experience scale raw score (FIES)	-11.7***	3.1	1,821
FIES HH members are food secure (0/1)	6.2***	59.6	1,821
FIES HH members are moderately food insecure (0/1)	-1.9	18.8	1,821
FIES HH members are severely food insecure (0/1)	-4.3**	21.6	1,821
Nb of months the HH experienced food shortage during the past 12 months	-16.9**	1.7	1,821

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; HH: household.

Impact on Women's empowerment (Mainstreaming Theme: MT)

When MIVARF was launched in 2012, approximately 60% of women were employed in agriculture in Africa South of the Sahara[9] (73% in Tanzania) and it was estimated that their contribution to farm work equalled that of men (FAO 2011). For instance, in the maize value chain in Tanzania, "both men and women work on maize production, though women undertake the majority of the field-labour. Men are more involved in the trade of maize grain, while women are the main traders in maize flour" (Wilson and Lewis 2015). However, unequal access to key agricultural inputs and control over incomes generated by agricultural activities often prevent women from overcoming poverty. MIVARF specifically targeted women through all its components and seek to *(i) increase women farmers influence in decision making in the value chain; (ii) increase women farmers' knowledge and information and link them to appropriate credit facilities; (iii) involve men in understanding that shared control over value chain of agricultural produce are beneficial to the well-being of the family and the community; and (iv) explore new niche products and high value chains that women producers might better remain control of* (ADF 2011).

This impact assessment was therefore designed to capture female participation and decision making in the agricultural value chain, assess overall farm income in female headed households and included a i-WEAI module (see section 3.2.) allowing for the construction of core indicators of women's empowerment. While results in

Table 15 do not show significant impact on female ownership, female participation, as well as indicators of female economic mobility and market access. On the other hand, we find that MIVARF increased joint decision making in agricultural production. Specifically, the number of crops and the number of fields under joint decision making increased by 21% and 11%, respectively, among beneficiaries. The total value of harvest from fields jointly controlled by males and females also grew by 21%. Similarly, we find a 13 percentage points increase in joint participation in decisions about earnings from crop sales, associated with a 26% gain in sales from crops under joint decision making. Those results suggest that although MIVARF fell short on achieving its gender goal, it worked towards the right direction by encouraging joint decision making.

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[9] World Bank WDI, accessed April 2022 https://data.worldbank.org/indicator/SL.AGR.EMPL.FE.ZS?locations=ZG

Table 15. Gender disaggregated indicators

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Female ownership and decision-making			
Female ownership of productive assets (owns at least 1) (0/1)	1.1	30.2	1,815
Female ownership of durable assets (owns at least 1) (0/1)	1.5	41.0	1,815
Female ownership of land (owns at least 1 parcel) (0/1)	0.6	31.9	1,683
Female participation in decisions about crops to be planted (0/1)	-0.5	23.8	1,691
Female participation in decisions about earnings from crop sales (0/1)	1.3	18.6	1,691
Annual gross crop income: female headed HH (TZS)	16.1	112,040	357
Value of total harvest for fields where female are d.-m. (TZS)	10.2	179,931	415
Sales from crops whose earnings are controlled by females (TZS)	3.4	67,487	328
Joint decision making			
Joint participation in decisions about crops to be planted	0	45.8	1,691
Joint participation in decisions about earnings from crop sales	4.9**	36.8	1,691
Nb of fields (parcels) with joint d.-m.	21***	2.0	770
Nb of crops with joint d.-m.	11**	3.1	765
Value of total harvest for fields with **joint** d.-m. (TZS)	20.8**	489,449	764
Sales from crops whose earnings are **jointly** controlled (TZS)	26.1***	194,184	646

Note: Impacts on all variables measured by shares and dummy variables (0/1) are reported in percentage points (pp). Female participation is measured by using the answers to the question of "who makes the decisions on…" for each generating activity. Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01; d.-m.: decision making; HH: household; TZS: Tanzanian Shillings

Table 16 reports impact estimates on core indicators of women's empowerment. The mean empowerment score is a continuous indicator of the level of women's empowerment, where those with scores of 0.75 or higher are considered empowered. The mean empowerment score has improved by 5% through participation in the program. Beneficiary women are 3 percentage points more likely to have an empowerment score of 0.75 or higher and therefore achieve empowerment. Impact on intra-household inequality score was not significant suggesting that progamme participation did not help narrow the gender gap in empowerment. The share of households achieving gender parity declined marginally (0.1 percentage points) among beneficiary households.

Table 16. ATET Results for Women's Empowerment Indicators

Indicator name	ATET IPWRA (%/pp)	PO mean	Nb. of obs.
Empowerment Score (1)	4.8**	0.5	1,379
% Achieving Empowerment (2)	3.5***	18.2	1,379
Intra-household inequality score (3)	-14.2	0.1	966
% Achieving Gender Parity (4)	-0.1***	40.2	966

Table 17 reports the impact of the programme on the 12 i-WEAI indicators of women and men's agency. Full definitions of all the indicators are given in Appendix 4, Table A2. Table A3 gives the survey questions used for the i-WEAI indicators. Among intrinsic agency indicators, we find a significantly higher adequacy for beneficiary women but no significant impact of the programme on intrinsic agency.

The programme had significant and positive impacts on the instrumental agency of women. Three of the six indicators of instrumental agency show a positive and significant impact: ownership of land and other assets, access to and decisions on financial services, and control over use of income have all significantly, though slightly, increased for women in beneficiary households.

When asked about their membership in groups, respondents were asked whether they believed that their group could influence life in the community beyond the group activities. Indicator of group membership was positively impacted for men and membership in influential groups, referring to the active membership of the individual in at least one group that can influence the community, was positively impacted by MIVARF for both women and men, though the effect for men was stronger. Finally, we find that men who participated in the programme are less likely to have an adequate work balance.

Table 17. ATET Results for Empowerment Indicators for Men and Women

Indicator name	MEN			WOMEN		
	ATET IPWRA (pp)	PO mean	Nb. of obs.	ATET IPWRA (pp)	PO mean	Nb. of obs.
Intrinsic Agency (0/1)						
Autonomy in income	3.9	17.52	1,264	0.75	20.61	1,591
Self-efficacy	2.79	52.67	1,264	3.45	41.21	1,591
Attitudes about intimate partner violence	-2.78	76.94	1,264	-2.08	43.70	1,591
Respect among household members	4.5	61.75	1,234	6.7**	47.13	1,490
Instrumental Agency (0/1)						
Input in productive decisions	-4.8	73.21	1,267	2.02	58.05	1,591
Ownership of land and other assets	-0.14	96.17	1,267	4.52**	83.95	1,591
Access to and decisions on credit	0.47	87.40	1,267	4.36*	81.20	1,591
Control over use of income	0.98	42.74	1,267	4.8*	32.70	1,591
Work balance	-7.23**	58.48	1,267	-3.19	37.54	1,591
Visiting important locations	-3.4	71.74	1,266	-1.33	72.81	1,591
Collective Agency (0/1)						
Group membership	10.9***	71.73	1,177	3.57	78.66	1,478
Membership in influential groups	12.88***	54.90	1,177	7.06**	57.65	1,478

All impacts are reported in percentage points (pp) as the indicators are dummy variables (0/1). Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01

Conclusion and recommendations

Smallholders are the backbone of Tanzanian agriculture and central to the production of food crops, accounting for 90% of the country's cultivated land. However, their linkages to input and output markets remain weak, limiting their capacity to significantly contribute to poverty reduction and food security. Market and institutional imperfections often prevent farmers and other value chain actors from accessing information, identifying business opportunities, and allocating their resources efficiently. Use of improved inputs such as inorganic fertilizers is strikingly low among Tanzanian farmers. Limited financial inclusion among smallholders is another major constraint to agricultural development. Tanzanian smallholder producers also face informational, institutional, and infrastructural constraints to access output markets resulting in high transaction costs and low competitiveness.

The Marketing Infrastructure, Value Addition and Rural Finance Support (MIVARF) programme was developed by the Government of Tanzania and funded by the International Fund for Agricultural Development (IFAD) and the African Development Bank (AfDB) to tackle these challenges and support the government's Agriculture Sector Development Programme. Implemented between 2011 and 2020, MIVARF aimed to enhance income and food security of smallholder farmers through increased access to financial services and better market integration by addressing bottlenecks encountered by smallholders along the agricultural value chain, including access to credit and inputs, increased productive capacity and marketing.

Impact assessment results presented in this report show that MIVARF achieved many of its objectives in line with its theory of change. *First*, it enhanced farmers' engagement with more formal financial institutions where MIVARF participants were 7 percentage points more likely to have interacted with formal sources and the amount of their loans was 45% higher than among the control group.

Second, through its promotion of production and marketing driven extension services, it boosted agricultural technology adoption especially in the rice value chain. Rice growing MIVARF beneficiaries were 7 percentage points more likely to have used improved seeds and 27 percentage point more likely to irrigate.

Third, the programme increased the stock of durable agricultural assets, measured by a 7% increase in the agricultural assets index among beneficiaries.

Fourth, due to higher engagement with financial institutions, enhanced productive capacity and strengthened linkages with input suppliers, crop production grew by 20% and 19% in quantity and value, respectively, while crop yields increased by 29% among beneficiaries.

Fifth, the improvements in agricultural production and the programme's focus on strengthening forward linkages, marketing channels, and infrastructure resulted in higher rates of commercialization. Beneficiaries experienced an 18% increase in crop revenues, with the share of crops sold out of total harvest increasing by 6 and 5 percentage points in quantity and value, respectively. Rice and maize growing MIVARF beneficiaries boosted crop commercialization by 42 and 50 percentage points, respectively.

Six, higher input and output market engagement translated into crop income gains and improved food security and nutrition. The annual gross crop income among MIVARF beneficiaries rose by 16% and, conditional on producing rice or maize, total gross household income among treated households increased by 73% and 13% respectively. These monetary gains were accompanied by non-monetary benefits where food insecurity, as measured by the FIES, dropped by 12% and the likelihood of experiencing severe food insecurity decreased by 4 percentage points among beneficiaries. Dietary diversity of beneficiary households also increased by 3 to 4% relative to that of the control group.

Finally, MIVARF had a positive impact on instrumental agency of women. Three of the six indicators of instrumental agency show a positive impact: ownership of land and other assets, access to and decisions on financial services, and control over use of income have all significantly, though slightly, increased for beneficiary women with an increase of 4-7 percentage points depending on the indicator. Collective agency also improved among beneficiaries where beneficiary men were 11 percentage points more likely to actively participate in a group while beneficiary men and women were 13 and 7 percentage points, respectively, more likely to be active in an association that they think can influence the community beyond group activities.

The following key lessons were learned for future program design.

Financial inclusion. While MIVARF contributed to a 45% increase in the amount of loan borrowed among beneficiaries, it did not improve the share of households receiving loans (*i.e.*, impact occurred at the intensive but not at the extensive margin). This implies that the credit component of MIVARF might not have helped smallholders without sufficient wealth to pay the upfront cost of getting a loan. Future programmes should incorporate strategies to ease credit market entry as well as informational, transactional, and other costs, to encourage productive but wealth- and information-constrained smallholders to seek out and secure loans.

Resilience. MIVARF did not seem to improve the adaptive capacity of beneficiaries. While development of stronger market linkages, increased access to information, and greater farm performance can lead to more resilient farming systems, impact of programme participation on households' stated ability to recover from climatic and non-climatic shocks was not statistically significant. Furthermore, greater crop specialization was observed among MIVARF beneficiaries, which could expose households to higher vulnerability to climate and market shocks. Increasingly, Tanzania is facing unpredictable rainfall, shifting agro-ecological zones, and increased dry periods that are expected to negatively impact agricultural production and development outcomes. Future programmes should therefore, incorporate adaptation strategies to enhance the capacity and resilience of beneficiaries to cope with climatic and market shocks.

Empowerment. Despite the focus of the programme on enhancing women's participation, results on women's empowerment were modest. While the programme improved joint decision making, impact on female assets ownership and participation in decision making was not statistically significant. Results from i-WEAI indicators were also mixed, as beneficiary women's empowerment score grew by 5% but there was no improvement in intra-household inequality. Future programmes should include gender transformative approaches that aim to address the root causes of gender-based inequalities in access to and control over productive resources along the value chain.

Spillover effects. For a programme such as MIVARF with considerable investments on marketing infrastructures (*e.g.*, upgrade of gravel feeder roads, construction of markets and warehouses, and training on infrastructure maintenance), spillover effects may go beyond the physical borders of treated wards. Future impact assessment of programmes such as MIVARF may therefore benefit from integrating local economy-wide impact evaluations (LEWIE) to understand the full impacts of programme interventions on local economies through production, employment generation, and trade linkages.

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Appendix 1: Power calculation

Table A 1. Recommended sample size based on power calculations with different outcome variables

Outcome variable	Min expected change	D	σ	ρ	Nb. Of clusters	Sample Size (+10%)
Net income from crop & livestock (using crop1)	0.20	98,193	548,215	0.143	261	1,822 (2,004)
Net income from crop & livestock (using crop2)	0.20	149,822	652,913	0.148	162	1,130 (1,243)
Net income from own-farm production of crop - calculated value.	**0.20**	**69,375**	**405,464**	**0.095**	**242**	**1,690 (1,859)**
Net income from own-farm production of crop - info from food ques.	0.20	121,005	518,183	0.095	130	904 (994)
Annual value of sold crops, imputed	0.20	54,335	455,906	0.065	440	3,080 (3,388)
Annual value of sold crops + by-products	0.20	54,777	457,484	0.069	443	3,096 (3,406)
Non-agricultural wealth index	0.20	-0	1	0.109	6,976	48,830 (53,713)
Per capita expenditure	0.20	87,474	276,676	0.209	102	714 (785)
HH expenditures	0.20	451,707	1,612,137	0.033	69	482 (530)
Total annual food expenditure (purchases, own consumption, gifts), Imputed	0.20	237,986	687,949	0.170	77	534 (587)

Power calculation with 7 HHs per cluster, done using Tanzania National Panel Survey (NPS) 2010/2011 data for MIVARF targeted areas. A 10% is added to the resulting sample size to account for potential non-responses as well as for trimming of off-support observations that could happen after matching treated with control households. Final sample size marked in **bold**.

Appendix 2: Matching diagnostics

Figure A 1. Standardized percentage bias reduction (kernel matching)
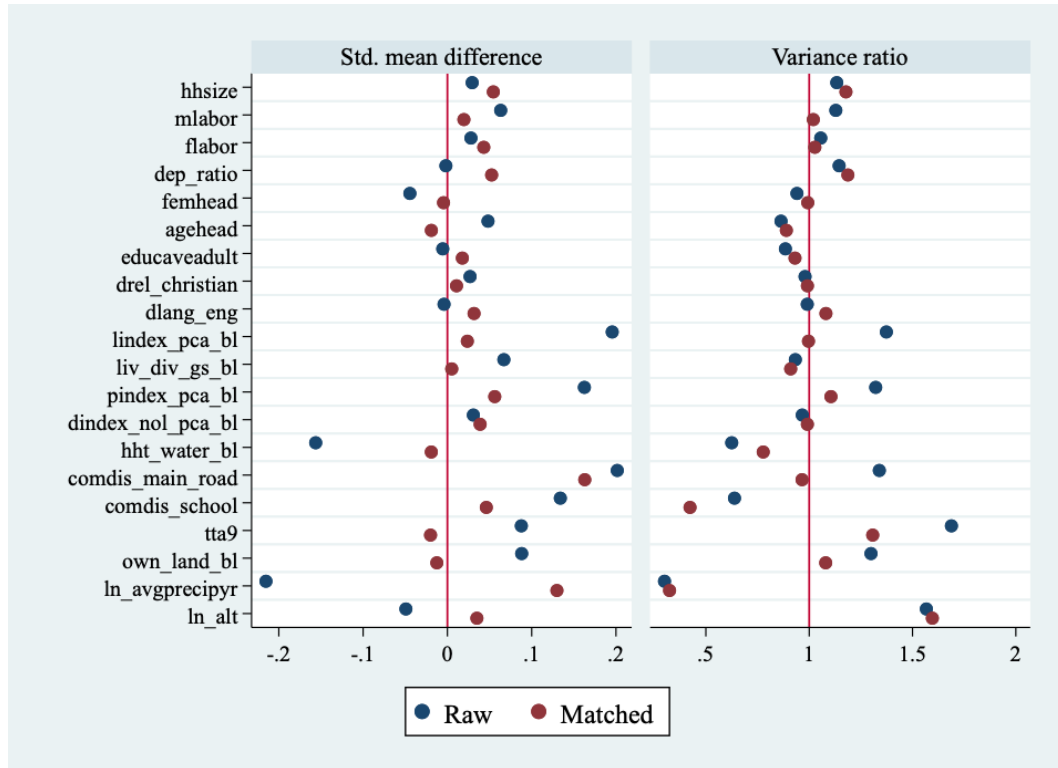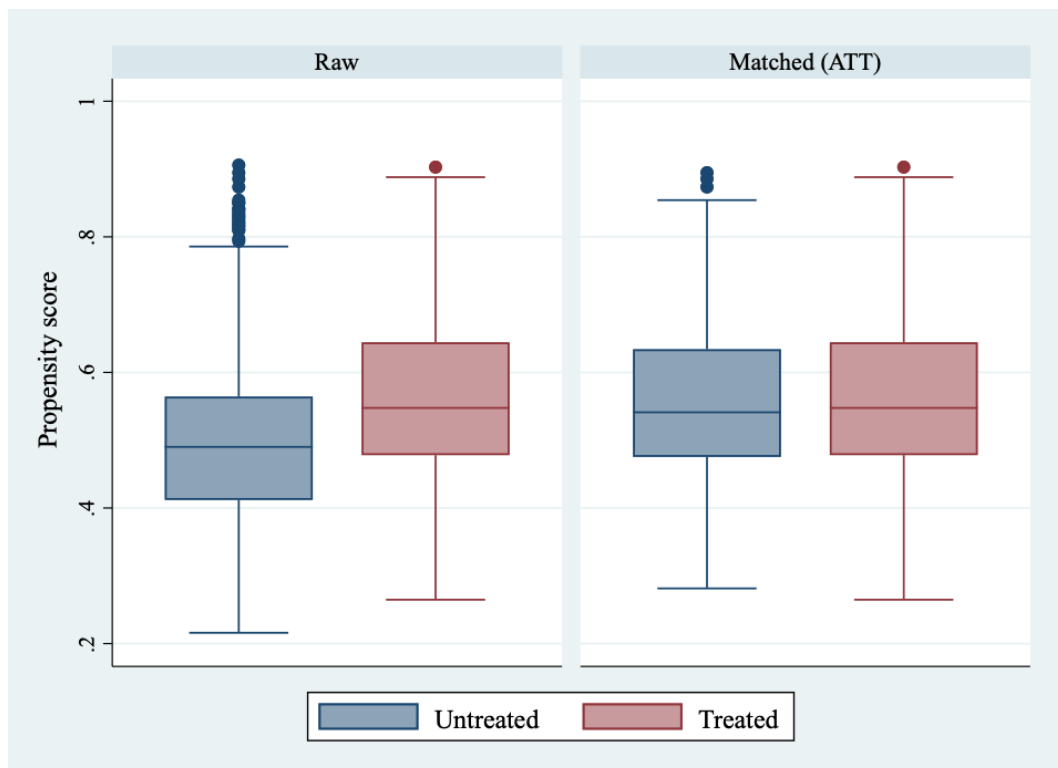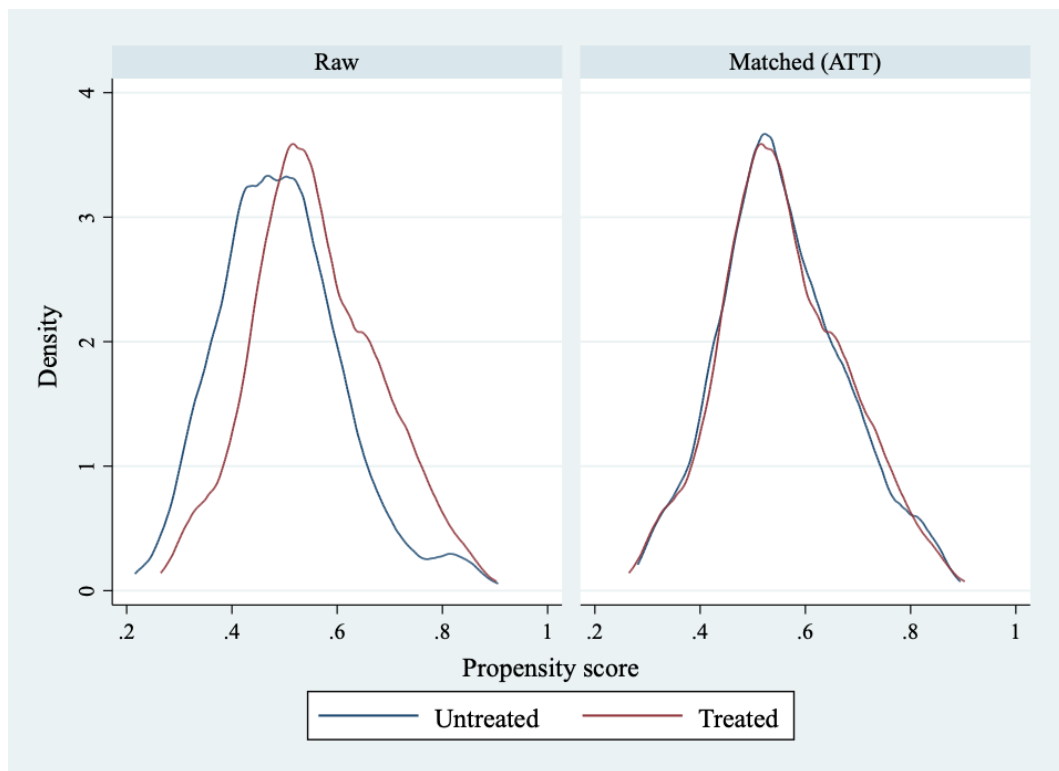

Figure A 2. Box plots of propensity score for raw and matched sample

Figure A 3. Kernel density plots of propensity score for raw and matched sample

Appendix 3: Detailed ATET results

The below tables present the full ATET results including actual coefficients, standard errors, sample sizes overall and for treated (T) and control (C). ATET was estimated using Inverse Probability Weighted Regression Adjustment and impacts were computed based on the log transformed variables for continuous variables other than scores and indices. Asterisks indicate the level of statistical significance from the t-test of mean differences: * < 0.10; ** < 0.05; *** < 0.01

Indicator name	ATET IPWRA coef. (s.e.)	PO mean (s.e.)	Nb. of obs. (T;C)
ATET Results for Economic Goal (OG)			
Total gross household income	0.05 (0.05)	1,993,561 (78,627)	1821 (965;856)
Gross income from agricultural activities	0.16*** (0.05)	665,900 (21,124)	1691 (892;799)
Gross income from livestock activities	0.08 (0.06)	230,524 (11,909)	1389 (750;639)
Gross income from self-employment	0.02 (0.1)	2,051,241 (122,143)	783 (414;369)
Income from wage employment	0.03 (0.1)	414,716 (37,674)	718 (355;363)
Income from transfers	0.004 (0.092)	146,731 (10,907)	684 (363;321)
Income from other sources	0.02 (0.16)	371,160 (30,269)	345 (196;149)
Total gross household income: rice growers	0.73*** (0.12)	1,424,787 (213,163)	501 (258;243)
Total gross household income: maize growers	0.13** (0.05)	1,976,473 (133,214)	1416 (720;696)
Gross income share: Agricultural activities	0.008 (0.015)	0.46 (0.01)	1821 (965;856)
Gross income share: Livestock activities	0.011 (0.009)	0.13 (0.01)	1821 (965;856)
Gross income share: Self-employment	-0.001 (0.015)	0.23 (0.01)	1821 (965;856)
Gross income share: Wage employment	-0.015* (0.009)	0.1 (0.01)	1822 (965;856)
Gross income share: Transfers	-0.011* (0.006)	0.06 (0.01)	1821 (965;856)
Gross income share: Other sources	0.008 (0.005)	0.03 (0)	1821 (965;856)
Livestock asset index (PCA)	0.15*** (0)	0.09 (0)	1821 (965;856)
Productive asset index (PCA)	0.07*** (0)	0.19 (0)	1821 (965;856)
Durable asset index (PCA)	0.01 (0)	0.19 (0)	1821 (965;856)
Housing index (MCA)	0.03*** (0.01)	0.48 (0.01)	1821 (965;856)

Indicator name	ATET IPWRA coef. (s.e.)	PO mean (s.e.)	Nb. of obs. (T;C)
ATET Results for productive capacity (SO1)			
HH has a bank account (0/1)	0.03 (0.02)	0.71 (0.02)	1821 (965;856)
HH obtained a loan since baseline (0/1)	0.03 (0.02)	0.65 (0.02)	1821 (965;856)
Source of the loan: bank (0/1)	0.07*** (0.02)	0.12 (0.02)	1209 (650;559)
Use of the loan: farm inputs, equipment, animals, land, other farm costs (0/1)	0.07** (0.03)	0.61 (0.02)	1209 (650;559)
Total amount in loans taken out since baseline (TZS)	0.45*** (0.08)	705,220 (53,143)	1209 (650;559)
Extension training received on crops management (0/1)	0.07*** (0.03)	0.69 (0.02)	1359 (750;609)
Extension training received on soil and natural resources management (0/1)	0.05** (0.02)	0.25 (0.02)	1359 (750;609)
HH cultivates irrigated land (0/1)	0.1*** (0.02)	0.09 (0.01)	1697 (897;800)
Share of total cultivated land irrigated	0.04*** (0.01)	0.05 (0.01)	1697 (897;800)
Rice grower with irrigated land (0/1)	0.27*** (0.04)	0.04 (0.03)	501 (258;243)
HH used improved seeds for cultivating rice (0/1)	0.02** (0.01)	0.01 (0)	1691 (892;799)
HH used improved seeds for cultivating maize (0/1)	0.01 (0.02)	0.27 (0.02)	1691 (892;799)
HH used hired labor in production process (0/1)	0.14*** (0.02)	0.6 (0.02)	1691 (892;799)
Total quantity harvested (KG)	0.2*** (0.05)	1,675 (75)	1691 (892;799)
Value of total harvest (TZS)	0.19*** (0.06)	1,015,505 (50,316)	1691 (892;799)
Yield: KG of crop harvested per HA	0.29*** (0.05)	1,121 (50)	1691 (892;799)
Rice yield: KG harvested per HA	0.64*** (0.12)	1,600 (154)	501 (258;243)
Maize yield: KG harvested per HA	0.35*** (0.05)	1,192 (64)	1416 (720;696)
ATET Results for market access (SO2)			
Extension training received on sales/marketing and Business mgt. (0/1)	0.1*** (0.03)	0.29 (0.02)	1359 (750;609)
Harvest was mainly sold on farm/home (0/1)	-0.01 (0.03)	0.57 (0.02)	1691 (892;799)
Harvest was mainly sold at the market (0/1)	0.03* (0.02)	0.18 (0.01)	1691 (892;799)
Harvest main buyer: trader (0/1)	0.05** (0.02)	0.59 (0.02)	1691 (892;799)
Harvest main buyer: cooperatives (0/1)	0.07*** (0.02)	0.15 (0.01)	1691 (892;799)
Harvest main buyer: other (0/1)	-0.03* (0.02)	0.17 (0.01)	1691 (892;799)
Total revenue from crop sales (TZS)	0.2** (0.1)	359,113 (17,915)	1317 (734;583)
Revenue from rice sales (TZS)	0.4* (0.2)	119,714 (35,941)	331 (175;156)
Revenue from maize sales (TZS)	0.2 (0.1)	33,744 (5,610)	316 (187;129)
Share of quantity of harvest sold out of total harvest	0.06*** (0.01)	0.3 (0.01)	1691 (892;799)
Share of value of crop sales out of total harvest value	0.05*** (0.02)	0.35 (0.01)	1691 (892;799)
Share of value of crop used for own consumption out of total harvest value	-0.06*** (0.02)	0.5 (0.01)	1632 (861;771)
Proportion of sale value of rice over total value of rice harvested	0.42** (0.04)	0.22 (0.03)	499 (256;243)
Proportion of sale value of maize over total value of maize harvested	0.5*** (0.01)	0.07 (0.01)	1416 (720;696)

Indicator name	ATET IPWRA coef. (s.e.)	PO mean (s.e.)	Nb. of obs. (T;C)
ATET Results for Resilience (SO3)			
Crop diversification index: Gini Simpson index	-0.13*** (0.01)	0.48 (0.01)	1691 (892;799)
Income diversification index: Gini Simpson index	-0.02 (0.01)	0.41 (0.01)	1821 (965;856)
Corrected subjective ability to recover from shock	-0.0003 (0.0553)	4.12 (0.04)	1238 (666;572)
Corrected subjective ability to recover from climate shocks	-0.001 (0.091)	3.99 (0.07)	601 (336;265)
Corrected subjective ability to recover from non-climate shocks	-0.0005 (0.0618)	4.21 (0.05)	970 (509;461)
Ability to recover from shocks (raw self-reported answer)	0.02 (0.02)	0.24 (0.02)	1254 (671;583)
Ability to recover from climate related shocks (0/1)	0.002 (0.042)	0.31 (0.04)	616 (339;277)
Ability to recover from non-climate related shocks (0/1)	0.03 (0.03)	0.19 (0.02)	994 (520;474)
ATET Results for Household Nutrition and Food Security (MT)			
Household dietary diversity score based on 7-day recall	0.037*** (0.091)	8.8 (0.1)	1821 (965;856)
Household dietary diversity score based on 24 h recall	0.033*** (0.083)	6.8 (0.1)	1821 (965;856)
Food insecurity experience scale raw score	-0.12*** (0.13)	3.1 (0.1)	1821 (965;856)
FIES HH members are food secure (0/1)	0.06*** (0.02)	0.6 (0.02)	1821 (965;856)
FIES HH members are moderately food insecure (0/1)	-0.019 (0.02)	0.19 (0.02)	1821 (965;856)
FIES HH members are severely food insecure (0/1)	-0.043** (0.019)	0.22 (0.02)	1821 (965;856)
Nb of months the HH experienced food shortage during the past 12 months	-0.17** (0.12)	1.7 (0.1)	1821 (965;856)
Gender-specific results for self-employment (s.-e.) income			
Female ownership of productive assets (owns at least 1) (0/1)	0.011 (0.015)	0.3 (0.02)	1815 (963;852)
Female ownership of durable assets (owns at least 1) (0/1)	0.015 (0.02)	0.41 (0.02)	1815 (962;853)
Female ownership of land (owns at least 1 parcel) (0/1)	0.006 (0.017)	0.32 (0.02)	1683 (896;787)
Female participation in decisions about crops to be planted (0/1)	-0.005 (0.013)	0.24 (0.02)	1691 (892;799)
Female participation in decisions about earnings from crop sales (0/1)	0.013 (0.015)	0.19 (0.01)	1691 (892;799)
Annual gross crop income: female headed HH (TZS)	0.16 (0.11)	112,040 (12,697)	357 (180;177)
Value of total harvest for fields where female are d.-m. (TZS)	0.1 (0.11)	179,931 (25,992)	415 (208;207)
Sales from crops whose earnings are controlled by females (TZS)	0.03 (0.16)	67,487 (9,479)	328 (178;150)
Joint participation in decisions about crops to be planted	0 (0.025)	0.46 (0.02)	1691 (892;799)
Joint participation in decisions about earnings from crop sales	0** (0)	0.37 (0.02)	1691 (892;799)
Nb of fields (parcels) with joint d.-m.	0.4*** (0.1)	2 (0.1)	770 (409;361)
Nb of crops with joint d.-m.	0.3** (0.1)	3.1 (0.1)	765 (407;358)
Value of total harvest for fields with joint d.-m. (TZS)	0.21** (0.09)	489,449 (43,654)	764 (408;356)
Sales from crops whose earnings are jointly controlled (TZS)	0.26*** (0.09)	194,184 (15,771)	646 (372;274)

Indicator name	ATET IPWRA coef. (s.e.)	PO mean (s.e.)	Nb. of obs. (T;C)
ATET Results for Women's Empowerment Indicators			
Empowerment Score	0.05** (0.01)	0.53 (0.01)	1379 (735;644)
% Achieving Empowerment	0.03*** (0)	0.18 (0)	1379 (735;644)
Intra-household inequality score	-0.14 (0.02)	0.11 (0.01)	966 (506;460)
% Achieving Gender Parity	-0.001*** (0)	0.4 (0)	966 (506;460)
ATET Results for Empowerment Indicators for Men and Women			
Men			
Autonomy in income	0.04 (0.03)	0.18 (0.02)	1264 (668;596)
Self-efficacy	0.03 (0.03)	0.53 (0.03)	1264 (668;596)
Attitudes about intimate partner violence	-0.03 (0.03)	0.77 (0.02)	1264 (668;596)
Respect among household members	0.04 (0.03)	0.62 (0.03)	1234 (653;581)
Input in productive decisions	-0.05 (0.03)	0.73 (0.02)	1267 (670;597)
Ownership of land and other assets	0 (0.01)	0.96 (0.01)	1267 (670;597)
Access to and decisions on credit	0 (0.02)	0.87 (0.02)	1267 (670;597)
Control over use of income	0.01 (0.03)	0.43 (0.03)	1267 (670;597)
Work balance	-0.07** (0.04)	0.58 (0.03)	1267 (670;597)
Visiting important locations	-0.03 (0.03)	0.72 (0.03)	1266 (669;597)
Group membership	0.11*** (0.03)	0.72 (0.03)	1177 (637;540)
Membership in influential groups	0.13*** (0.03)	0.55 (0.03)	1177 (637;540)
Women			
Autonomy in income	0.01 (0.02)	0.21 (0.02)	1591 (824;766)
Self-efficacy	0.03 (0.03)	0.41 (0.02)	1591 (824;766)
Attitudes about intimate partner violence	-0.02 (0.03)	0.44 (0.02)	1591 (824;766)
Respect among household members	0.07** (0.03)	0.47 (0.03)	1490 (771;718)
Input in productive decisions	0.02 (0.03)	0.58 (0.02)	1591 (824;766)
Ownership of land and other assets	0.05** (0.02)	0.84 (0.02)	1591 (824;766)
Access to and decisions on credit	0.04* (0.02)	0.81 (0.02)	1591 (824;766)
Control over use of income	0.05* (0.03)	0.33 (0.02)	1591 (824;766)
Work balance	-0.03 (0.03)	0.38 (0.02)	1591 (824;766)
Visiting important locations	-0.01 (0.02)	0.73 (0.02)	1591 (824;766)
Group membership	0.04 (0.02)	0.79 (0.02)	1478 (782;695)
Membership in influential groups	0.07** (0.03)	0.58 (0.03)	1478 (782;695)

Appendix 4: IFAD i-WEAI Indicators

Table A 2. Construction of indicators in IFAD I-WEAI

Indicator	Definition of adequacy in pro-WEAI
Intrinsic agency	
Autonomy in income	More motivated by own values than by coercion or fear of others' disapproval: *Relative Autonomy Index[A]* score>=1 RAI score is calculated by summing responses to the three vignettes (yes=1; no=0), using the following weighting scheme: -2 for vignette 2 (external motivation), -1 for vignette 3 (introjected motivation), and +3 for vignette 4 (autonomous motivation)
Self-efficacy	"Agree" or greater on average with self-efficacy questions: *New General Self-Efficacy Scale[B]* score>=32
Attitudes about intimate partner violence against women	Believes husband is NOT justified in hitting or beating his wife in all 5 scenarios: 1) She goes out without telling him 2) She neglects the children 3) She argues with him 4) She refuses to have sex with him 5) She burns the food
Respect among household members	Meets ALL of the following conditions related to another household member: 1) Respondent trusts relation (MOST of the time) AND 2) Respondent is comfortable disagreeing with relation (MOST of the time)
Instrumental agency	
Input in productive decisions	Adequacy: Sole or joint decision making for at least ONE activity that the household participates in.
Ownership of land and other assets	Owns, either solely or jointly, at least ONE of the following: 1) Any THREE assets 2) At least TWO large assets 3) Land
Access to and decisions on financial services	Meets at least ONE of the following conditions: 1) Belongs to a household that used a source of credit in the past year AND participated in at least ONE sole or joint decision about it 2) Belongs to a household that did not apply for credit because they already had enough current loans, or had no need for external financing or did not like to be in debt. 3) Has access, solely or jointly, to a financial account
Control over use of income	Has input in decisions related to how to use BOTH income and output (if measured) from ONE of the agricultural or non-agricultural activities their household participates in, unless no decision was made
Work balance	Works less than 10.5 hours per day: Workload = time spent in primary activity + (1/2) time spent in childcare as a secondary activity
Visiting important locations	Meets at least ONE of the following conditions:

	1) Visits at least TWO locations at least ONCE PER WEEK of [city, market, family/relative], or
	2) Visits least ONE location at least ONCE PER MONTH of [health facility, public meeting]
Collective agency	
Group membership	Active member of at least ONE group
Membership in influential groups	Active member of at least ONE group that can influence the community to at least a MEDIUM extent

Table A 3. Survey questions used for IFAD I-WEAI indicators

Indicator	Questions used for i-WEAI
Intrinsic Agency	
Autonomy in income	For each case, are you like this person? 1. "[PERSON'S NAME] uses her (his) income how another person tells her (him) she (he) must use it." 2. "No one tells [PERSON'S NAME] how to use her (his) income. But, she (he) uses her (his) income in the way that her (his) family or community expects." 3. "[PERSON'S NAME] chooses to use her (his) income how she (he) personally wants to, and thinks is best."
Self-efficacy	How much you agree or disagree with the statement: 1. I will be able to achieve most of the goals that I have set for myself. 2. When facing difficult tasks, I am certain that I will accomplish them. 3. In general, I think that I can obtain outcomes that are important to me. 4. I believe I can succeed at most any endeavor to which I set my mind 5. I will be able to successfully overcome many challenges. 6. I am confident that I can perform effectively on many different tasks. 7. Compared to other people, I can do most tasks very well. 8. Even when things are tough, I can perform quite well.
Attitudes about intimate partner violence against women	In your opinion, is a husband justified in hitting or beating his wife in the following situations? 1. If she goes out without telling him? 2. If she neglects the children? 3. If she argues with him? 4. If she refuses to have sex with him? 5. If she burns the food?
Respect among household members	Do you trust your [RELATION] to do things that are in your best interest? When you disagree with your [RELATION], do you feel comfortable telling him/her that you disagree?
Instrumental Agency	
Input in productive decisions	Who in the household makes the decisions concerning crops to be planted, input use and the cropping activities on [PARCELNAME]? Who in the household generally makes decisions about [ASSET]? Who in the household manages [SELF EMPLOYMENT ACTIVITY]?

Ownership of land and other assets	Who in the household owns [PARCEL NAME]? Who in the household owns [ASSET]?
Access to and decisions on financial services	Who made the decision to apply for the loan? Why did you not apply for a loan? Who makes the decision about the use of the loan? Does anyone in your household, either by themselves or together with someone else, currently have an account at a bank or other formal institution?
Control over use of income	Who in the household makes the decision concerning the use of [CROP] harvested from [PLOT] during the last 12 months? Who in your household decided the use of the earnings from unprocessed [CROP] sales? Who in your household decided what to do with the earnings from [LIVESTOCK]? Who makes decisions about how to use profit generated from [SELF EMPLOYMENT ACTIVITY]? Who in the household controls / decides on the use of [MEMBER ID]'s earnings from their job?
Work balance	Time use module: how did you spend your time during the past 24 hours?
Visiting important locations	How often do you visit [LOCATION]?
Collective Agency	
Group membership	Which household members belong to [GROUP]?
Membership in influential groups	To what extent does this [GROUP] influence life in the community beyond the group activities?