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An approach for assessing whether agricultural projects help smallholders transition to better livelihood strategies: A malawian case study☆

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ABSTRACT

Agricultural projects typically aim to promote the uptake of project components amongst targeted small farm populations to improve their farm productivity and welfare. While this approach can be an important first step towards improving smallholder livelihoods, it ignores alternative and often superior livelihood options that might arise within the rural transformation process, particularly in commercial agriculture and the rural nonfarm economy. We argue that the design of smallholder projects implemented within regions already undergoing a dynamic transformation and/or projects which have significant value chain components, should be broadened to assist smallholders in making successful transitions to their best livelihood options. For such projects, monitoring and evaluation activities should track livelihood transitions as well as the usual assessments of productivity and welfare outcomes. To help operationalize such an approach, we propose a typology of smallholder livelihood strategies that can track transitions over time and illustrate its use with data from the Sustainable Agricultural Production Program (SAPP), an agricultural value chain project in Malawi. Using available household panel data and quasi-experimental econometric approaches, we find that the project helped smallholders transition out of subsistence farming to market-oriented farming and helped already existing market-oriented farmers remain as such. Even though the project did not have any specific components designed to promote off-farm incomes, nevertheless, it facilitated many farm household transitions to off-farm diversified livelihoods, possibly due to spillover benefits generated within the local nonfarm economy. All SAPP facilitated transitions led to increases in household incomes. We conclude with some lessons for designing, monitoring, and the evaluation of future agricultural projects.

1. Introduction

Recent literature on the rural transformation of developing countries has highlighted the alternative livelihood pathways pursued by smallholder farm (SF) households as they adjust to new opportunities and threats that arise within the rural transformation process. While some poorer SFs remain trapped in subsistence modes of farming, others are emerging as commercial farmers and successfully engaging with today's more urbanized and higher-value markets while others are successfully diversifying into off-farm sources of income (e.g., World Bank, 2007; Hazell and Rahman, 2014). So far, this literature has had little impact on the way agricultural projects are designed and evaluated, even though many projects aim to promote smallholder transitions to commercial farming and the development of agricultural value chains. While projects are typically designed and evaluated in terms of their contributions to improvements in smallholder productivity, incomes, and welfare, this narrow focus ignores the potential longer-term impact of projects on farm household transitions to alternative livelihoods. Many transitions can be beneficial, such as when a project enables SFs to establish links with input and output markets and transition to commercial farming or diversify into new and better paying off-farm employment opportunities. But some transitions may be less desirable, for example, if some SFs are displaced by market forces and become locked in subsistence modes of farming or low-paying off-farm employment. We argue that

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the design of smallholder projects implemented within regions undergoing a dynamic transformation and/or projects that have significant value chain components should be broadened to include assistance to smallholders in making transitions to their best livelihood options for the longer term. This calls for relevant ways of segmenting SFs and targeting appropriate forms of assistance to each group. It also calls for broadening the scope of project impact assessments to go beyond the analysis of immediate productivity and welfare gains to assess how successful a project has been in helping SF households transition to better livelihoods.

To identify an appropriate SF typology for this purpose, we build on work previously conducted by the World Bank, (2007), Dorward et al (2009), and the Alliance for a Green Revolution in Africa (AGRA: 2017) and categorize SF farmers into four groups: subsistence-oriented households, pre-commercial or emerging farmers, market-oriented farmers, and off-farm diversified households. These categories are based on the importance of agricultural sales and off-farm income to a farm household's livelihood. We illustrate use of the typology in a project context using panel data from the Sustainable Agricultural Production Program (SAPP), an agricultural value chain project implemented in Malawi between 2014–2020. Our findings show that the project made significant contributions to household transitions to better livelihoods. In particular, SAPP helped some subsistence-oriented and pre-commercial farmers transition to either market-oriented or off-farm diversified livelihood strategies, all with significant increases in average incomes. SAPP also helped market-oriented, and off-farm diversified farmers stick to their original livelihood strategies which were more rewarding in terms of income than available alternatives. These transitions were facilitated by SAPPs contributions to increased agricultural productivity and improved access to markets and non-farm opportunities. Our findings suggest that it can take several years for household transitions to occur and settle in, implying that SF projects should embrace sufficiently long timeframes in their design, implementation, and evaluation.

The remainder of the paper is structured as follows: section 2 provides a review of the existing SF typologies and introduces our proposed typology approach for segmenting SFs for project analysis. Section 3 provides a description of the SAPP project, the study area, available survey data, and some summary statistics about the households. Section 4 provides a descriptive analysis of the household transitions that occurred between 2014 and 2020, and Section 5 describes our econometric approach and results evaluating the impacts of SAPP on household transitions and associated welfare changes. Section 6 provides our conclusions.

2. Smallholder farm typologies

Many different SF typologies have been proposed in the literature. Some are based on the type of region in which SFs live and its connectivity to markets (e.g., Vorley 2002; Berdegué and Escobar 2002). Others consider the scale of production, such as land size, technologies used, or the intensity of production, e.g., production per acre or animal (Kutcher and Scandizzo, 1981; Van der Ploeg et al., 2007; Christen and Anderson, 2013; Cortez-Arriola et al. 2015). Some typologies have been developed for specific situations using statistical clustering techniques (e.g., Bidogeza et al. 2009; Pacini et al. 2014; Berre et al. 2019; Hammond et al. 2020; Kaur et al. 2021). Most of these typologies are motivated by the desire to target specific types of assistance, such as new agricultural technologies or farming practices, credit, or input subsidies, to increase on-farm production, productivity, and incomes.

An alternative approach takes a more holistic and dynamic view of the rural transformation process and classifies SFs based on the type of livelihood strategy they are pursuing. Urbanization, rising per capita incomes, and the development of agricultural value chains (AVCs) can help in creating new market opportunities for SFs to grow and market higher-value crops and livestock products. Additionally, these same drivers of change can generate growth dynamics within secondary towns and the rural nonfarm economy, enabling some SFs to diversify into off-farm sources of income. These spillover benefits can be significant for projects that promote additional market-based production and the development of AVCs, creating substantial new employment and business opportunities amongst small and medium-sized businesses in the midstream of the agri-food system (Reardon 2015; Reardon et al. 2021; Barrett et al. 2022). Additionally, projects that increase SF incomes can generate robust income and employment multipliers in many other sectors of the local nonfarm economy, primarily because SFs spend substantial shares of their income gains on local consumer goods and services (Haggblade et al. 2007).

Typologies that more explicitly address these dynamics include Dorward et al. (2009), who identified three types of SFs: ones that are "stepping up" as commercial farmers, ones that are "stepping out" by diversifying into off-farm activities or leaving farming altogether, and ones "hanging in" as subsistence farmers. The Dorward et al. (2009) framework recognizes the dynamic aspirations of SFs, the diversity among them, and the changing role of the agricultural system. Recent studies have adopted and expanded this framework to livestock farmers in developing countries (McPeak and Little 2017; Lind et al. 2020; Kirui et al. 2022).

One of the main challenges of the Dorward et al. (2009) framework is that there are no empirically defined boundaries for segmenting farmers into the proposed categories. When typologies are motivated by the desire to track household transitions over time within specific regions then the boundaries that best fit with local circumstances might be chosen. However, if comparisons are to be made across geographies (such as projects or countries) and over time, then a more generalized approach is needed. The World Development Report (World Bank 2007) takes such a generalized approach to define typology segments for SFs that are useful for comparing farm household transitions across countries. Unlike the Dorward et al. (2009) approach, the World Bank disaggregates the "stepping out" category into three subgroups based on the type of their non-farm income: off-farm diversified, migration-oriented, and those that are 'diversified' into multiple income sources. The approach also defines standard boundaries for each category based on the household share of marketed agricultural output and the shares of different types of off-farm income in total income (Table 1). Quantification of the boundaries between groups was based on analysis of household distributional data for a mix of countries from Asia, Africa, and Latin America representing different stages of economic transformation, leading to numbers that, while reasonably robust for individual countries, also make sense for comparative purposes, even if they are not the best possible fit for each country (World Bank, 2007, Chapter 3). Such tradeoffs arise in defining many socio-economic indicators (e.g., poverty, food security, and literacy rates) used in cross-country comparisons, and they can also arise when constructing indicators for cross-project comparisons.

More recently, the Alliance for Green Revolution in Africa (AGRA, 2017) developed a SF typology for Africa, which, while sharing

Table 1
World Bank typology of smallholders.

Share of off-farm income	Share of agricultural output that is marketed	
	Low (≤50 %)	High (>50 %)
Low (≤25 %)	Subsistence oriented	Market-oriented
High (>75 %) – local employment	Labor oriented	
High (>75 %) – transfers[a]	Migration oriented	
No income share exceeds 75 %	Diversified[b]	

Notes: [a]Transfers include remittances from family members living elsewhere, pensions, safety net transfers, etc. [b] Diversified households receive less than 25% of their income from farming and between 25% and 75% of their income from off-farm sources.

similarities with the World Bank typology, differs in three ways (Table 2). First, the AGRA typology separates a group of "pre-commercial" (sometimes called "emerging)" farmers from "subsistence" farmers, where pre-commercial farmers are defined as farmers that have the potential to undertake profitable commercial production activities but face challenges such as weak land tenure, poor access to credit, input and output markets, and risks related to climate change. Some development aid agencies see the pre-commercial SFs as a promising SF target group for interventions that can facilitate the transition to commercial farming and the transformation of rural livelihoods (Fan and Rue, 2020). Second, the AGRA typology has a minimum off-farm income share of 33 % to define the stepping out categories, compared to 25 % in the WB typology. Third, AGRA reduced the "stepping out" category from three to two groups. Both groups receive at least one third of their income from non-farm sources, but households that obtain half or less of their income from the sale of farm production are called transitioning households while those selling more than half are classified as diversified commercial farms.

Both the World Bank (2007) and AGRA (2017) typologies are attractive for potential use in project design and evaluation, but we chose to combine them into a more simplified typology that captures key features of both approaches. We adopted the AGRA distinction between pre-commercial and subsistence farms but collapsed the "stepping out" households into a single group of off-farm diversified households. As with the World Bank typology, we also defined the "stepping out" households as ones that obtain at least 75 % of their income from off-farm sources. The result is a simple 4-category typology (Table 3) that retains much of the simplicity of the Dorward et al (2009) framework.

3. A Malawian case study

In the following sections, we apply our typology to evaluate the livelihood transitions that occurred among SF households over the course of the SAPP project in Malawi. We chose this project in part because it is a long-running AVC project focused on SFs, and it is of interest to know how successful it was in helping SFs transition to better livelihood options. Household data based on the SAPP project were also collected over the period 2014 to 2020, enabling observation of farm household transitions to different livelihood strategies over an extended timeframe.

3.1. Agriculture and smallholder livelihoods in Malawi

Malawi remains one of the poorest countries in Africa in terms of Gross Domestic Product (GDP) per capita; about 70 % of the population live below the international poverty line of $2.15/day. Slow agricultural and national economic growth combined with rapid population growth has, over decades, led to weak growth in per capita incomes averaging less than 1.5 % per annum. The country remains at an early stage of economic transformation, and agriculture accounts for about one-third of national GDP, two-thirds of the total labor force, and three-quarters of total exports (mainly tobacco). Over 80 % of Malawi's households depend on agriculture for at least some of their income. Urbanization is also low by African standards, with only about 20 % of the population living in urban areas. Other than tobacco, agricultural value chains are mostly poorly developed with limited value addition beyond the farm gate. Farms are also small (0.8 ha on average) and shrinking due to rapid rural population growth. Apart from smallholders engaged in tobacco production, most depend primarily on low-value crops like maize and legumes for their subsistence, grown under rainfed conditions with a single rainy season and frequent droughts. Most farm households try to supplement their farm livelihoods by engaging in nonfarm activities, though opportunities for many are constrained by limited access to urban areas (Benson et al. 2024).

Table 2
AGRA typology of smallholders.

Share of nonfarm income	Share of agricultural output that is marketed		
	Low (≤5%)	Medium (5–50 %)	High (>50 %)
Low (≤33 %)	Subsistence	Pre-commercial	Specialized commercial
High (>33 %)	Transitioning		Diversified commercial

Table 3
Simplified typology of smallholders.

Share of nonfarm income	Share of agricultural output that is marketed		
	Low (≤5%)	Medium (5–50 %)	High (>50 %)
Low (≤75 %)	Subsistence oriented	Pre-commercial	Market-oriented
High (>75 %)	Off-farm diversified		

The government of Malawi has long centered its approach to agricultural development on a green revolution in maize and has spent substantial shares of its agricultural budget on fertilizer and seed subsidies for maize (Benson et al. 2024). The approach is premised on the large yield gaps between actual and best farm yields but is handicapped in practice by the low farm gate price of maize compared to the high costs of fertilizer and other key inputs that prevail in the open market and by declining soil fertility. Recent years have seen a shift in government policies towards the promotion of more sustainable farming practices, with emphasis on small-scale irrigation, crop diversification, conservation agriculture, other methods of improved land management, watershed and catchment management, adaptation to climate change, and organizing farmers into farmer based organizations (FBOs) and village savings and loan groups to better link them to markets, modern inputs, and financial services (Malawi Government, 2018). It is within this context that the government and the International Fund for Agricultural Development (IFAD) funded and implemented the SAPP project over 2014 to 2020.

3.2. About SAPP

The main thrust of SAPP was to enhance agricultural productivity based on simple and affordable Good Agricultural Practices (GAPs). The GAP packages include improved access to inputs and practices for increasing the yields of staple and commercial crops, improved soil management practices, and crop rotations. The project supported an adaptive research program to fine-tune GAP packages to local socio-economic and agro-ecological conditions. To promote widespread adoption, the project included a range of communication and extension activities and offered assistance to SFs in accessing required inputs (e.g., farm tools, improved seed varieties, fertilizers, and post-harvest facilities). To facilitate SF access to financial services and markets, the project organized SFs into FBOs, invested in market infrastructure, and engaged directly with private seed companies, input suppliers, and micro-finance institutions to link them to groups of SFs. SAPP's main target group was defined as "smallholder food security" households comprising "productive men and women who have the potential to achieve household food security, but due to limited resources find it difficult to produce a surplus for the market". This is a good example of targeting a "pre-commercial" or "emerging" group of farmers (see Table 3). Poorer and food-insecure households (mostly subsistence) were also included in the intervention. A detailed description of SAPP is available in Cavatassi and Maggio (2022).

The project interventions covered 46 Extension Planning Areas (EPAs) within six districts, the Northern (Chitipa), Central (Lilongwe and Nkhotakota), and Southern (Blantyre, Chiradzulu, and Balaka) regions, geographically distributed from the north to the south of Malawi

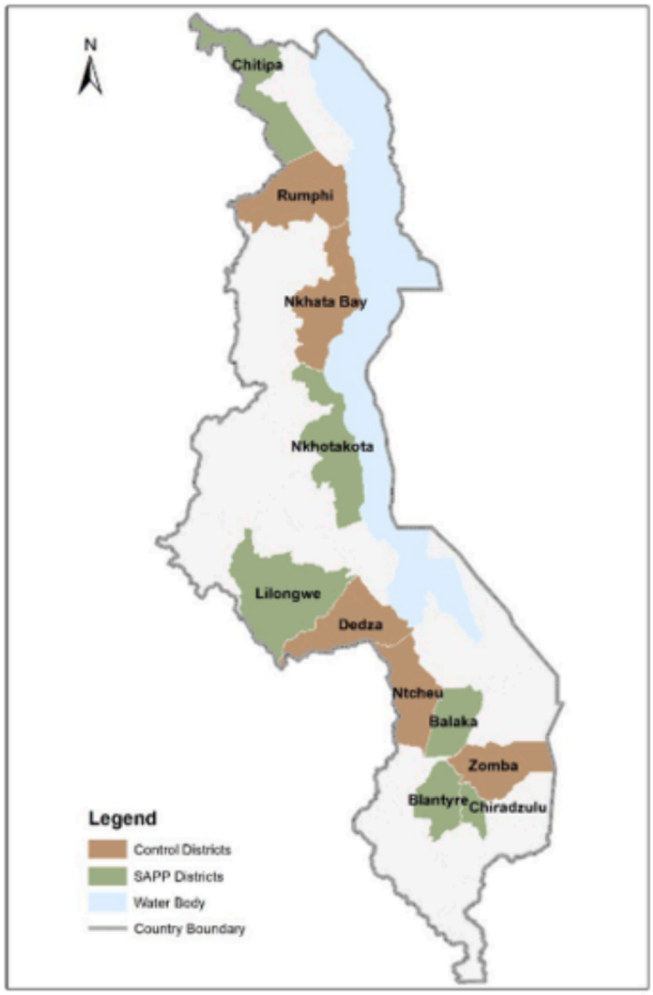

Fig. 1. Map of the SAPP study area.

(Fig. 1). The selection of districts was based on three criteria: First, districts were selected according to their agricultural potential with respect to suitable GAPs, and how these might contribute to increasing farm productivity, food security, and incomes. Second, the SAPP program aimed at targeting the districts with a relatively high prevalence of poverty and food insecurity. At the time of project design, the poverty rate in these districts ranged between 38 and 67 %, and the proportion of ultra-poor households was between 11 and 33 %. The third criterion was the presence or absence of other projects and the level of interest shown by the district council in SAPP participation. Various government programs were already active in promoting better farming practices in the project region, but their efforts were constrained by the lack of staff and funds. Project funds were used in part to strengthen and expand these ongoing programs in the project area.

3.3. Survey data

The SAPP project was monitored using a rigorous system with well-designed baseline, midline, and endline household surveys (Cavatassi and Maggio, 2022). Randomly selected households from the project districts were selected for inclusion in the household surveys. To establish counterfactuals, comparable control districts within the project EPAs were identified before the intervention. For each treatment district, a control district that closely matched the characteristics of the treatment districts was selected based on demographic, socio-economic, agricultural production, and climatic characteristics that were gathered from existing databases (such as census) and supplemented with remote sensing data.[1] The risk of contamination between treated and control sites was reduced by ensuring buffer sites between matching districts and using sites that were mostly non-contiguous (about 15 km radius). The final set of controls comprised five districts namely, Rumphi, Nkhata Bay, Dedza, Ntcheu, and Zomba. The location of the treated and control districts is mapped in Fig. 1.

Sampling of the households was conducted at the ward level,[2] and a total of 120 wards were surveyed in both the control and treated districts. A minimum of 15 and a maximum of 20 households from each ward were randomly selected to be included in the survey. Baseline data were collected from 1,800 households in 2014 prior to project implementation. Follow-up surveys were conducted in 2018 and 2020 respectively. The SAPP survey tools have a structure very similar to those used in the World Bank's living standards measurement study (LSMS) surveys. Unlike the LSMS, the data collected under SAPP are not nationally representative but are representative of the households in the study areas. In each round of survey, households were asked questions about i) key demographic and socio-economic characteristics such as age, sex, health, educational level, livelihood activities, and income levels of household members; ii) agricultural production, including livestock ownership, land under crop cultivation, land area under irrigation, type of crop cultivated, input usage, and total harvest in the previous cropping season; iii) market participation proxied by the amount and share of crop sold in the various market outlets; iv) information on household welfare such as food consumption, exposure to natural shocks, durable and productive assets owned, and type of housing; and v) information on the various types of interventions received from SAPP by the treated households. The attrition rates between the baseline, midline, and endline surveys were eight and three percent, respectively. We evaluate whether attrition rates substantially varied by treatment status and find no evidence of systematic attrition ($p > 0.01$).

The household surveys were also complemented with a village-level baseline survey (hereafter referred to as community survey) to collect additional information on variables of importance for understanding and evaluating SAPP's performance. This included data on key village-level social, economic, and agricultural variables such as population density, agricultural potential, and the number of agrovets and extension officers in the community. The community survey also collected information on other agricultural and non-agricultural interventions in the communities for a more rigorous attribution of impacts to SAPP in terms of output and outcome indicators.

The survey data has already been used by Cavatassi and Maggio (2022) to conduct a standard impact assessment that measured and attributed SAPP's impacts using a quasi-experimental approach. This involved analysis of differences in the uptake of GAPs between treatment and control households, and associated differences in their crop yields, household income, and other welfare measures at the end of the project. Their report describes the project in more detail within an extensive theory of change framework. They find that the project significantly increased the uptake of GAPs by targeted SFs, led to increases in the yields of most food crops, the number of crops grown, and led to improvements in household food security and women's empowerment. However, the project was found to have had an insignificant impact on market access or household incomes. One reason for this could be that since the study only analyzed changes for the average SF, it may have missed any differences in outcomes that could have occurred for different types of households in terms of their livelihood strategies.

Our study does not attempt to replicate the Cavatassi and Maggio

[1] Only Chitipa district in the treatment areas, did not have a direct comparable control district, but it was still similar to the selected control districts in terms of poverty, geographic and climatic conditions, and agricultural and economic settings.

[2] Smaller administrative units within districts.

study but instead asks the more dynamic questions: did SAPP also help its target group of subsistence-oriented farmers either "step up" into commercial farming or "step out" into off-farm income diversification? If so, did those transitions lead to better welfare outcomes? We take advantage of the available panel data set for 2014 and 2020 and use our proposed typology to a) track and enumerate the household livelihood transitions over the period 2014 to 2020, b) estimate a quasi-experimental model to assess the extent to which the project impacted on those transitions, and c) assess the income outcomes associated with each type of transition. As noted above, our disaggregation of households by livelihood strategies should also unravel any income gains that may have accrued to some household types even if, as reported by Cavatassi and Maggio (2022), the average income for all project households did not increase,

3.4. Summary statistics

Table 4 presents some summary statistics for the study households and communities from the baseline survey. Given that we are interested in tracking household livelihood transitions over the life of the project, we use only data from a balanced panel of 1589 households. The results are presented for the pooled sample (Column 1) and separately for treated (Column 3: N=938) and control (Column 5: N=651) households. We also present the significance levels of the p-value for the test of the null hypothesis that there are no significant differences in means between the treated and control households (Column 7).

The overall picture from the pooled sample is one of a population of small farms (1.2 ha) headed by mostly male (70 %), full-time (80 %) middle-aged (49 years) farmers, with medium family sizes (5.2 members). Their livestock ownership is low (0.43 tropical livestock units (TLUs)), they borrow little agricultural credit, and only about 20 % belong to a farmers' organization. Their gross household income is a modest US$653/year, or US$125 per capita, which is well below the national poverty line. They live in moderately sized communities (10,210 people) that, on average, are reasonably close to a daily market (5.8 km) but are rather poorly served in terms of access to agro-dealers for fertilizers and hybrid seeds. Encouragingly, about 80 % of the communities have government agricultural extension workers, suggesting ease of access to extension services. On a decadal scale, the communities receive an average of 37 mm rainfall but with wide variation; the coefficient of variation is 23.8 %.

There are some important differences between the treated and control households. As shown in column 7, the treated households are significantly smaller and younger than the controls, less educated, have less land, and live further from an extension office and daily market. Their incomes are also significantly lower (30 %) than the controls and they live in communities that are less likely to grow cash crops, have less access to vets and agro-dealers, and have lower rainfall on average. These differences in the baseline confirm the selection biases inherent in the SAPP project design which must be controlled for when evaluating the project's impact.

4. Livelihood strategies and household transitions

In this section, we enumerate the livelihood strategies pursued by the sample households and the transitions they made between 2014 and 2020 using our simplified typology. Table 5 shows the distribution of households by type in 2014 and 2020 for the pooled, treated, and control samples. In 2014 (pre-intervention), 23.7 % of the households were subsistence-oriented, 31.8 % were pre-commercial, 10.1 % pursued market-oriented production, and 34.4 % were off-farm diversified. By 2020 there had been a 24 % reduction in the share of subsistence-oriented households in the pooled sample and a 37 % reduction in the share of pre-commercial farms. However, it would seem most of these households did not transition to commercial farming (whose share declined by 17 %) but instead transitioned into off-farm diversified livelihoods (whose share increased by 56 %). These patterns were more pronounced amongst the treated than control households, but not enough to suggest that SAPP had helped many subsistence or pre-commercial farmers transition into commercial farming or off-farm diversified livelihood.

The trends in Table 5 could also be misleading because they may conceal more diverse and offsetting patterns of movement between types that can occur at household levels. For example, if some households transitioned from subsistence to market-oriented farming while a similar number of market-oriented farmers transitioned backward to subsistence farming, the two would cancel out and not be captured in Table 5.

Table 4
Summary statistics for pooled, treated and control households and communities, (Baseline survey data).

	Pooled sample		*Treated sample*		*Control sample*		*Difference (3–5)*
	mean	*sd*	*mean*	*sd*	*mean*	*sd*	
Household variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Age of HH head (years)	49.34	15.39	48.64	15.21	50.35	15.60	−1.71*
Household size (count)	5.23	2.27	5.09	2.12	5.42	2.45	−0.33**
Educ. of HH head (years)	5.64	3.79	5.35	3.68	6.06	3.90	−0.71***
Educ. of all HH members (years)	5.02	2.37	4.76	2.29	5.39	2.43	−0.63***
Female headed HHs (%)	0.29	0.45	0.30	0.46	0.26	0.44	0.04
Farming main occup. (%)	0.81	0.39	0.80	0.40	0.82	0.39	−0.01
Land owned (Ha)	1.21	2.15	1.06	1.37	1.42	2.93	−0.36**
Gross HH income (US$)	653	5400	556	4778	793	6190	−237
Total livestock (TLU)	0.43	0.98	0.44	0.99	0.42	0.95	0.02
Took ag. credit (%)	0.08	0.27	0.09	0.29	0.07	0.25	0.02
Group membership (%)	0.19	0.39	0.19	0.39	0.20	0.40	−0.00
Distance to ext. office (Km)	2.44	3.73	2.63	3.73	2.16	3.72	0.47*
Distance to daily market (Km)	5.80	8.61	6.91	10.28	4.20	4.95	2.72***
Community variables							
Population ('000)	10.21	19.81	9.91	10.68	10.64	28.18	−0.73
Cash crop in the comm. (%)	0.26	0.44	0.29	0.45	0.21	0.41	0.08***
Agrovet in the comm. (%)	0.11	0.31	0.08	0.27	0.14	0.35	−0.06***
# fertilizer sellers in comm (count)	0.26	1.03	0.21	1.00	0.33	1.08	−0.12*
# hybrid seed sellers (count)	0.36	1.17	0.31	1.14	0.42	1.20	−0.11
Extension service in comm (%)	0.82	0.39	0.81	0.39	0.83	0.38	−0.02
Average decadal rainfall (mm)	36.65	8.74	35.72	8.66	37.98	8.68	−2.26***
N	**1589**		**938**		**651**		**1589**

Note: Columns (2), (4), and (6) present the standard deviations. *** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$.

Table 5
Distribution of households by type, 2014 and 2020, percent.

Farm typology	2014				2020			
	Pooled	*Treated*	*Control*	*Diff*	*Pooled*	*Treated*	*Control*	*Diff*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Subsistence oriented	23.7	22.5	25.3	−2.8	17.9	14.4	23.0	−8.6***
Pre-commercial	31.8	31.2	32.6	−1.4	19.9	19.6	20.3	−0.7
Market oriented	10.1	10.8	9.2	1.6	8.4	9.5	6.8	2.7*
Off-farm diversified	34.4	35.5	32.9	2.6	53.8	56.5	49.9	6.6**
N	**1589**	**938**	**651**		**1589**	**938**	**651**	

Note: Columns (4) and (8) present the significance level of the p-values of a test of differences between the two groups. *** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$.

A better way to track household transitions is to calculate a transition matrix (Table 6) showing how households of each type in 2014 (the rows) transitioned to the different possible types by 2020 (the columns). For example, the first row in Table 6 shows that of all the households that were subsistence oriented in 2014, only 24.5 % remained so in 2020, while 19.4 % had transitioned to pre-commercial farming, 7.5 % to market-oriented farming, and 48.7 % to off-farm diversified livelihoods. Table 6 shows much greater household mobility between livelihood types than Table 5 suggests. It also demonstrates the importance of offsetting patterns of household transitions. For example, while Table 5 shows a 25 % reduction in the share of subsistence farms between 2014 and 2020, Table 6 reveals that this figure masks a lot of underlying transitions. Three-quarters of the households that were subsistence oriented in 2014 had transitioned out of subsistence farming by 2020, but this was offset to a considerable extent by some 15 % of the pre-commercial, market-oriented, and off-farm diversified households in 2014 transitioning backwards into subsistence farming by 2020.

The dominant livelihood transitions are towards off-farm income diversification. On average, nearly 50 % of subsistence, pre-commercial, and market-oriented households had transitioned to off-farm diversified livelihoods by 2020 and two-thirds of those who were already off-farm diversified in 2014 remained so in 2020. At the same time, only 11 % of the market-oriented farmers in 2014 remained as such in 2020. These patterns were slightly more marked for the treated than control households (Fig. 2). In all cases, higher shares of the treated households transitioned to off-farm diversified livelihoods than the controls, and lower shares of the treated remained or fell into subsistence farming.

Prima facie, there is little evidence here to suggest the SAPP project was very successful in helping many subsistence or pre-commercial households transition to commercial farming. However, we have not yet corrected for selection biases implicit in the way SAPP was targeted which may help explain why the treated households did not transition better than the controls, a more correct analysis requires an econometric approach to measure the impact of the project, which is presented in the next section.

Table 6
Household transitions matrix, 2014 to 2020, pooled sample, percent.

Pre-Intervention Typology (%)	Post-Intervention Typology (%)				
	Subsistence	Pre-commercial	Market oriented	Off-farm diversified	N
	(1)	*(2)*	*(3)*	*(4)*	*(6)*
Subsistence oriented	24.47	19.41	7.5	48.62	**376**
Pre-commercial	17.23	26.73	9.70	46.34	**505**
Market oriented	13.66	29.81	11.18	45.35	**161**
Off-farm diversified	15.36	10.97	6.95	66.72	**547**
N	**285**	**316**	**133**	**855**	**1,589**

5. Impacts of SAPP on household transitions

5.1. Empirical approach

In this section, we employ econometric approaches to assess whether the SAPP project had any significant impact on household decisions to transition to different livelihood strategies. A challenging problem in evaluating the impact of agricultural projects like SAPP is that they are targeted at specific geographies and types of households (e.g., food insecure households in poorer and more remote areas). As such, simply comparing the differences between SAPP recipient and non-recipient households based on an ordinary least squares (OLS) estimator could lead to biased estimates of the true impact of the project. In addition, the non-random treatment assignment and lack of plausible instrumental variables make it difficult to estimate the structural cause and effect relations within a theory of change for the project. To overcome these challenges, we employ appropriate quasi-experimental approaches that compare the livelihood outcomes of households endowed with similar attributes but with and without SAPP interventions. This approach essentially measures the impact of SAPP above and beyond all other sources of change in the communities from 2014 to 2020. Consider the following regression function:

$$Y_{mn} = \propto + \gamma T_i + \beta X_i + \delta M_c + \varepsilon_i \quad (1)$$

where for all households of livelihood strategy m, where $m = 1, 2, 3, 4$ in 2014, Y_{mn} is a binary variable indicating whether a household transitioned from livelihood strategy m to n in the 2014–2020 period. This, therefore, implies that a household pursuing livelihood strategy m at baseline can have one of the following outcomes: i) remain in livelihood strategy m or, ii) transition to livelihood strategy n, where $n = 3$, and $n \neq m$. T_i is a binary variable indicating whether household i was a beneficiary of SAPP ($T_i = 1$ if treated and 0 if a control), X_i is a vector of independent variables that are thought to influence household transitions across different livelihood strategies. These include i) household demographic and socio-economic characteristics such as gender of household head, age of the household head, number of years of formal education completed by the household head, household dependency ratio, livestock ownership, and area of land owned, ii) market characteristics, including, commodity prices, distance to the nearest daily or weekly markets, and access to agricultural credit. M_c are community-level variables including rainfall outcomes, population density, numbers of agrovets and physical markets, and extension workers in the community, the number of non-SAPP agricultural and non-agricultural interventions within the community, and a share of land under tobacco, the most important commercial crop in the study area (see Table 4 for a summary of household and community characteristics). ε_i is the error term.

We estimate the above model using two different approaches. First, we use a village-level fixed effects (FE) regression model. The FE model makes SAPP and non-SAPP farmers more comparable by addressing any unobserved heterogeneity in geographical characteristics that are not captured in our X variables. In the second estimation strategy, we follow

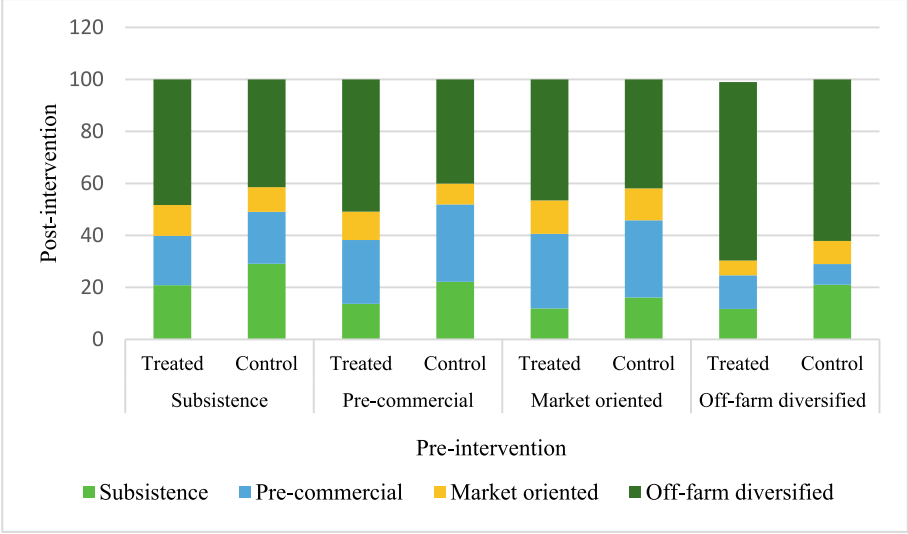

Fig. 2. Comparison of transitions between treated and control households, 2014 to 2020.

earlier quasi-experimental impact studies (such as, Mano et al. 2020; Kafle et al., 2022; Shibatu et al. 2022; Cavatassi and Maggio 2022) and employ an inverse probability weighted regression adjustment (IPWRA) approach. IPWRA combines inverse probability weighting and regression adjustment to model the likelihood of project participation and estimate the project impacts contingent on participation. The model is appropriate when there is selection bias in the sample and inadequate information to control for it in a more structural way (Imbens and Wooldridge, 2009; Wooldridge, 2010). To create matching counterfactuals for each household in the treatment pool, propensity scores (or the probabilities of receiving treatment) are predicted using maximum likelihood estimation of a probit model, where the dependent variable is

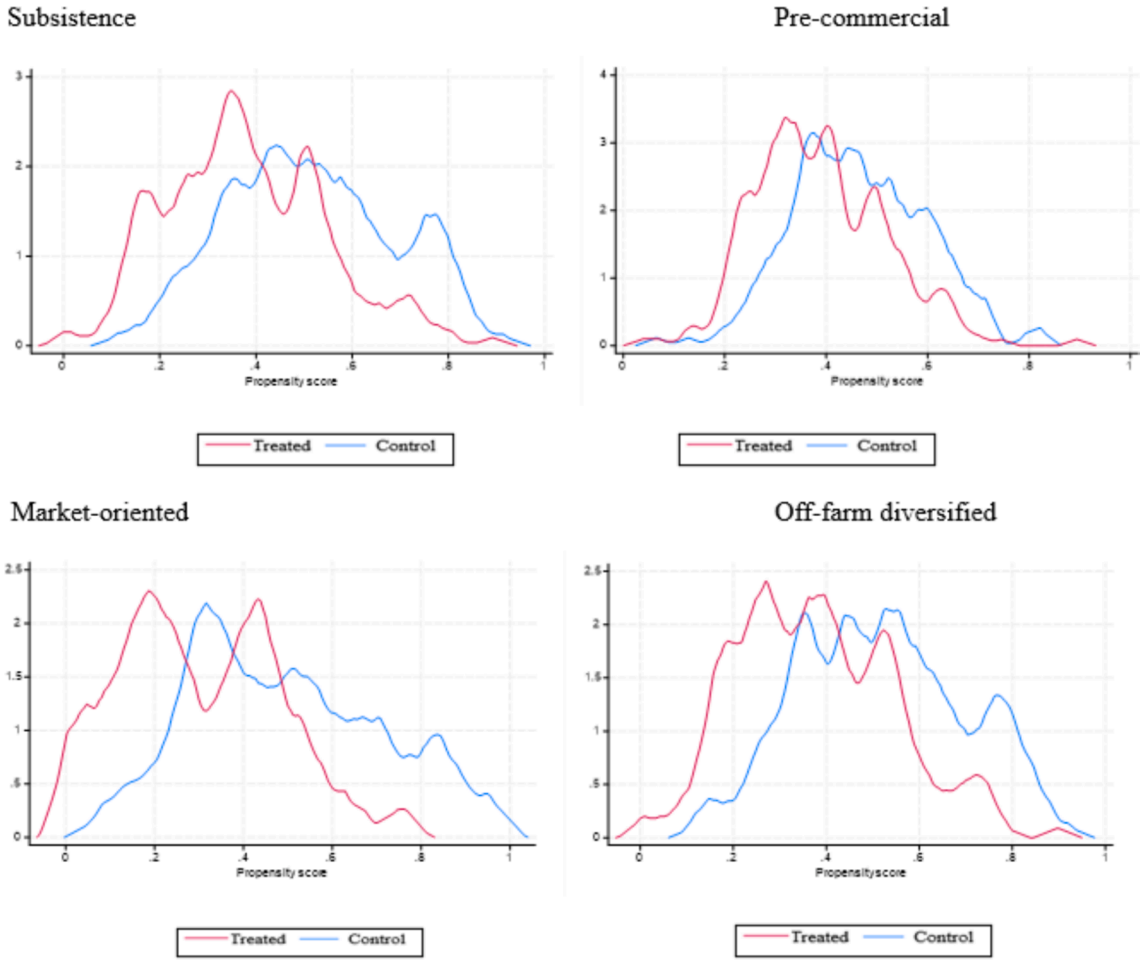

Fig. 3. Covariate distribution overlap plots.

the SAPP treatment status, and the independent variables are the set of covariates described in Table 4. The propensity weighting is conducted by taking simple inverse weights of the propensity scores, mathematically expressed as; $w_{ATT}(T,X) = T + (1-T)\frac{\widehat{P}(X)}{1-\widehat{P}(X)}$. For every treated household, we select three control households that most closely resemble the treated household in question. We then run a regression adjustment model using the specification of Equation (1) weighted by the propensity scores separately for SAPP and non-SAPP households. The average treatment effect is estimated by taking the differences in the estimators for the treatment and control households.

A substantial overlap in the covariate distributions between treatment and control groups is essential for the IPWRA model if it is to minimize estimation biases and variance inflations (Imbens et al. 2014). Fig. 3 demonstrates sufficient overlap in the covariate distribution between SAPP recipients and non-recipients across the four groups in our sample. In addition, the balance diagnostic test in Table 7 shows insignificant chi-squared statistics, indicates that after matching the covariates on propensity scores, the control and treatment households are statistically very similar.

5.2. Impact of SAPP on household livelihood transition

Table 8 presents the estimated impact of SAPP on farmer livelihood transitions based on the FE (Column 1) and IPWRA (Column 2) models. We separately present four sets of outcomes based on the livelihood strategy that the farmer was pursuing at baseline: that is, subsistence-oriented (Panel A), pre-commercial (Panel B), market-oriented (Panel C), and off-farm diversified (Panel D). In both estimations, the standard errors are adjusted for clustering at the district level. The coefficients from the two econometric approaches are very consistent with each other. However, given that IPWRA estimates the impacts of SAPP while controlling for a wider set of household and community characteristics that could also influence livelihood transitions, we focus our discussion below on the IPWRA estimator.

Focusing on the statistically significant results, we find that the SAPP intervention helped 7.9 % of households that were subsistence oriented in the baseline transition to market oriented farming by 2020, and reduced the likelihood that they would remain in subsistence farming by 12.3 % (Panel A), The project results are more disappointing for the pre-commercial households in the baseline; the project reduced their likelihood of falling into subsistence farming by 2020 by 9.6 % and increased the likelihood that they would transition to off-farm diversified livelihoods by 10.2 %, but had no significant impact on the likelihood they would transition to market oriented farming (Panel B). Although the project was not targeted at the market oriented or off-farm diversified households, it did indirectly help these two groups remain in their baseline livelihood strategies, and reduced the likelihood that off-farm diversified households would fall into subsistence farming (Panels C and D).

Some insights about the pathways through which SAPP impacted on the different types of households can be gleaned using the same modelling approach. We estimated of the impact of SAPP on household agricultural productivity, agricultural income, and non-agricultural income for each of the four SF categories by specifying these variables in the FE and IPWRA models highlighted in section 5.1. The results in Table 9 indicate that SAPP increased agricultural productivity among subsistence, market-oriented, and off-farm diversified farmers, potentially facilitating a shift towards greater agricultural commercialization. The program also significantly boosted farm incomes for subsistence, pre-commercial, and market-oriented farmers, further indicating a shift towards commercialization. SAPP also had positive and significant impacts on the non-farm incomes for farmers that were pre-commercial at baseline, suggesting the possibility of creation of new market opportunities for this group.

Table 7
Covariate balancing test by SF livelihood strategies.

Livelihood strategy at baseline	Chi-square	P-value
Subsistence	3.765	0.999
Pre-commercial	10.478	0.574
Market-oriented	4.934	0.986
Off-farm diversified	5.193	0.736

Table 8
Impacts of SAPP on household transition over 2014 to 2020.

	FE	IPWRA
Transition outcome *in 2020*	**(1)**	**(2)**
Panel A: Subsistence at baseline		
Remain subsistence	−0.107*	−0.123**
	(0.053)	(0.044)
Transition to pre-commercial	0.029	0.061
	(0.051)	(0.089)
Transition to market-oriented	0.134***	0.079**
	(0.033)	(0.029)
Transition to off-farm diversified	0.055	0.023
	(0.059)	(0.051)
N	***376***	***376***
Panel B: Pre-commercial at baseline		
Transition to subsistence oriented	−0.096*	−0.096**
	(0.039)	(0.034)
Remain pre-commercial	−0.020	−0.078
	(0.045)	(0.068)
Transition to market oriented	0.050	0.022
	(0.031)	(0.027)
Transition to off-farm diversified	0.096**	0.102***
	(0.046)	(0.044)
N	***505***	***505***
Panel C: Market-oriented at baseline		
Transition to subsistence	−0.039	−0.027
	(0.089)	(0.047)
Transition to pre-commercial	0.052	−0.094
	(0.092)	(0.072)
Remain market oriented	0.080	0.087*
	(0.055)	(0.051)
Transition to off-farm diversified	0.039	0.047
	(0.089)	(0.079)
N	***161***	***161***
Panel D: Off-farm diversified at baseline		
Transition to subsistence	−0.152***	−0.112***
	(0.037)	(0.033)
Transition to pre-commercial	0.083*	0.056*
	(0.032)	(0.026)
Transition to market-oriented	−0.028	−0.020
	(0.026)	(0.022)
Remain off-farm diversified	0.098*	0.098*
	(0.048)	(0.042)
N	***547***	***547***

Notes: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$. Standard errors accounting for clustering at the district level are in parentheses. Each coefficient estimate comes from a separate individual regression equation. The IPWRA models controls for a set of covariates including age, gender and education level of the household head, TLU ownership, access to daily and weekly markets, rainfall, natural log of agricultural commodity prices, access to credit and agricultural extension, and number of non-SAPP interventions in the community.

5.3. Impact of livelihood transition on household welfare

We have demonstrated that the SAPP interventions effectively assisted some smallholder farmers in transitioning out of subsistence and pre-commercial farming, while at the same time helping those in market-oriented and off-farm diversified livelihood strategies to maintain their status. Although we have shown that these transitions were

Table 9
SAPP impact pathways.

Livelihood strategy at baseline	*Subsistence*		*Pre-commercial*		*Market-oriented*		*Off-farm diversified*	
	FE	*IPWRA*	*FE*	*IPWRA*	*FE*	*IPWRA*	*FE*	*IPWRA*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Agricultural production (ln)	0.451*	0.213**	0.097	0.082	0.261*	0.322**	0.307***	0.275***
	(0.223)	(0.081)	(0.068)	(0.061)	(0.131)	(0.103)	(0.008)	(0.072)
Agricultural income (ln)	0.037*	0.055*	0.352*	0.470**	0.517*	0.365**	0.155	0.093
	(0.191)	(0.032)	(0.182)	(0.126)	(0.255)	(0.117)	(0.416)	(0.158)
Non-agricultural incomes (ln)	−0.210	−0.055	0.064**	0.042**	0.276	0.244	0.121	0.240*
	(0.255)	(0.230)	(−0.021)	(0.014)	(0.376)	(0.237)	(0.395)	(0.140)
N	**376**	**376**	**505**	**505**	**161**	**161**	**547**	**547**

Notes: *** p < 0.01 ** p < 0.05 * p < 0.10. Standard errors accounting for clustering at the district level are in parentheses. Each coefficient estimate comes from a separate individual regression equation. The IPWRA models controls for a set of covariates including age, gender and education level of the household head, TLU ownership, access to daily and weekly markets, rainfall, natural log of agricultural commodity prices, access to credit and agricultural extension, and number of non-SAPP interventions in the community.

supported by SAPPs impacts on farm productivity and participation in farm and non-farm income earning opportunities, from a policy standpoint, it is crucial to understand whether SAPP facilitated livelihood transitions led to significant improvements in overall household welfare. In this section, we assess the impact of SAPP-supported livelihood transitions on household welfare, using gross household income as our best available welfare indicator. We again utilize the FE and IPWRA models discussed in section 5.1 defining the outcome variable as the logarithm of gross household income derived from the endline survey. The results of the income analysis are presented in Table 10 and the following discussion is based on the IPWRA estimates, which provide a robust evaluation of SAPP's impact on household incomes.

Comparison of Tables 7 and 9 shows a high degree of correspondence between the statistically significant coefficients. All the transitions for which the project had a statistically significant and positive (negative) impact also led to significant increases (reductions) in household income, suggesting households were rational in their choice of livelihood strategies. Specifically, we find that for farmers who were subsistence-oriented in 2014, remaining as such reduced their incomes by approximately 36 %, while those who transitioned with the help of SAPP to a market-oriented strategy experienced a 35 % increase in their incomes. For farmers that were pre-commercial in 2014, we find that falling into a subsistence livelihood would have reduced their incomes by 20 %, but when these farmers transitioned to an off-farm diversified livelihood strategy, their incomes significantly increased by 17 %, but these effects are only weakly significant. For market-oriented households, we find that remaining in the same typology is associated with a 41.5 % increment in incomes, which is also weakly significant. For the off-farm diversified households, we find that falling into subsistence farming would have reduced their incomes by 33.4 %, while remaining in off-farm diversified strategy increased incomes by 30 %.

Overall, these findings suggest that remaining in or transitioning to subsistence farming leads to significant reductions in household income. Households that remained in subsistence farming earned approximately USD 220 less income than those that transitioned to other livelihood strategies. The results also show that transitioning to either market-oriented or off-farm diversified strategies can significantly boost incomes for subsistence and pre-commercial farmers. The fact that some household livelihood transitions led to income losses while others led to gains is consistent with Cavatassi and Maggio's (2020) finding, which we independently confirmed with our more limited matching panel subsample, that the average income over all households did not increase as a result of the project. It also illustrates the importance of disaggregating impact analyses by different types of households to avoid missing out on possible different outcomes amongst targeted populations and for improving the targeting and effectiveness of future SF interventions.

Table 10
Impacts of livelihood transition on household income.

Outcome: Income in 2020 (US$ gross hh income)	FE	IPWRA
	(1)	**(2)**
Panel A: Subsistence at baseline		
Remain subsistence	−0.409**	−0.364**
	(0.149)	(0.141)
Transition to pre-commercial	0.157	0.050
	(0.163)	(0.139)
Transition to market-oriented	0.373*	0.379**
	(0.217)	(0.136)
Transition to off-farm diversified	0.159	0.137
	(0.141)	(0.122)
N	***376***	***376***
Panel B: Pre-commercial at baseline		
Transition to subsistence	−0.304*	−0.200*
	(0.126)	(0.111)
Remain pre-commercial	0.139	−0.100
	(0.111)	(0.086)
Transition to market-oriented	0.160	0.027
	(0.161)	(0.169)
Transition to off-farm diversified	0.132	0.176*
	(0.108)	(0.082)
N	***505***	***505***
Panel C: Market-oriented at baseline		
Transition to subsistence	0.048	−0.112
	(0.249)	(0.178)
Transition to pre-commercial	−0.029	−0.054
	(0.190)	(0.137)
Remain market-oriented	0.520*	0.415*
	(0.260)	(0.235)
Transition to off-farm diversified	−0.305	−0.032
	(0.186)	(0.128)
N	***161***	***161***
Panel D: Off-farm diversified at baseline		
Transition to subsistence	−0.398**	−0.334**
	(0.141)	(0.113)
Transition to pre-commercial	0.058	0.050
	(0.111)	(0.098)
Transition to market-oriented	0.227	0.103
	(0.200)	(0.100)
Remain off-farm diversified	0.341*	0.302**
	(0.167)	(0.109)
N	***547***	***547***

Notes: *** p < 0.01 ** p < 0.05 * p < 0.10. Standard errors accounting for clustering at the district level are in parentheses. Each coefficient estimate comes from a separate individual regression equation. The IPWRA models controls for a set of covariates including age, gender and education level of the household head, TLU ownership, access to daily and weekly markets, rainfall, natural log of agricultural commodity prices, access to credit and agricultural extension, and number of non-SAPP interventions in the community.

6. Conclusions

Through our Malawi Sustainable Agricultural Production Program (SAPP) case study, we have demonstrated that it is possible to identify and track smallholder household transitions across different types of livelihood strategies that are meaningful within the changing opportunities available over the life of a project. Also, by using quasi-experimental econometric approaches, we quantified the project's impact in facilitating the household transitions and their income outcomes.

We find that the SAPP project was successful in helping some subsistence farmers transition to market-oriented farming, and it also helped increase the likelihood that some farmers already engaged in market-oriented farming would remain as such. The project also helped reduce backward transitions to subsistence farming among pre-commercial and off-farm diversified farmers. These transitions were supported by SAPPs positive impacts on agricultural productivity and access to markets. The project also assisted some households to either transition to, or retain, an off-farm income diversification strategy. Although there were no specific project components designed to promote off-farm incomes, these transitions may have been helped by spillover benefits from the project in creating additional income and employment opportunities along AVCs and within the rural nonfarm economy more generally.[3] They may also have been helped by increases in on-farm productivity releasing family labor for additional off-farm activities.

From a policy perspective, our findings show that farmers pursue broader goals than just increasing farm productivity and they are willing to pursue new livelihood strategies when this can improve their welfare. However, household transitions between livelihood types can take several years to achieve. For example, the transition from subsistence or pre-commercial to market-oriented farming might first involve creating the conditions for productivity growth, such as providing secure property or tenancy rights over land so that SFs can access credit and invest in new technologies. This in turn may lead to increased market shares of agricultural outputs, a key step towards becoming market-oriented farmers. However, this is not an assured step because small-scale producers may have trouble accessing credit and modern inputs or may be unable to monetize their increased production because of market constraints (e.g., small, marketed surpluses or ones of poor quality that may not be attractive to traders). Solving these problems requires parallel development of the relevant AVCs and their upstream and downstream linkages to SFs. To achieve the longer-term goal of sustainably increased incomes, many SFs may also need to diversify into off-farm sources of income, and this in turn may require them to acquire new employment skills or establish a nonfarm business of their own. Achieving these transformations requires a holistic approach to agriculture and rural development and one that is sustained over a sufficiently long period of time for household transitions to occur and take root. It also requires sufficiently long panel data sets if household transitions are to be assessed in project evaluations.

Our proposed typology of household livelihood strategies is intended to help bridge the gap between the literature on rural transformation and project analysis. However, it is not unique and needs to be tested and adapted as needed through further case studies. For agencies that invest in agricultural projects, the challenge is less to find an optimal typology than to select one that can be used to make comparisons across projects, over time and in different geographies, and to use this consistently in their work. This seems especially relevant for projects undertaken within regions already undergoing a dynamic transformation, and/or projects that have significant agricultural value chain components, conditions which can both facilitate household transitions to commercial farming and create new income earning opportunities in the non-farm economy.

[3] Although such spillovers have been widely demonstrated in the literature (e.g., Haggblade et al, 2007), verification for the SAPP project would require data and modeling approaches that lie beyond the scope of this study.

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Anne G. Timu: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization.. **Peter Hazell:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Sara Savastano:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

AGRA., 2017. Africa Agriculture Status Report: The Business of Smallholder Agriculture in Sub-Saharan Africa (Issue 5). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA). Issue No. 5.

Barrett, C.B., Reardon, T., Swinnen, J., Zilberman, D., 2022. Agri-food value chain revolutions in low- and middle-income countries. J. Econ. Lit. 60 (4), 1316–1377.

Benson, T., De Weerdt, J., Duchoslav, J., Masanjala, W., 2024. Fertilizer subsidies in Malawi: From past to present. International Food Policy Research Institute, Washington, DC. MaSSP Working Paper 44.

Berdegué, J., Escobar, G., 2002. Rural diversity, agricultural innovation policies and poverty reduction. Network Paper No. 122, Agricultural Research and Extension Network, Overseas Development Institute, London.

Berre, D., Baudron, F., Kassie, M., Craufurd, P., Lopez-Ridaura, S., 2019. Different ways to cut a cake: comparing expert-based and statistical typologies to target sustainable intensification technologies. A case-study in southern Ethiopia. Exp. Agric. 55 (S1), 191–207.

Bidogeza, J.C., Berentsen, P.B.M., De Graaff, J., Oude Lansink, A., 2009. A typology of farm households for the Umutara Province in Rwanda. Food Security 1 (3), 321–335.

Cavatassi, R., Maggio, G., 2022. Impact assessment report: Sustainable Agricultural Production Programme. Malawi, IFAD, Rome, Italy.

Christen, R.P., Anderson, J., 2013. Segmentation of Smallholder Households: Meeting the Range of Financial Needs in Agricultural Families No. 78232, 1–32.

Cortez-Arriola, J., Rossing, W.A., Massiotti, R., Scholberg, J., Groot, J., Tittonell, P., 2015. Leverages for on-farm innovation from farm typologies? An illustration for family-based dairy farms in north-west Michoacán, Mexico. Agr. Syst. 135, 66–76.

Dorward, A., Anderson, S., Bernal, Y., Vera, E., Rushton, J., Pattison, J., Paz, R., 2009. Hanging in, stepping up and stepping out: livelihood aspirations and strategies of the poor. Dev. Pract. 19 (2), 240–247.

Fan, S., Rue, C., 2020. The role of smallholder farms in a changing world. The Role of Smallholder Farms in Food and Nutrition Security 13–28.

Haggblade, S., Hazell, P., Dorosh, P. A., 2007. Sectoral growth linkages between agriculture and the rural nonfarm economy. In: Haggblade, Hazell and Reardon (eds.), Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World. Baltimore: Johns Hopkins University Press.

Hammond, J., Rosenblum, N., Breseman, D., Gorman, L., Manners, R., van Wijk, M.T., Sibomana, M., Remans, R., Vanlauwe, B., Schut, M., 2020. Towards actionable farm typologies: scaling adoption of agricultural inputs in Rwanda. Agr. Syst. 183, 102857.

Hazell, P., Rahman, A., 2014. Concluding chapter: the policy agenda. In: Hazell, P., Rahman, A. (Eds.), New Directions for Smallholder Agriculture. Oxford University Press for IFAD, Oxford.

Imbens, G.W., Wooldridge, J.M., 2009. Recent developments in the econometrics of program evaluation. J. Econ. Lit. 47 (1), 5–86.

Kafle, K., Songsermsawas, T., Winters, P., 2022. Agricultural value chain development in Nepal: understanding mechanisms for poverty reduction. Agric. Econ. 53, 356–373.

Kaur, J., Prusty, A.K., Ravisankar, N., Panwar, A.S., Shamim, M., Walia, S.S., Kashyap, P., 2021. Farm typology for planning targeted farming systems interventions for smallholders in Indo-Gangetic Plains of India. Sci. Rep. 11 (1), 1–16.

Kutcher, G., Scandizzo, P. L., 1981. The agricultural economy of Northeast Brazil. Unnumbered series; no. UNN 184 Washington, D.C: World Bank Group.

Lind, J., Sabates-Wheeler, R., Caravani, M., Kuol, L.B.D., Nightingale, D.M., 2020. Newly evolving pastoral and post-pastoral rangelands of Eastern Africa. Pastoralism 10 (1), 1–14.

Malawi Government. 2018. National Agricultural Investment Plan. Ministry of Agriculture, Irrigation and Water Development. https://faolex.fao.org/docs/pdf/mlw190532.pdf.

Mano, Y., Takahashi, K., Otsuka, K., 2020. Mechanization in land preparation and agricultural intensification: the case of rice farming in the Cote d'Ivoire. Agric. Econ. 51, 899–908.

McPeak, J., Little, P., 2017. Applying the concept of resilience to pastoralist household data. Pastoralism: Res, Policy and Practice 7 (1), 1–18.

Pacini, G.C., Colucci, D., Baudron, F., Righi, E., Corbeels, M., Tittonell, P., Stefanini, F. M., 2014. Combining multi-dimensional scaling and cluster analysis to describe the diversity of rural households. Exp. Agric. 50 (3), 376–397.

Reardon, T., 2015. The hidden middle: the quiet revolution in the midstream of agrifood value chains in developing countries. Oxf. Rev. Econ. Policy 31 (1), 45–63.

Reardon, T., Liverpool-Tasie, L., Minten, B., 2021. Quiet revolution by SMEs in the midstream of value chains in developing regions: wholesale markets, wholesalers, logistics, and processing. Food Sec. 13, 1577–1594.

Shibatu, K.T., Arslan, A., Zucchini, E., 2022. The effect of agricultural programs on dietary diversity and food security: insights from the smallholder productivity promotion program in Zambia. Food Policy 113, 102268.

Van der Ploeg, J.D., Groot, J.C.J., Verhoeven, F.P.M., Lantinga, E.A., 2007. Interpretation of results of on-farm experiments: slurry nitrogen recovery on grassland as affected by slurry quality and application technique. 2. A sociological analysis. NJAS-Wageningen J. Life Sci. 54, 255–268.

Vorley, W., 2002. Sustaining agriculture: policy, governance, and the future of family farming. International Institute for Environment and Development (IIED), London.

Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data, 2nd ed. MIT Press, Cambridge, MA.

World Bank, 2007. World Development Report 2008: Agriculture for Development. Washington, DC: The World Bank.