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Impact of collective action on household welfare: Empirical evidence from baobab collectors in Malawi

Dennis Etemesi Olumeh | **Dagmar Mithöfer**

Humboldt-Universität zu Berlin, Agrifood Chain Management Group, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences, Berlin, Germany

Correspondence
Dennis Etemesi Olumeh, Humboldt-Universität zu Berlin, Agrifood Chain Management Group, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences, Invaliden Str. 42, 10099, Berlin, Germany.
Email: dennis.olumeh@hu-berlin.de

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Abstract

Empirical studies show that smallholder farmers can benefit from collective action by improving their crop production and access to better markets. Although there are numerous studies on the effects of collective action on production and marketing of staple crops, such studies, particularly on the analysis of gender and collective action, are scarce for underutilized crops such as baobab. To address this gap, we estimate the impacts of cooperative membership on baobab income and food security, using data collected from a survey of 864 baobab collectors in Malawi. We employ the Inverse Probability Weight Regression Adjustment estimator to account for selection bias. We also analyse heterogeneity in the impact of cooperatives attributable to gender. We find that cooperative membership increases baobab income, household dietary diversity score, and food consumption score by 3.57%, 11%, and 5.6%, respectively. However, the welfare outcome of cooperative members differs based on gender. In particular, households with male baobab managers that are cooperative members have higher income and are more food secure. Households with unmarried female managers have better welfare outcomes. The results, therefore, highlight the need to promote collective action through cooperatives in the underutilized crop sector to enhance household welfare.

KEYWORDS
baobab, cooperatives, heterogeneous effects, impact evaluation, Malawi, welfare

JEL CLASSIFICATION
O13, Q12, Q13

1 | INTRODUCTION

High levels of food and nutrition insecurity persist in sub-Saharan Africa (SSA) (IFPRI, 2018; FAO et al., 2019) with 19.1% of the population malnourished, which is the highest in the world and twice the global average (FAO et al., 2020). In Southern Africa and Malawi, 8.3% and 82% of the population, respectively, are affected by moderate or severe food insecurity. In addition, 71% of the Malawian population is poor and lives on less than US$1.90 per day (IMF, 2017). Among other factors, low crop diversification, biotic and abiotic stresses and climate change contribute to poor household welfare in SSA (Markelova & Mwangi, 2010; Massawe et al., 2016).

The persistence of poverty and food and nutrition insecurity in SSA, and Malawi in particular, highlights the need for a paradigm shift in food systems that focuses on diversification into other food chains such as underutilized crops (Dawson et al., 2018; Mustafa, Mayes & Massawe, 2019). Food chain diversification has the potential to ensure resilience in harsh environmental conditions that affect individual crops differently (Ray et al., 2012). For example, Asfaw et al. (2019) found that income and crop diversification strategies had a positive impact on household welfare among farming households in Malawi, Zambia, and Niger. One such diversification pathway identified for SSA is the promotion and use of underutilized plant species (UPS)[1] such as baobab.

The utilization of UPS is not a new concept in SSA (Akinnifesi et al., 2008). These crops have the potential to provide SSA with a productive, nutrition-sensitive, and resilient food system (Hendre et al., 2019). They contribute to various welfare outcomes such as improved incomes, better food and nutrition security, and employment opportunities for rural populations (Baldermann et al., 2016; Adongo et al., 2019). Despite these economic opportunities and the availability of baobab, their commercialization in rural areas is still low (Rudebjer et al., 2014).

Rural areas are characterized by poor infrastructure and poor networks; therefore, access to market is limited and transaction costs are high (Barrett, 2008). Smallholders in SSA are thought to be able to overcome high transaction costs and other market imperfections through collective

[1] "Any agricultural or non-timber forest species, collected, managed or cultivated and it is locally abundant, there is limited scientific knowledge on it and its current use is limited in comparison to its economic potential value" (Gruère et al. 2006).

action and also strengthen their bargaining power to obtain better prices (Bernard, Collion, et al., 2008; Markelova et al., 2009; Verhofstadt & Maertens, 2015).

The importance of collective action for rural development has attracted the attention of researchers, policymakers, and development practitioners. Recent reviews (Grashuis & Ye, 2019; Bizikova et al., 2020; Ma et al., 2023) have reported mixed findings on the impact of collective action on the livelihoods of smallholders. For instance, in Zambia, Minah (2021) and Manda et al. (2020), find that cooperative membership positively and significantly increased income levels and technology adoption rates by 43% and 11–24%, respectively. In Kenya, Mutonyi (2019) found that collective action increased household income and asset holding by 24–35% and 19–33%, respectively. Another strand of literature reported the lack of benefits of cooperatives among smallholder members in Ethiopia (Bernard et al., 2008; Chagwiza et al., 2016; Shumeta & D'Haese, 2016). For example, Bernard et al. (2008) and Chagwiza et al. (2016) found that cooperative membership did not have any significant effect in the share of commercialized cereal and the prices obtained by dairy farmers in Ethiopia, respectively. Most of these impact studies focus on staple crops and high-value crops with a few studies on UPS (e.g., Gruère et al., 2009; Kruijssen et al., 2009; Tita et al., 2011; Tilahun et al., 2016; Gelo, 2020). However, there is no empirical evidence on baobab from Southern Africa, particularly Malawi. In the case of UPS, some studies (Gruère et al., 2009; Kruijssen et al., 2009; Paumgarten et al., 2012; Gyau et al., 2014) neither accounted for selection bias nor used a counterfactual group, which may generate biased estimates.

Furthermore, the collection and utilization of UPS is mainly by the rural poor, such as women. Whether UPS are collected for subsistence or commercial purposes, their utilization is guided by traditions and norms, including gender norms (Sunderland et al., 2014). Low entry requirements (both financial and technical), free available resource base, and the safety net advantage are the reasons why women and the resource-poor find UPS chains attractive (Carr & Hartl, 2008). Hence, previous studies on gender and UPS have mainly focused on perceptions of forest product use (Sunderland et al., 2014); activities and roles (Ingram et al., 2014); forest management (Leone, 2019; Zhu et al., 2020); and dimensions of forest income (Asfaw et al., 2013). The heterogeneous impacts based on gender are neglected in these few studies on UPS. However, literature (Wossen et al., 2017; Gelo & Dikgang, 2019; Ji et al., 2019; Grashuis & Skevas, 2022) shows that the welfare impacts of cooperatives can vary depending on the socioeconomic characteristics of the members.

In this context, our study aims to answer the following research questions: (1) What factors influence the decision of baobab collectors to participate in a cooperative? (2) How does cooperative membership affect income and food security of baobab collectors? (3) How do the levels of income and food security differ based on gender and other socioeconomic characteristics of member households?

By answering the research questions, our paper contributes to the literature in the following ways. First, baobab constitutes a unique case as it exemplifies a crop with increased commercialization in the recent past. The fruit has been commercialized domestically in Malawi (Darr et al., 2020; Meinhold & Darr, 2022), regionally in SSA (Sanchez, 2011; Jäckering et al., 2019; Kaimba et al., 2020), and internationally (Meinhold et al., 2022). Hence this study will be instrumental in generating insights into the nexus of an emerging commercial crop and collective action opportunities. Baobab markets are thin or non-existent in some cases, therefore collective action can have a greater impact depending on members' socioeconomic characteristics, relative to working individually (Rudebjer et al., 2014). Generally, collective action may enable smallholders in the UPS value chain to achieve economies of scale, improve their bargaining power, and have better product quality and quantity (Gruère et al., 2009). Second, our study deviates from the norm of most previous studies on the impact of cooperatives that assume homogeneous effects among members. We extend our analysis by exploring the heterogeneous treatment effects as defined by gender and other socio-economic characteristics among member households. We disaggregate our analysis further by exploring this heterogeneity among the female baobab collectors who are members in cooperatives. Such analyses are critical for developing gender-sensitive policies that ensure inclusive and sustainable benefits through collective action in the baobab value chain.

The rest of the paper is organized as follows. Section 2 briefly highlights the evolution of cooperatives in Malawi. Section 3 provides the conceptual framework. Section 4 describes the empirical framework, and Section 5 details the data collection method. Section 6 gives the descriptive and analytical results, and Section 7 concludes.

2 | COOPERATIVES IN MALAWI

The history of cooperatives in Malawi dates back to the colonial period; they were introduced in the early 1900s by the British regime to trade cash crops (Borda-Rodriguez & Vicari, 2015). In 1946, the Cooperatives Act was established. However, due to high illiteracy levels, limited information, poor leadership, and misappropriation of funds, the majority of cooperatives failed (Nkhoma, 2011). In 1964, after Malawi gained independence, the cooperative movement was dismantled and all the cooperatives were deregistered (Nkhoma, 2011). The government adopted a monopoly system for input provision and purchasing and marketing smallholder produce. Cooperatives were replaced with the agricultural development and marketing corporation (ADMARC) and special crop authorities, such as coffee and tea authorities, were established to manage the production of export crops (Borda-Rodriguez & Vicari, 2014). Further, inputs and production credit were provided by the smallholder agricultural credit administration (SACA) (Kachule, 2004).

In 1994, cooperatives were reintroduced. This was spearheaded by the change in the political situation, with Malawi adopting a multiparty system coupled with market liberalization (Nkhoma, 2011). The Malawian government advocated for cooperatives to help communities to utilize their resources for their needs. Since then, the legislative and policy framework that recognizes cooperatives was adopted (Borda-Rodriguez & Vicari, 2014). The Cooperative Development Policy was adopted in 1997, followed by the Cooperatives Society Act in 1998, and the Cooperative Society Regulations in 2002 (ibid.). Currently, national policies recognize the pivotal role of cooperatives. For example, the Malawi growth and development strategy of 2017–2022 identifies cooperatives as a main mechanism for coordinating and strengthening agricultural marketing (Government of Malawi, 2017). As of 2015, there were 681 registered cooperatives in Malawi, out of which 56% were agricultural cooperatives (Borda-Rodriguez & Vicari, 2015). Cooperatives are communally owned with members and have a constitution that regulates their activities.

Cooperatives in baobab collection is exhibited through formation of collector clubs. The number of members in a club range from 15 to 40 members. Members pay a registration fee of Malawian kwacha (MWK) 3000 (about US$3) and an annual maintenance fee of MWK 3000. The main aim of the clubs is to promote training among members on harvesting, storage, and quality control processes (Meinhold & Darr, 2022). The club is also responsible for aggregating output from the registered collectors. All the baobab clubs are under an umbrella association called the Zankhalango Association (Amosi, 2018), whose main role is to look for markets for the aggregated baobab, offer training to clubs, and undertake baobab processing activities.

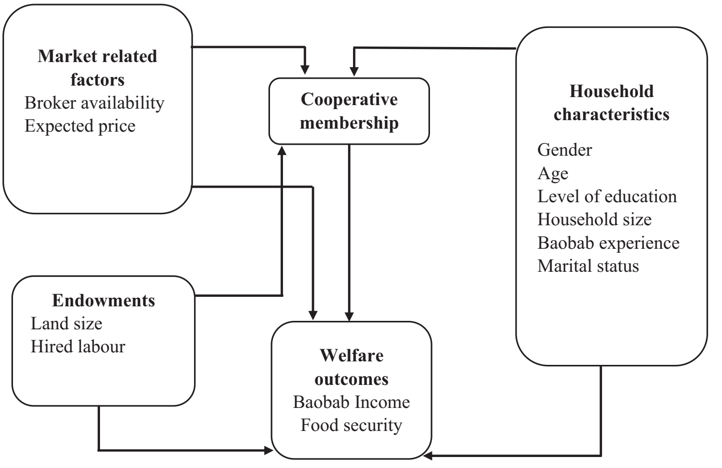

FIGURE 1 Conceptual framework. Source: Authors' conceptualization.

3 | CONCEPTUAL FRAMEWORK

Collectors of underutilized plant species (UPS) such as baobab are usually faced with different challenges in commercializing these products (Russell & Franzel, 2004). Some of these challenges include high transaction costs, information asymmetry, poor access to financial markets, weak demand, poor policy support, and long distances to markets (Hellin & Higman, 2009; Kruijssen et al., 2009; Gelo, 2020). High transaction costs can limit or prevent rural households from participating in the market (Randela et al., 2008), which can have a negative effect on their welfare. Hence, smallholders organize themselves into groups to reduce transaction costs and promote market integration.

The theoretical perspective of this paper is based on the theory of collective action. The theory of collective action provides insight on why individuals choose to cooperate (Olson, 1965; Ostrom, 2007). It is also based on the idea that a group of individuals with common interests act voluntarily in support of their interests to achieve common goals (Meinzen-Dick et al., 2004; Ostrom, 2007). Collective action through the formation of cooperatives among smallholder farmers has been identified as a strategy to promote rural development in Africa (World Bank, 2008). Cooperatives provide smallholders with access to technical training, bulking, grading, and selling produce (Fischer & Qaim, 2012). The literature shows that collective action can help expand demand, develop competitive market channels, pool resources and efforts to achieve economies of scale, share information, access better market prices, strengthen value chains by increasing bargaining power, improve product quality and quantity, and cost-sharing on capital investments among UPS producers and collectors (Gruère et al., 2009; Kruijssen et al., 2009; Padulosi et al., 2019; Gelo, 2020) in some developing countries. The organization of smallholders through collective action increases efficiency by reducing transaction costs in accessing markets, which may improve their incomes and food security.

Figure 1 shows our conceptual framework that explains the relationship between collective action and welfare outcomes (income and food security) as well as other factors influencing participation in collective action, and the heterogeneity in the welfare effects subject to cooperative membership. Recent reviews (Grashuis & Ye, 2019; Bizikova et al., 2020) have shown that cooperatives contribute to improved livelihoods in the welfare of smallholders. For instance, Bizikova et al. (2020) in their review highlight that changes in income were the most investigated impacts. More than half of the studies that were reviewed (58%) identified positive impacts on income while

15% found no income effects. In Rwanda, Verhofstadt and Maertens (2014) found a positive impact of cooperative membership on household income among farm producers. Similar results are also found among coffee farmers in Ethiopia (Mojo et al., 2017) and farming households in Zambia (Minah, 2021). In the context of collectors of UPS, empirical evidence has shown that cooperative membership is positively associated with welfare outcomes, even though some of the studies do not control for selection bias and do not use a counterfactual comparison. For example, Gyau et al. (2014) in Cameroon, and Paumgarten et al. (2012) in Zambia, Ethiopia, and Burkina Faso neither corrected for selection bias nor employed a counterfactual comparison, but they found that collective action improved livelihoods of collectors of agroforestry and forest products, respectively. In Ethiopia, Tilahun et al. (2016) and Gelo (2020) accounted for selection bias and developed counterfactual groups using econometric methods and found that cooperative membership among collectors of forest products improved their livelihoods. Based on the theory of collective action and these empirical findings, we expect membership of baobab cooperatives to improve income and food security of baobab collectors in Malawi. We also hypothesize that the impacts of collective action on welfare (income and food security) of baobab collectors are likely to differ according to the socioeconomic characteristics of the respondents, as illustrated in Figure 1. For example, the extent of these gains depends on many specific factors, including gender (Baden, 2014).

There are various mechanisms through which cooperatives can improve household welfare. First, collective action may facilitate farmers' access to high-level markets by enhancing the capacity of farmers to undertake joint investments and providing farmers with information (Naziri et al., 2014). Second, cooperatives may also offer marketing services to smallholders, which ensures that farmers have more stable sales at better prices (Ji et al., 2019). In Africa, Shiferaw et al. (2011) concluded that the provision of economic services by cooperatives helps to improve the food security status of farmers. Third, cooperatives also offer support in facilitating purchase and sale transactions (Tefera et al., 2017). Some of these transactions include linkages to modern value chains, enhancing bargaining power, and providing technical training and assistance. Fourth, cooperatives may also improve the management skills of their members, provide training and development programs meant to enhance the efficiency of smallholders, and assist in accessing extension and financial support services (Fischer & Qaim, 2012; Zheng et al., 2023).

Literature shows that farmers' participation in collective action is influenced by household characteristics (gender, age, level of education, household size, experience, and marital status), market-related factors (broker availability and expected price), and endowments (land size and access to hired labour) (Abebaw & Haile, 2013; Chagwiza et al., 2016; Ma & Abdulai, 2016; Tilahun et al., 2016; Wossen et al., 2017; Mojo et al., 2017; Ciliberti et al., 2020; Manda et al., 2020; Blekking et al., 2021; Ma et al., 2021; Minah, 2021). Hence, we hypothesize that these factors are likely to have either negative or positive correlation with participation in collective action. For example, studies have shown that due to reproductive roles women may have limited time to participate in other activities such as collective action (Quisumbing & Pandolfelli, 2010; Baden, 2014). Thus, we expect that households with male baobab managers are more likely to be cooperative members than those with female managers (see, e.g., Abebaw & Haile, 2013; Ma et al., 2021). Household size is proxied as access to family labour; hence, we expect households with a high number of members to exhibit higher levels of participation in cooperatives (see, e.g., Tilahun et al., 2016; Blekking et al., 2021). Older and more experienced baobab collectors are hypothesized to be more likely cooperative members. We expect that longer experience exposes smallholders to benefits of collective action. Similar to Mojo et al. (2017) and Manda et al. (2020), we expect more educated baobab collectors to be members of a cooperative, as education allows baobab managers to understand the significance of joining cooperatives.

The size of land owned by a smallholder is an important resource for production; similar to other previous studies (Minah, 2021), we expect a positive relationship between land ownership and cooperative membership among baobab collectors.

4 | MATERIALS AND METHODS

This study aims to assess the impact of collective action on household welfare, specifically focusing on baobab income and household food security status. Baobab income is calculated as the total annual revenue from sale of both baobab whole fruit and baobab pulp by the household, measured in Malawian kwacha (MWK). We measure baobab collector's household food security status using two indicators: the household dietary diversity score (HDDS) and the food consumption score (FCS). Based on Carletto et al. (2013), the HDDS is used as a measure of diet quality at the household level. We calculate the HDDS based on 12 food groups and a 24-hour recall period. These food groups include cereals; tubers and roots; vegetables; fruits; meat; eggs; fish and other sea food; legumes and nuts; milk and milk products; oil and fats; sweets; and spices, condiments, and beverages. The final score is obtained by summing up the total number of food groups consumed over the referenced period. A higher score indicates a higher level of food security of the household. The FCS is a frequency-weighted dietary diversity score, which is based on a household consumption of eight key food groups within a 7-day reference period. The frequency of consumption within seven days prior to the survey is multiplied by the weight. The score is then summed to generate a food consumption score. A higher score indicates a higher level of food security of the household.

One simple approach to carry out this analysis would involve using a dummy variable that captures membership of baobab collectors in a producer organization in the outcome equation (baobab income and food security), then use ordinary least squares (OLS) to estimate the coefficient. However, this approach might yield biased estimates, as it assumes that participation in producer groups is determined exogenously, when it could be potentially endogenous. The decision of baobab collectors to join a producer organization is voluntary and may be based on individual self-selection. Collectors who are members of producer organizations may possess systematically different characteristics compared to non-members, and their decision to be group members may be driven by expected benefits. Moreover, collectors' unobservable characteristics may also affect their decision to participate in producer organizations and also influence the outcome variables, potentially leading to inconsistent and biased estimates.

To address these challenges, we follow Blekking et al. (2021) and apply the inverse probability weighted regression adjustment (IPWRA) estimator. This approach helps in controlling for selection bias arising from non-random treatment assignment and provides results that are robust against misspecification (Wossen et al., 2017; Nikam et al., 2022). The IPWRA estimator uses the inverse of the estimated treatment-probability weights to estimate missing data-corrected coefficients that are subsequently used to generate robust estimates of the average treatment effect on the treated (ATT) (Manda et al., 2018). The IPWRA uses a three-step procedure in estimating treatment effects (StataCorp, 2019), which is described below.

First, we estimate the parameters of the treatment model and inverse-probability weights. Here, we estimate the probability of baobab collecting households deciding whether to participate in collective action, conditional on household characteristics, endowments, and market related factors. Following Fischer and Qaim (2012), we assume that a baobab collector's decision to join cooperatives at a given period is associated with maximization of expected utility. In particular, a baobab collecting household would participate in a producer organization if the utility derived from being a member outweighs being a non-member. Let U_M and U_N denote the utilities derived from marketing baobab through producer groups and from marketing baobab individually, respectively. Let D_i^* ($D_i^* = U_M - U_N$) denotes the difference between expected net returns from marketing baobab through groups and individually. A baobab collector is likely to choose to market their output collectively rather than individually if $D_i^* > 0$. The incremental net benefit (D_i^*) that the baobab collector gains from marketing their output through a group rather than individually is a latent variable determined by observable characteristics (z_i) and an error term (μ_i):

$$D_i^* = z_i\,\beta + \mu_i \text{ where } D_i = \begin{cases} 1\ if\ D_i^* > 0 \\ 0\ otherwise \end{cases} \tag{1}$$

If a collector markets baobab through a group, $D_i = 1$ for household i and 0 otherwise; z_i is a vector of the household characteristics (gender, age, level of education, household size, baobab experience, and marital status), market-related factors (broker availability and expected price), and endowments (land size and access to hired labour); β is a vector of parameters to be estimated; and μ_i is an error term with zero mean and normal distribution. Hence, the probability (propensity scores) of a baobab collector participating in a cooperative is expressed as:

$$Pr(\ = 1) = Pr(D_i^* > 0) = Pr(\mu_i > -z_i\beta) = 1 - \mathrm{F}(-z_i\beta) \tag{2}$$

where F is the cumulative distribution function for the error term μ_i. The above equation was estimated using a probit regression model.

Second, using the weights derived in step 1, weighted regression models of the outcome (baobab income and food security status) are fitted for each treatment level ($D = 1$ for participation in collective action and $D = 0$ for non-participation) as specified in Equations (3) and (4):

$$Y_{i1} = \beta_1 + \theta_1 x_i + \varepsilon_{i1} \text{ for } D = 1 \tag{3}$$

$$Y_{i0} = \beta_0 + \theta_0 x_i + \varepsilon_{i0} \text{ for } D = 0 \tag{4}$$

The parameters ($\beta_0, \theta_0\ \beta_1, \theta_1$) in Equations (5) and (6) are estimated using the inverse probability-weighted least squares, specified as:

$$\frac{min}{(\beta_0\theta_0)} \sum_i^N \frac{(y_i - \beta_0 - \theta_0 x_i)}{p\ (x,\ \vartheta)} \text{ if } D_i = 0 \tag{5}$$

$$\frac{min}{(\beta_1\theta_1)} \sum_i^N \frac{(y_i - \beta_1 - \theta_1 x_i)}{p\ (x,\ \vartheta)} \text{ if } D_i = 1 \tag{6}$$

In the third step, ATT is calculated by subtracting Equations (5) and (6) as shown below:

$$ATT = \frac{1}{N_M} \sum_i^{N_M} \left[\left(\widehat{\beta_1} - \widehat{\beta_0}\right) - \left(\widehat{\theta_1} - \widehat{\theta_0}\right) x_i \right] \tag{7}$$

where, $(\widehat{\beta}_1, \widehat{\theta}_1)$ are the estimated inverse probability weighted parameters for baobab collectors participating in cooperatives, and $(\widehat{\beta}_0, \widehat{\theta}_0)$ are estimated inverse probability weighted parameters for baobab collectors who are non-cooperative members. D_i is the treatment indicator; $D_i = 1$ if a collector markets baobab through a group for household i and 0 otherwise. N_M is the total number of treated households. The difference of these averages provides the estimated treatment effects. Since there are several methods that can be used in estimating treatment effects, Athey and Imbens (2017) recommend the use of more than one approach to estimate treatment effects to check the robustness of the results. We use the propensity score matching (PSM) for a robustness check. Further, even though the IPWRA is considered double robust, it does not control for selection bias based on unobserved heterogeneity. To assess whether selection on unobservable factors has an effect on our results, we use the Rosenbaum bounds (Rosenbaum, 2002) to assess sensitivity of the results to hidden bias.

With regards to heterogeneous effects, we follow previous studies (Verhofstadt & Maertens, 2015; Ji et al., 2019; Grashuis & Skevas, 2022) and explore whether the treatment effects of cooperative membership on household welfare vary with gender, marital status, and other socioeconomic characteristics.

5 | SOURCES OF DATA

We use data from a household survey collected from baobab collectors in March–April 2021 in Malawi. A multistage sampling procedure was employed in the selection of respondents. First, the southern and central regions were purposively selected based on the national intensity of collection and marketing of forest products (Sanchez, 2011; Darr et al., 2020). In the second stage, four districts where baobab is extensively collected were chosen. They include Mangochi and Neno districts in the southern region and Salima and Dedza districts in the central region. In the third stage, 4–6 villages were selected based on the density of baobab collectors in each district. Fourth, with the help of cooperative officials and agricultural officers, two lists of baobab collecters were generated for cooperative members and non-members in the selected villages. Finally, approximately 30–40 baobab collecting households, composed of cooperative members and non-members in each village, were randomly selected from each sub-group using the list of baobab collectors, resulting in a sample of 864 households. The collected data includes information on socio-economic characteristics of collectors, indicators on transaction costs, perceptions of collective action, and baobab collection and marketing. Following data cleaning and removal of outliers, our analysis included 795 households.

6 | RESULTS AND DISCUSSION

6.1 | Summary statistics of characteristics of members and non-members of cooperatives

Table 1 presents an overview of the definition and summary statistics of the variables included in the analysis. We find that 38% of baobab collectors are members of a baobab group. Approximately 40% of baobab collectors are male, most them are 40 years old, and have attained 5 years of formal education, cultivate about 2.8 acres of land, and have a household size of 5.

TABLE 1 Definition and summary statistics of selected variables.

		Overall ($n = 795$)		Non-members ($n = 496$)		Members ($n = 299$)		Mean differences
Variable	**Variable description**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	
Dependent variables								
Baobab income	Total baobab income (10,000 MWK)	4.37	5.27	3.37	3.77	6.03	6.78	−2.66***
Dietary diversity score	Household dietary diversity score (HDDS)	4.29	1.84	4.00	1.86	4.77	1.71	−0.77***
Food consumption score	Household food consumption score (FCS)	40.07	15.26	38.15	15.20	43.24	14.84	−5.09***
Treatment variable								
Group membership	Household belonged to a baobab cooperative (1 = yes)	0.38						
Explanatory variables								
Male	=1 if baobab manager is male	0.39		0.40		0.37		0.03
Age	Age of the baobab manager (years)	40	13	37	12	44	12	−7***
Level of education	Baobab manager maximal education level (years)	5	3	5	3	4	3	1***
Household size	Number of people residing in the household	5	2	5	2	6	2	−1***
Land size	Total land size owned by the household (acres)	2.84	2.72	2.70	2.27	3.07	3.33	−0.37*
Baobab experience	Number of years manager has been collecting baobab	7	5	7	5	8	5	−1***
Married	Married = 1 if baobab manager is married	0.79		0.78		0.81		-0.03
Hired labour	Access to hired labour (1 = yes)	0.23		0.14		0.38		−0.24***
Broker availability	Availability to brokers (1 = yes)	0.23		0.21		0.27		−0.06**
Expected price	Dummy variable if the expected price was higher than what was received	0.27		0.28		0.24		0.04

Note: *, **, and *** denote statistical significance levels at 10%, 5%, and 1%, respectively.

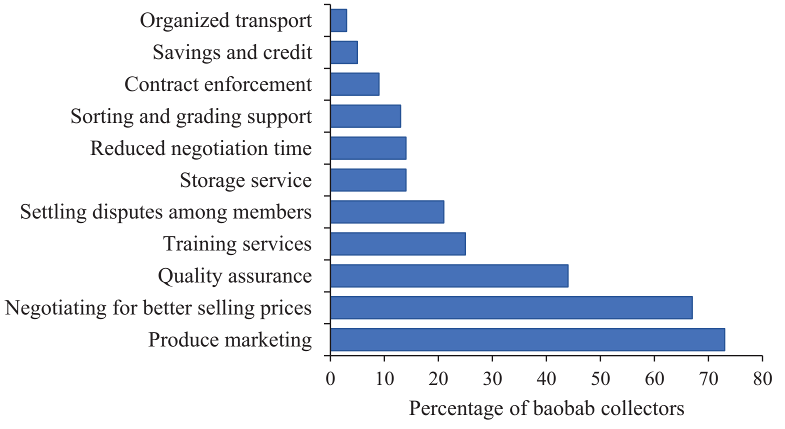

FIGURE 2 Services offered by the baobab group. [Colour figure can be viewed at wileyonlinelibrary.com]

The mean differences in the characteristics of baobab cooperative members and non-members are also presented in Table 1. Members and non-members have similar characteristics in terms of marital status, expected price, negotiation time, and coordinated transport, but they exhibit statistically significant mean differences in other covariates. In particular, members are older, have larger household sizes and land sizes, and are more experienced in baobab collection than non-members. The group members have a higher likelihood of accessing hired labour.

We observe that members have higher baobab income and food security levels than non-members. However, these results cannot be used to make inferences on the impact of the group membership on the welfare of baobab collectors. This simple comparison does not account for confounding factors such as observable and non-observable characteristics. Hence, further analysis using IPWRA was conducted to provide more reliable and unbiased estimates.

6.2 | Benefits of cooperative membership and reasons for non-membership

Figure 2 shows the benefits received by members of baobab groups. We find that marketing products, negotiating better prices, and quality assurance are the three most important services received by cooperative members. These results are consistent with the observations of Bizikova et al. (2020), who indicated in their review that marketing commodities and providing information on selling prices are the core functions of cooperatives.

Although we focus on the role of collective action in the welfare of baobab collectors, we also want to find out why non-members have not joined baobab groups. Figure 3 shows that delayed payments, preference of selling to other output channels, and payment defaults are the major reasons for non-membership. These results concord with the findings of Mujawamariya et al. (2013) on coffee cooperatives in Rwanda, and Chagwiza et al. (2016) on dairy cooperatives in Ethiopia, who highlighted that participation may be affected by payment defaults, delayed payments, and the probability of competitors offering better prices than cooperatives.

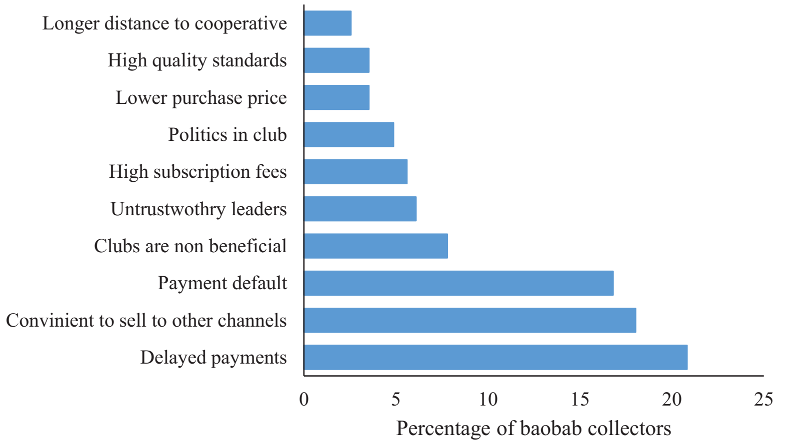

FIGURE 3 Reasons for non-membership in cooperatives. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Probit model estimates of cooperative membership.

VARIABLES	Coefficients	SE	Marginal effects	SE
Male	−0.16	(0.17)	−0.06	(0.06)
Age	0.02***	(0.01)	0.01***	(0.00)
Level of education	−0.01	(0.02)	−0.00	(0.01)
Household size	0.07*	(0.04)	0.03*	(0.01)
Baobab experience	0.02	(0.02)	0.01	(0.01)
Married	0.18	(0.13)	0.07	(0.04)
Land size	−0.00	(0.02)	−0.00	(0.01)
Access to hired labour	0.86***	(0.15)	0.33***	(0.05)
Brokers availability	0.18	(0.14)	0.07	(0.05)
Expected price	−0.28***	(0.10)	−0.10***	(0.04)
Constant	−1.95	(0.33)		
Model chi-square	159.06***			
Obs	795			

Note: Standard errors in parentheses are clustered at the village level; *, **, *** denote significant values at 10%, 5%, and 1%. SE denotes standard errors.

6.3 | Correlates of participation in cooperatives

The estimates of the correlates of cooperative membership are presented in Table 2. The goodness-of-fit tests indicate that the selected covariates provide good estimates of the conditional density of cooperative membership. The independent variables are jointly statistically significant (LR χ^2 test statistics = 159.06, $p < 0.00$). Although we do not discuss estimates of the outcome equations based on the IPWRA, the results are presented in Table A1 of the Appendix. We find that older collectors are more likely to be cooperative members compared to young collectors. Older farmers have more information regarding benefits of collective action from the years of experience they

TABLE 3 Impact of cooperative membership on baobab income and food security.

	Cooperative membership status			
Outcome variables	**Members**	**Non-members**	**ATT**	**Change (%)**
Ln (baobab income)	10.43	10.07	0.36 (0.08) ***	3.57
HDDS	4.77	4.29	0.48 (0.19) ***	11.19
FCS	43.24	40.93	2.31 (1.56) **	5.64

Note: ** and *** denote 5% and 1% level of significance, respectively; standard errors in parentheses; ATT denotes average treatment effect on the treated; income values are in natural log; HDDS denotes household dietary diversity score; and FCS denotes food consumption score.

have been involved in baobab collection and marketing (Fischer & Qaim, 2012). These results may also indicate the presence of barriers for younger generations to join forms of collective action (Mojo et al., 2017). These results are consistent with findings in Ghana that show a positive and significant effect of age on cooperative membership (Abdul-Rahaman & Abdulai, 2018). We also find that larger household sizes are more likely to join baobab cooperatives.

Baobab collectors with access to hired labour are more likely to join a cooperative. The collection of baobabs is labour intensive; the availability of non-family labour can be important in ensuring that higher quantities of fruits are collected. Our finding corroborates with the evidence of Chagwiza et al. (2016) that higher access to labour was positively associated with group membership in Ethiopia.

6.4 | Impacts on baobab income and food security

Results on the impact of cooperative membership on the three outcome variables (baobab income, household dietary diversity score, and food consumption score) are presented in Table 3. The IPWRA results show that cooperative membership improves income from baobab sales and the household food security status in Malawi. Cooperative membership increases baobab income for cooperative members by MWK 10,236 (US$10) (taking the difference of antilogs of the estimates in Table 3), which is approximately 3.57% higher than the baobab income of non-members. This finding is consistent with evidence from Tilahun et al. (2016), Fischer and Qaim (2012), and Verhofstadt and Maertens (2015) in Ethiopia, Kenya, and Rwanda, respectively, that cooperative membership increased members' incomes. This may indicate a specialization in marketing among cooperative members and thus an increase in their incomes (Minah, 2021). More detailed analysis revealed that baobab contributes about 26% of the household income to non-members, and 34% of the household income to members (Figure A1 in Appendix C). This result shows that income from baobab contributes greatly to total household income, particularly members of cooperatives. This evidence also emphasizes the need to promote the baobab value chains to stimulate rural economic development.

Similarly, group membership among baobab collectors improves their food security. In particular, the HDDS increases by 11%, whereas the FCS increases by 5.6%. These findings are consistent with evidence from Shumeta and D'Haese (2018) and Nugusse et al. (2013) in Ethiopia, and Theng et al. (2014) in Cambodia. In the case of coffee cooperatives and food security in Ethiopia, the income effects of cooperative membership among coffee farmers improved their purchasing power and allowed them to acquire adequate and diverse food from the market

TABLE 4 Average treatment effects using propensity score matching (PSM).

Matching algorithm	Outcome variables	Outcome means: Members	Outcome means: Non-members	ATT	Change (%)
NNM	Ln (baobab income)	10.43	10.06	0.37 (0.12) ***	3.68
	HDDS	4.77	4.21	0.56 (0.18) ***	13.30
	FCS	43.24	40.57	2.67 (1.47) *	6.58
Radius	Ln (baobab income)	10.43	10.08	0.35 (0.09) ***	3.47
	HDDS	4.77	4.23	0.55 (0.16) ***	13
	FCS	43.24	40.45	2.79 (1.33) **	6.90
Kernel	Ln (baobab income)	10.43	10.07	0.36 (0:09) ***	3.57
	HDDS	4.77	4.25	0.53 (0.16) ***	12.47
	FCS	43.24	40.52	2.72 (1.30) **	6.71

Note: *and *** denote significance levels at 10% and 1%, respectively; standard errors in parentheses; ATT (average treatment effect on the treated); Ln denotes natural logarithm; HDDS denotes household dietary diversity score; and FCS denotes food consumption score.

(Shumeta & D'Haese, 2018), which could also be an explanation of our results. An analysis of the consumption of food items based on cooperative membership status, reveals that members ranked higher in consumption of fish, vegetables, meat, and legumes (Figure A2 in Appendix C), which highly contributes to higher dietary diversity and food consumption scores.

6.5 | Robustness check

As a robustness check of the IPWRA estimates, we compare our results with estimates from propensity score matching (PSM). The diagnostic results from the PSM estimates show that the balancing of the covariates was successful (Table A2 in the Appendix). We observe that before matching, seven variables show statistically significant differences, whereas after matching the differences are not statistically significant. This confirms a good quality for the covariates used in matching to generate a reliable counterfactual. Second, we compared the pseudo-R^2 before and after matching (Table A3). For us to conclude that the matching is acceptable, the pseudo-R^2 should be low after matching. We employed three matching algorithms to generate our estimates: nearest neighbour matching (NNM), radius matching (RM), and kernel-based matching. The results in Table 4 show that the estimated ATT for baobab income, HDDS, and FCS are positive and statistically significant and very comparable to the IPWRA results in Table 3, confirming that our ATT estimates are robust.

Further, we also check if the PSM results are sensitive to hidden bias due to unobserved selection. We use the bounding approach proposed by Rosenbaum (2002) to determine if unobserved factors may influence selection into cooperative membership and therefore bias the PSM results. The Rosenbaum sensitivity test results are presented in Table A3. The results show that robustness to hidden bias varies across the outcome variables. The value of gamma (γ) for the impact of cooperatives on baobab income, household dietary diversity, and food consumption score vary from 1.7 to 1.8, 1.5 to 1.7, and 1.1 to 1.3, respectively. For example, for the impact of cooperative membership on baobab income, the critical value of gamma γ with NNM is between 1.7 and 1.8. This suggests that the unobserved factors would have to increase the odds ratio of participation by

TABLE 5 Heterogeneity in treatment effect of cooperative membership by gender and marital status of female managers.

	Gender of the baobab manager		Marital status of female baobab managers	
Dependent variable	**Male**	**Female**	**Married**	**unmarried**
Ln (baobab income)	0.61***	0.20	0.14	0.35
	(0.15)	(0.14)	(0.14)	(0.24)
HDDS	0.89**	0.17	0.03	0.59
	(0.40)	(0.20)	(0.24)	(0.31)
FCS	3.27	1.16	0.62	3.86*
	(2.75)	(2.00)	(2.47)	(2.08)

Note: Standard errors in parentheses; ***, **, * denote significance at 1% level, 5% level, and 10% level, respectively.

70–80% before we can render the estimated impact spurious. Based on the results of the sensitivity analysis, we can conclude that estimates of membership in cooperatives on baobab income and food security remain robust even in the presence of unobserved heterogeneity.

6.6 | Heterogeneous impacts of cooperative membership over household characteristics

The previous results on the ATT of cooperative membership on outcome variables assume a homogeneous impact of membership on welfare outcomes across all baobab collectors. However, previous studies (Verhofstadt & Maertens, 2015; Shumeta & D'Haese, 2016; Wossen et al., 2017; Ma et al., 2021) have shown that the effect of cooperative membership can be heterogeneous within members. In this paper, we are interested in the heterogeneity effects of gender, and we extended our analysis by comparing between both male and female managers, but also among female baobab managers. We analysed the effect of gender and the marital status on the ATT of cooperative membership among all baobab collectors and female baobab managers in cooperatives, respectively (Table 5). Further, we also present graphical analyses of heterogeneous treatment effects based on other socioeconomic characteristics. We show the results of heterogeneity over land ownership and experience in baobab collection (Figure 4). First, we follow previous studies (Ali & Abdulai, 2010; Ji et al., 2019; Grashuis & Skevas, 2022) and explore whether the treatment effects of cooperative membership on household welfare vary with gender among all baobab collectors and marital status among female baobab managers, the IPWRA results are estimated separately for male and female baobab collectors (Table 5). Table 5 indicates that the impact of cooperative membership on food security and baobab income among collectors is not homogeneous. Specifically, the positive impacts of cooperative membership on baobab income and food security are stronger for households with a male baobab manager. This could be due to severe market access constraints and high opportunity costs of time that make group membership more beneficial for men than women (Fischer & Qaim, 2012a). With the marital status among female baobab managers, we find that the impact of cooperative membership on food security is more pronounced among unmarried female managers (Table 5). A plausible explanation for these findings could be that married female managers may need to consult their spouses on household expenditure; thus, male managers may have a lower preference for purchasing diverse foods than asset investments.

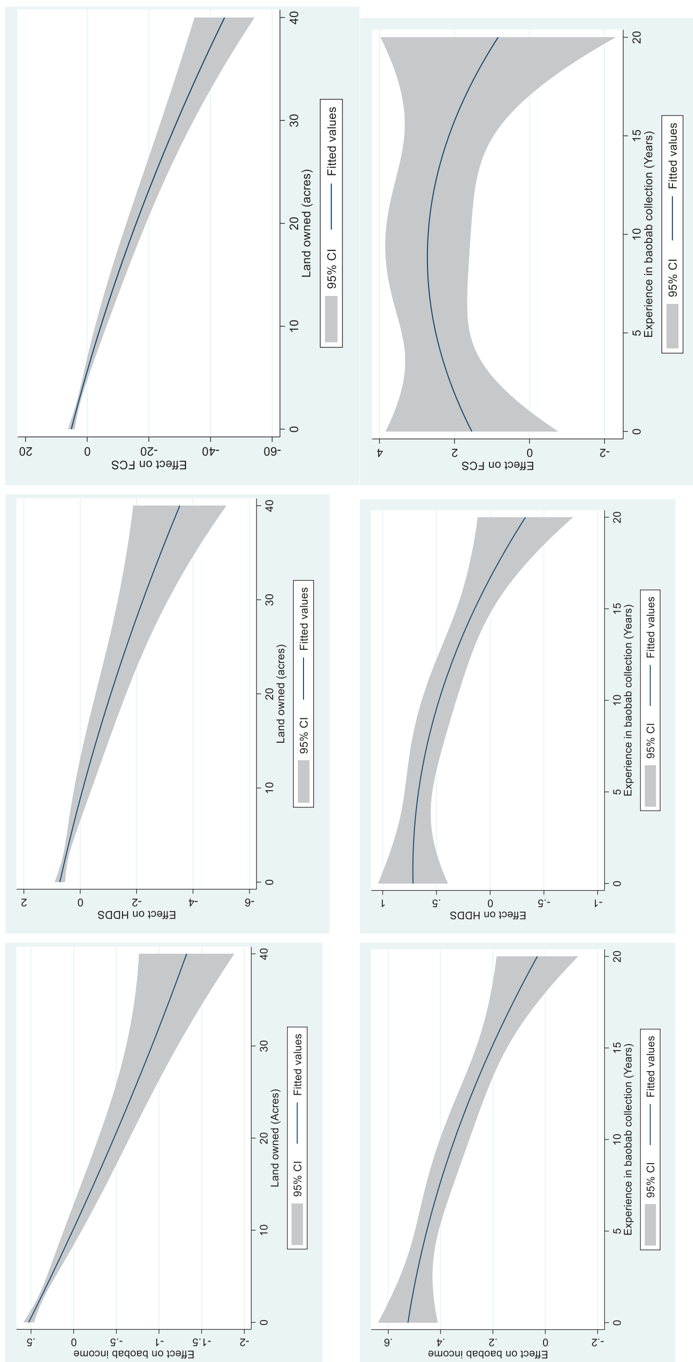

FIGURE 4 Heterogeneity of treatment effects over land ownership and experience in baobab collection. [Colour figure can be viewed at wileyonlinelibrary.com]

Results on heterogeneous impacts of cooperative membership on household welfare confirm that the ATT varies within cooperative members. Gender is an important correlate of the effect of cooperative membership on household welfare. Even more nuanced is that when we only focus on the group of female managers who are members (Table 5), the heterogeneous effects driven by their marital status still persist.

Second, to gain more insights on the extent to which heterogeneity of cooperative treatment effects on household welfare vary with baobab collector's characteristics, we conduct more graphical analyses. Following Verhofstadt and Maertens (2015), we focus on two key variables—land ownership and experience in baobab collection. The results in Figure 4 reveal that there is an inverse relationship between land ownership, experience in baobab collection and the estimated ATT on baobab income and food security. These findings imply that cooperatives are most effective in increasing baobab income and food security among baobab collectors with smaller land holdings and those with few years of experience in baobab collection. The results of treatment effects and land size are consistent with the findings of Fischer and Qaim (2012), Ji et al. (2019) and Grashuis and Skevas (2022) in Kenya, China, and Peru, respectively, that found cooperative membership to be associated with a larger impact for smaller farms. Baobab collectors with large land sizes may gain the least from cooperative membership. Compared to collectors with relatively small land sizes, they may already be operating efficiently (Grashuis & Skevas, 2022).

With regards to experience in baobab collection, the effects are more pronounced for collectors with less experience than those with more experience. A similar observation is reported by Ji et al. (2019) for China.

7 | CONCLUSION

Using household survey data from baobab collectors in Malawi, this study examined the impact of cooperative membership on food security and baobab income using the IPWRA estimator. In doing so, the paper provides both methodological and empirical contributions. Methodologically, the paper goes beyond descriptive and case studies that are prevalent in the literature on the impact of cooperatives on underutilized plant species (UPS). The paper provides a rigorous econometric analysis that accounts for endogeneity due to selection bias on observables, thereby producing an unbiased causal effect of cooperative membership on the welfare of baobab collectors.

The results showed a positive correlation between baobab managers' membership in cooperatives and their age, household size, and access to hired labour. The findings of this study show that patterns observed in the majority of agricultural crops also apply to baobab. Similar to other agricultural crops, baobab cooperative membership improves the welfare (e.g., income and food security) of baobab collectors. However, this positive effect is not distributed uniformly among all members, but differs based on some household characteristics, such as gender, land size, and the experience in baobab collection. We find that male baobab managers benefited more from cooperatives than their female counterparts. Further, when we focus solely on female baobab managers who are cooperative members, the results show that the impact is stronger for unmarried females—that is, widowed, divorced, or separated. Additionally, we also find that the effect of cooperative membership is more pronounced among members with smaller land sizes and those with less experience in baobab collection. These results on the heterogeneity of impacts reveal the significance of looking beyond average treatment effects and the need to move beyond the assumption that one size fits all and adopt more specific, targeted, and contextual interventions.

Our results are relevant for those tasked with improving the livelihoods of smallholders in emerging value chains, such as baobab. We demonstrate that cooperative membership can be instrumental in enhancing the welfare of baobab collectors. Therefore, policymakers and cooperative promotion officers should intensify incentives for training baobab collectors in organizational development, to motivate them to join existing cooperatives or form viable ones. Additionally, considering that the impact of cooperatives is greater among collectors with smaller land sizes and less experience, who may face greater information and financial barriers, it may be preferable to target these groups who face more constraints in participating in cooperatives. Lastly, the positive association between cooperative membership and welfare outcomes suggests the need to increase awareness about the benefits of cooperatives among baobab collectors. This awareness can be improved through extension services and outreach efforts by development practitioners.

Our study demonstrates that membership in cooperatives can have positive welfare effects on baobab collectors. However, membership is measured as a dummy variable, where participants take a value of 1, and 0 for non-participants. Using this dummy variable, we are not able to demonstrate how impacts may vary based on the intensity of participation. Further research on collective action should focus on how impacts vary based on intensity of participation among members. Such insights can provide evidence on how to maximize welfare effects that are subject to cooperative membership. More empirical research on the baobab value chain is required in southern Africa, especially in Malawi.

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ORCID

Dennis Etemesi Olumeh https://orcid.org/0000-0001-8174-1457
Dagmar Mithöfer https://orcid.org/0000-0002-9347-682X

REFERENCES

Abdul-Rahaman, A., & Abdulai, A. (2018). Do farmer groups impact on farm yield and efficiency of smallholder farmers? Evidence from rice farmers in northern Ghana. *Food Policy*, *81*(October), 95–105. https://doi.org/10.1016/j.foodpol.2018.10.007

Abebaw, D., & Haile, M. G. (2013). The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia. *Food Policy*, *38*(1), 82–91. https://doi.org/10.1016/j.foodpol.2012.10.003

Adongo, W. A., Osei, C. K., & Wongnaa, C. A. (2019). Contribution of nontimber forest products to rural household income in the Kassena-Nankana West district of Ghana. *Forest Products Journal*, *69*(3), 217–227. https://doi.org/10.13073/FPJ-D-18-00049

Akinnifesi, F. K., Leakey, R. R. B., Ajayi, O. C., Sileshi, G., Tchoundjeu, Z., Matakala, P., & Kwesiga, F. R. (2008). Indigenous fruit trees in the tropics: Domestication, utilization and commercializtion. In F. K. Akinnifesi, R. R. B. Leakey, O. C. Ajayi, G. Sileshi, Z. Tchoundjeu, P. Matakala, & F. R. Kwesiga (Eds.), *INDIGENOUS FRUIT TREES IN THE TROPICS Domestication, Utilization and Commercialization*. CABI.

Ali, A., & Abdulai, A. (2010). The adoption of genetically modified cotton and poverty reduction in Pakistan. *Journal of Agricultural Economics*, *61*(1), 175–192. https://doi.org/10.1111/j.1477-9552.2009.00227.x

Amosi, N. (2018). *Value Chain Analysis of Baobab Products for Improved Marketing and Sustainability of Their Trade in Malawi*. Mzuzu University.

Asfaw, A., Lemenih, M., Kassa, H., & Ewnetu, Z. (2013). Importance, determinants and gender dimensions of forest income in eastern highlands of Ethiopia: The case of communities around Jelo Afromontane forest. *Forest Policy and Economics*, *28*, 1–7. https://doi.org/10.1016/j.forpol.2013.01.005

Asfaw, S., Scognamillo, A., Caprera, G. Di, Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. *World Development*, *117*, 278–295. https://doi.org/10.1016/j.worlddev.2019.01.017

Athey, S., & Imbens, G. W. (2017). The state of applied econometrics: Causality and policy evaluation. *Journal of Economic Perspectives*, *31*(2), 3–32. https://doi.org/10.1257/jep.31.2.3

Baden, S. (2014). Collective action, gender relations and social inclusion in African agricultural markets. In *Future Agricultures* (No. 64; Future Agriculture). http://www.future-agricultures.org/publications/research-and-analysis/policy-briefs/1836-collective-action-gender-relations-and-social-inclusion-in-african-agricultural-markets/file%5Cn http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=c

Baldermann, S., Blagojević, L., Frede, K., Klopsch, R., Neugart, S., Neumann, A., Ngwene, B., Norkeweit, J., Schröter, D., Schröter, A., Schweigert, F. J., Wiesner, M., & Schreiner, M. (2016). Are Neglected Plants the Food for the Future? *Critical Reviews in Plant Sciences*, *35*(2), 106–119. https://doi.org/10.1080/07352689.2016.1201399

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy*, *33*(4), 299–317. https://doi.org/10.1016/j.foodpol.2007.10.005

Bernard, T., Collion, M. H., de Janvry, A., Rondot, P., & Sadoulet, E. (2008). Do Village Organizations Make a Difference in African Rural Development? A Study for Senegal and Burkina Faso. *World Development*, *36*(11), 2188–2204. https://doi.org/10.1016/j.worlddev.2007.10.010

Bernard, T., Taffesse, A. S., & Gabre-Madhin, E. (2008). Impact of cooperatives on smallholders' commercialization behavior: Evidence from Ethiopia. *Agricultural Economics*, *39*(2), 147–161. https://doi.org/10.1111/j.1574-0862.2008.00324.x

Bizikova, L., Nkonya, E., Minah, M., Hanisch, M., Turaga, R. M. R., Speranza, C. I., Karthikeyan, M., Tang, L., Ghezzi-Kopel, K., Kelly, J., Celestin, A. C., & Timmers, B. (2020). A scoping review of the contributions of farmers' organizations to smallholder agriculture. *Nature Food*, *1*(10), 620–630. https://doi.org/10.1038/s43016-020-00164-x

Blekking, J., Gatti, N., Waldman, K., Evans, T., & Baylis, K. (2021). The benefits and limitations of agricultural input cooperatives in Zambia. *World Development*, *146*, 105616. https://doi.org/10.1016/j.worlddev.2021.105616

Borda-Rodriguez, A., & Vicari, S. (2014). Rural co-operative resilience: The case of Malawi. *Journal of Co-Operative Organization and Management*, *2*(1), 43–52. https://doi.org/10.1016/j.jcom.2014.03.002

Borda-Rodriguez, A., & Vicari, S. (2015). Coffee co-operatives in malawi: Building resilience through innovation. *Annals of Public and Cooperative Economics*, *86*(2), 317–338. https://doi.org/10.1111/apce.12075

Carletto, C., Zezza, A., & Banerjee, R. (2013). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security*, *2*(1), 30–40. https://doi.org/10.1016/j.gfs.2012.11.006

Carr, M., & Hartl, M. (2008). Gender and non-timber forest products Promoting food security and economic empowerment. International Fund for Agricultural Development (IFAD). https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/5374/08_IFAD_Women_forest_products.pdf?sequence=1

Chagwiza, C., Muradian, R., & Ruben, R. (2016). Cooperative membership and dairy performance among smallholders in Ethiopia. *Food Policy*, *59*, 165–173. https://doi.org/10.1016/j.foodpol.2016.01.008

Ciliberti, S., Frascarelli, A., & Martino, G. (2020). Drivers of participation in collective arrangements in the agri-food supply chain. Evidence from Italy using a transaction costs economics perspective. *Annals of Public and Cooperative Economics*, *91*(3), 387–409. *October*, 1–23. https://doi.org/10.1111/apce.12263

Darr, D., Chopi-msadala, C., Namakhwa, C. D., Meinhold, K., & Munthali, C. (2020). Processed Baobab (Adansonia digitata L.) Food Products in Malawi : From Poor Men' s to Premium-Priced Specialty Food ? 1–14.

Dawson, I. K., Hendre, P., Powell, W., Sila, D., Mcmullin, S., Revoredo, C., Odeny, D. A., Graudal, L., Roshetko, J. M., Hale, I. L., Deynze, A. V., Prabhu, R., Cheng, S., Xu, X., Muchugi, A., Jamnadass, R., Buildings, K., Road, W. M., Africa, S., … Bonington, S. (2018). Supporting human nutrition in Africa through the integration of new and orphan crops into food systems: placing the work of the African Orphan Crops Consortium in context. In *ICRAF Working Paper* (No. 276). https://doi.org/10.5716/WP18003.PDF

FAO, IFAD, UNICEF, WFP, & WHO. (2019). The state of food security and nutrition in the word: Safeguarding against economic slowdowns and downturns. https://doi.org/10.1109/JSTARS.2014.2300145

FAO, IFAD, UNICEF, WFP, & WHO. (2020). The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. In *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. FAO. https://doi.org/10.1109/JSTARS.2014.2300145

Fischer, E., & Qaim, M. (2012). Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya. *World Development*, *40*(6), 1255–1268. https://doi.org/10.1016/j.worlddev.2011.11.018

Gelo, D. (2020). Forest commons, vertical integration and smallholder ' s saving and investment responses : Evidence from a quasi-experiment. *World Development*, *132*, 104962. https://doi.org/10.1016/j.worlddev.2020.104962

Gelo, D., & Dikgang, J. (2019). Collective action and heterogeneous welfare effects: Evidence from Ethiopian villages. *World Development Perspectives*, *16*(100150), 1–11. https://doi.org/10.1016/j.wdp.2019.100150

Government of Malawi. (2017). The Malawi growth and development strategy (MGDS) III (p. 236). Government of Malawi.

Grashuis, J., & Skevas, T. (2022). What is the benefit of membership in farm producer organizations? The case of coffee producers in Peru. *Annals of Public and Cooperative Economics*, *December 2021*, *94*(2), 423–443. https://doi.org/10.1111/apce.12390

Grashuis, J., & Ye, S. U. (2019). a Review of the Empirical Literature on Farmer Cooperatives: Performance, Ownership and Governance, Finance, and Member Attitude. *Annals of Public and Cooperative Economics*, *90*(1), 77–102. https://doi.org/10.1111/apce.12205

Gruère, G., Nagarajan, L., & King, E. D. I. O. (2009). The role of collective action in the marketing of underutilized plant species: Lessons from a case study on minor millets in South India. *Food Policy*, *34*(1), 39–45. https://doi.org/10.1016/j.foodpol.2008.10.006

Gruère, G. P., Giuliani, A., & Smale, M. (2006). Marketing underutilized plant species for the poor: A conceptual framework. In *Environment and production technology* (No. 154; Issue June). https://doi.org/10.4324/9780203890127

Gyau, A., Franzel, S., Chiatoh, M., Nimino, G., & Owusu, K. (2014). Collective action to improve market access for smallholder producers of agroforestry products: Key lessons learned with insights from Cameroon's experience. *Current Opinion in Environmental Sustainability*, *6*(1), 68–72. https://doi.org/10.1016/j.cosust.2013.10.017

Hellin, J., & Higman, S. (2009). Underutilized Plant Products and Market Access: Challenges and Opportunities. *Acta Horticulturae*, *806*, 393–406. https://doi.org/10.17660/actahortic.2009.806.49

Hendre, P. S., Muthemba, S., Kariba, R., Muchugi, A., Fu, Y., Chang, Y., Song, B., Liu, H., Liu, M., Liao, X., Sahu, S. K., Wang, S., Li, L., Lu, H., Peng, S., Cheng, S., Xu, X., Yang, H., Wang, J., … Jamnadass, R. (2019). African Orphan Crops Consortium (AOCC): status of developing genomic resources for African orphan crops. *Planta*, *250*(3), 989–1003. https://doi.org/10.1007/s00425-019-03156-9

IFPRI. (2018). Global Nutrition Report. https://globalnutritionreport.org/reports/global-nutrition-report-2018/

IMF. (2017). Malawi: Economic Development Document. In *IMF Country Report: Vol. 17/184*. https://doi.org/10.5089/9781484333945.002

Ingram, V., Schure, J., Tieguhong, J. C., Ndoye, O., Awono, A., & Iponga, D. M. (2014). Gender implications of forest product value chains in the Congo basin. *Forests Trees and Livelihoods*, *23*(1–2), 67–86. https://doi.org/10.1080/14728028.2014.887610

Jäckering, L., Fischer, S., & Kehlenbeck, K. (2019). A value chain analysis of baobab (Adansonia digitata l.) products in eastern and coastal Kenya. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, *120*(1), 91–104. https://doi.org/10.17170/kobra-20191030732

Ji, C., Jin, S., Wang, H., & Ye, C. (2019). Estimating effects of cooperative membership on farmers' safe production behaviors: Evidence from pig sector in China. *Food Policy*, *83*, 231–245. https://doi.org/10.1016/j.foodpol.2019.01.007

Kachule, R. (2004). Rural Producer Organisations and Policy Formulation in Malawi (2004:127). https://oda.oslomet.no/oda-xmlui/bitstream/handle/20.500.12199/2577/2004-127.pdf?sequence=1&isAllowed=y

Kaimba, G. K., Mithöfer, D., & Muendo, K. M. (2020). Commercialization of underutilized fruits: Baobab pulp supply response to price and non-price incentives in Kenya. *Food Policy*, *99*, 101980. https://doi.org/10.1016/j.foodpol.2020.101980

Kruijssen, F., Keizer, M., & Giuliani, A. (2009). Collective action for small-scale producers of agricultural biodiversity products. *Food Policy*, *34*(1), 46–52. https://doi.org/10.1016/j.foodpol.2008.10.008

Leone, M. (2019). Women as decision makers in community forest management: Evidence from Nepal. *Journal of Development Economics*, *138*, 180–191. https://doi.org/10.1016/j.jdeveco.2019.01.002

Ma, W., & Abdulai, A. (2016). Does cooperative membership improve household welfare? Evidence from apple farmers in China. *Food Policy*, *58*, 94–102. https://doi.org/10.1016/j.foodpol.2015.12.002

Ma, W., Hong, S., Reed, W. R., Duan, J., & Luu, P. (2023). Yield effects of agricultural cooperative membership in developing countries: A meta-analysis. *Annals of Public and Cooperative Economics*, *September 2022*, 1–20. https://doi.org/10.1111/apce.12411

Ma, W., Zheng, H., & Yuan, P. (2021). Impacts of cooperative membership on banana yield and risk exposure: Insights from China. *Journal of Agricultural Economics*, *73*(2), 564–579. *July*, 1–16. https://doi.org/10.1111/1477-9552.12465

Manda, J., Gardebroek, C., Kuntashula, E., & Alene, A. D. (2018). Impact of improved maize varieties on food security in Eastern Zambia: A doubly robust analysis. *Review of Development Economics*, *22*(4), 1709–1728. https://doi.org/10.1111/rode.12516

Manda, J., Khonje, M. G., Alene, A. D., Tufa, A. H., Abdoulaye, T., Mutenje, M., Setimela, P., & Manyong, V. (2020). Does cooperative membership increase and accelerate agricultural technology adoption? Empirical evidence from Zambia. *Technological Forecasting and Social Change*, *158*(March), 120160. https://doi.org/10.1016/j.techfore.2020.120160

Markelova, H., Meinzen-Dick, R., Hellin, J., & Dohrn, S. (2009). Collective action for smallholder market access. *Food Policy*, *34*(1), 1–7. https://doi.org/10.1016/j.foodpol.2008.10.001

Markelova, H., & Mwangi, E. (2010). Collective action for smallholder market access: Evidence and implications for Africa. *Review of Policy Research*, *27*(5), 621–640. https://doi.org/10.1111/j.1541-1338.2010.00462.x

Massawe, F., Mayes, S., & Cheng, A. (2016). Crop Diversity: An Unexploited Treasure Trove for Food Security. *Trends in Plant Science*, *21*(5), 365–368. https://doi.org/10.1016/j.tplants.2016.02.006

Meinhold, K., & Darr, D. (2022). Keeping Up With Rising (Quality) Demands? The Transition of a Wild Food Resource to Mass Market, Using the Example of Baobab in Malawi. *Frontiers in Sustainable Food Systems*, *6*(March), 1–14. https://doi.org/10.3389/fsufs.2022.840760

Meinhold, K., Dumenu, W. K., & Darr, D. (2022). Connecting rural non-timber forest product collectors to global markets: The case of baobab (Adansonia digitata L.). *Forest Policy and Economics*, *134*, 102628. https://doi.org/10.1016/j.forpol.2021.102628

Meinzen-Dick, R., DiGregorio, M., & McCarthy, N. (2004). Methods for studying collective action in rural development. *Agricultural Systems*, *82*(3), 197–214. https://doi.org/10.1016/j.agsy.2004.07.006

Minah, M. (2021). What is the influence of government programs on farmer organizations and their impacts? Evidence from Zambia. *Annals of Public and Cooperative Economics*, *93*(1), 29–53. *January*, 1–25. https://doi.org/10.1111/apce.12316

Mojo, D., Fischer, C., & Degefa, T. (2017). The determinants and economic impacts of membership in coffee farmer cooperatives: recent evidence from rural Ethiopia. *Journal of Rural Studies*, *50*, 84–94. https://doi.org/10.1016/j.jrurstud.2016.12.010

Mujawamariya, G., D'Haese, M., & Speelman, S. (2013). Exploring double side-selling in cooperatives, case study of four coffee cooperatives in Rwanda. *Food Policy*, *39*, 72–83. https://doi.org/10.1016/j.foodpol.2012.12.008

Mustafa, M. A., Mayes, S., & Massawe, F. (2019). Crop diversification through a wider use of underutilised crops: A strategy to ensure food and nutrition security in the face of climate change. In A. Sarkar, S. R. Sensharma, & G. W. VanLoon (Eds.), *Sustainable Solutions for Food Security: Combating Climate Change by Adaptation* (1st ed., pp. 125–149). Springer International Publishing. https://doi.org/10.1007/978-3-319-77878-5_7

Mutonyi, S. (2019). The effect of collective action on smallholder income and asset holdings in Kenya. *World Development Perspectives*, *14*(100099), 1–7. https://doi.org/10.1016/j.wdp.2019.02.010

Naziri, D., Aubert, M., Codron, J. M., Loc, N. T. T., & Moustier, P. (2014). Estimating the Impact of Small-Scale Farmer Collective Action on Food Safety: The Case of Vegetables in Vietnam. *Journal of Development Studies*, *50*(5), 715–730. https://doi.org/10.1080/00220388.2013.874555

Nikam, V., Ashok, A., & Pal, S. (2022). Farmers' information needs, access and its impact: Evidence from different cotton producing regions in the Maharashtra state of India. *Agricultural Systems*, *196*, 103317. https://doi.org/10.1016/j.agsy.2021.103317

Nkhoma, A. T. (2011). *Factors affecting sustainability of Agricultural Cooperatives: Lessons from Malawi*. Massey University, New Zealand.

Nugusse, W. Z., Huylenbroeck, G. V., & Buysse, J. (2013). Household Food Security through Cooperatives in Northern Ethiopia. *International Journal of Cooperative Studies*, *2*(1). https://doi.org/10.11634/216826311302299

Olson, M. (1965). The logic of collective action. In *Public Goods and the Theory of Groups*. Havard University Press.

Ostrom, E. (2007). Collective action and local development processes. *Sociologica*, 1–32. https://doi.org/10.2383/25950

Padulosi, S., Roy, P., & Rosado-May, F. J. (2019). *Supporting Nutrition-Sensitive Agriculture through Neglected and Underutilized Species Operational Framework*. Bioversity International and IFAD, Rome.

Paumgarten, F., Kassa, H., Zida, M., & Moeliono, M. (2012). Benefits, Challenges, and Enabling Conditions of Collective Action to Promote Sustainable Production and Marketing of Products from Africa's Dry Forests. *Review of Policy Research*, *29*(2), 229–249. https://doi.org/10.1111/ropr.12008

Quisumbing, A. R., & Pandolfelli, L. (2010). Promising Approaches to Address the Needs of Poor Female Farmers: Resources, Constraints, and Interventions. *World Development*, *38*(4), 581–592. https://doi.org/10.1016/j.worlddev.2009.10.006

Randela, R., Alemu, Z. G., & Groenewald, J. A. (2008). Factors enhancing market participation by small-scale cotton farmers. *Agrekon*, *47*(4), 451–469. https://doi.org/10.1080/03031853.2008.9523810

Ray, D. K., Ramankutty, N., Mueller, N. D., West, P. C., & Foley, J. A. (2012). Recent patterns of crop yield growth and stagnation. *Nature Communications*, *3*, 1293–1297. https://doi.org/10.1038/ncomms2296

Rosenbaum, P. R. (2002). Sensitivity to Hidden Bias. In *Observational Studies* (2nd ed., pp. 105–170). Springer, New York, NY. https://doi.org/10.1007/978-1-4757-3692-2_4

Rudebjer, P., Meldrum, G., Padulosi, S., Hall, R., & Hermanowicz, E. (2014). *Realizing the promise of neglected and underutilized species* (pp. 1–12). Bioversity International. https://www.bioversityinternational.org/fileadmin/user_upload/online_library/publications/pdfs/Realizing_the_promise_of_neglected_and_underutilized_species_1737.pdf

Russell, D., & Franzel, S. (2004). Trees of prosperity: Agroforestry, markets and the African smallholder. *Agroforestry Systems*, *61*, 345–355.

Sanchez, A. C. (2011). The status of baobab tree populations in southern malawi: Implications for further exploitation. *Forests Trees and Livelihoods*, *20*(2–3), 157–173. https://doi.org/10.1080/14728028.2011.9756704

Shiferaw, B., Hellin, J., & Muricho, G. (2011). Improving market access and agricultural productivity growth in Africa: What role for producer organizations and collective action institutions? *Food Security*, *3*(4), 475–489. https://doi.org/10.1007/s12571-011-0153-0

Shumeta, Z., & D'Haese, M. (2016). Do coffee cooperatives benefit farmers? An exploration of heterogeneous impact of coffee cooperative membership in Southwest Ethiopia. *International Food and Agribusiness Management Review*, *19*(4), 37–52. https://doi.org/10.22434/ifamr2015.0110

Shumeta, Z., & D'Haese, M. (2018). Do Coffee Farmers Benefit in Food Security from Participating in Coffee Cooperatives? Evidence from Southwest Ethiopia Coffee Cooperatives. *Food and Nutrition Bulletin*, *39*(2), 266–280. https://doi.org/10.1177/0379572118765341

StataCorp. (2019). Stata: Release 16. Statistical Software. College Station, TX.

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G. (2014). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*(S1), S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Tefera, D. A., Bijman, J., & Slingerland, M. A. (2017). Agricultural Co-Operatives in Ethiopia: Evolution, Functions and Impact. *Journal of International Development*, *29*(4), 431–453. https://doi.org/10.1002/jid.3240

Theng, V., Keo, S., Nou, K., Sum, S., & Khiev, P. (2014). Impact of Farmer Organisations on Food Security : The Case of Rural Cambodia (No. 95). http://www.cdri.org.kh/webdata/download/wp/wp95e.pdf

Tilahun, M., Maertens, M., Deckers, J., Muys, B., & Mathijs, E. (2016). Impact of membership in frankincense cooperative firms on rural income and poverty in Tigray, Northern Ethiopia. *Forest Policy and Economics*, *62*, 95–108. https://doi.org/10.1016/j.forpol.2015.08.009

Tita, D. F., D'Haese, M., Degrande, A., Tchoundjeu, Z., & Van Damme, P. (2011). Farmers' satisfaction with group market arrangements as a measure of group market performance: A transaction cost analysis of Non Timber Forest Products' producer groups in Cameroon. *Forest Policy and Economics*, *13*(7), 545–553. https://doi.org/10.1016/j.forpol.2011.07.005

Verhofstadt, E., & Maertens, M. (2014). Smallholder cooperatives and agricultural performance in Rwanda: Do organizational differences matter? *Agricultural Economics (United Kingdom)*, *45*(S1), 39–52. https://doi.org/10.1111/agec.12128

Verhofstadt, E., & Maertens, M. (2015). Can agricultural cooperatives reduce poverty? Heterogeneous impact of cooperative membership on farmers' welfare in Rwanda. *Applied Economic Perspectives and Policy*, *37*(1), 86–106. https://doi.org/10.1093/aepp/ppu021

World Bank. (2008). Agriculture and development. In *World development report*. https://doi.org/10.1007/978-1-349-02056-0

Wossen, T., Abdoulaye, T., Alene, A., Haile, M. G., Feleke, S., Olanrewaju, A., & Manyong, V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *Journal of Rural Studies*, *54*, 223–233. https://doi.org/10.1016/j.jrurstud.2017.06.022

Zheng, H., Vatsa, P., Ma, W., & Rahut, D. B. (2023). Does agricultural cooperative membership influence off-farm work decisions of farm couples ? June 2022, 1–25. https://doi.org/10.1111/apce.12417

Zhu, Z., Zhou, J., Li, B., Shen, Y., & Zhang, Y. (2020). How feminization of forest management drives households' adoption of technologies: Evidence from non-timber forest products operations in China. *Forest Policy and Economics*, *115*, 102154. https://doi.org/10.1016/j.forpol.2020.102154

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APPENDIX A: IPWRA estimates of factors influencing baobab income and food security

TABLE A1 Inverse probability weighted regression adjustment estimates for the determinants of baobab income and food security.

VARIABLES	Baobab income				Household dietary diversity score				Food consumption score			
	Non-members		Members		Non-members		Members		Non-members		Members	
Male	0.15	(0.12)	0.42***	(0.14)	-0.75***	(0.31)	0.32*	(0.19)	-5.83***	(2.08)	-0.02	(1.59)
Age	-0.00	(0.01)	-0.00	(0.01)	-0.02*	(0.01)	-0.01	(0.01)	-0.03	(0.11)	0.07	(0.08)
Level of education	-0.00	(0.02)	-0.02	(0.02)	0.00	(0.04)	0.07	(0.05)	0.64*	(0.36)	1.04***	(0.25)
Household size	0.03	(0.03)	-0.04	(0.03)	-0.04	(0.03)	0.02	(0.04)	-0.65	(0.40)	0.78**	(0.36)
Baobab experience	0.00	(0.01)	-0.01	(0.02)	0.07**	(0.02)	0.00	(0.02)	0.39	(0.25)	0.26	(0.19)
Married	0.12	(0.19)	0.16	(0.14)	0.44*	(0.23)	-0.08	(0.23)	3.92	(2.42)	-0.15	(1.36)
Land size	0.02	(0.03)	-0.03**	(0.01)	0.11	(0.08)	0.03	(0.04)	1.16*	(0.65)	0.14	(0.34)
Access to hired labour	0.33**	(0.14)	0.51***	(0.13)	1.43***	(0.24)	0.08	(0.22)	11.55***	(2.33)	3.91***	(1.30)
Broker availability	0.05	(0.16)	0.24	(0.20)	0.60	(0.39)	0.30	(0.24)	-0.45	(3.32)	-2.86*	(1.55)
Expected price	0.23**	(0.10)	-0.13	(0.13)	0.48*	(0.29)	-0.06	(0.15)	5.37**	(2.61)	4.15**	(1.74)
Constant	9.54	(0.30)	10.63	(0.34)	3.74	(0.90)	4.30	(0.58)	29.94	(7.81)	26.39	(4.07)

Overidentification test for covariate balance $\chi^2(12) = 7.33$; $p > \chi^2 = 0.84$.

Note: ***Significance level of 1%, **Significance level of 5%, and *Significance level of 10%; Robust standard errors in parentheses.

APPENDIX B: Propensity score matching (PSM) robustness check

TABLE A2 Covariate balancing test for selection bias before and after matching using radius matching.

		Mean		Bias	Significance
Independent variables	Sample	Treated ($n = 299$)	Control ($n = 496$)	% bias reduction	p-value
Gender	Before matching	0.37	0.40		0.40
	After matching	0.37	0.38	85.80	0.92
Age	Before matching	44.75	37.91		0.00
	After matching	44.75	44.79	99.40	0.97
Level of education	Before matching	4.54	5.16		0.01
	After matching	4.54	4.56	97.10	0.95
Household size	Before matching	6.00	5.29		0.00
	After matching	6.00	5.98	97.80	0.93
Baobab experience	Before matching	8.37	6.90		0.00
	After matching	8.37	8.66	80.90	0.55
Married	Before matching	0.81	0.78		0.25
	After matching	0.81	0.81	83.30	0.86
Land size	Before matching	3.07	2.70		0.06
	After matching	3.07	2.91	58.20	0.51
Access to hired labour	Before matching	0.38	0.14		0.00
	After matching	0.38	0.36	92.30	0.65
Broker availability	Before matching	0.27	0.21		0.04
	After matching	0.27	0.30	46.50	0.37
Expected price	Before matching	0.24	0.28		0.17
	After matching	0.24	0.26	50.60	0.53

TABLE A3 Covariate balancing tests, PSM quality indicators before and after matching with NNM and RM, and sensitivity analysis for hidden bias.

Matching algorithm	Pseudo R^2 before matching	Pseudo R^2 after matching	Mean bias before matching	Mean bias after matching	Outcome variable	Critical level of hidden bias (γ)
Nearest neighbour	0.126	0.007	24.4	5.1	Ln (baobab income)	1.7 – 1.8
					HDDS	1.5 – 1.6
					FCS	1.1 – 1.2
Radius	0.126	0.003	24.4	3.2	Ln (baobab income)	1.7 – 1.8
					HDDS	1.6 – 1.7
					FCS	1.2 – 1.3
Kernel	0.126	0.003	24.4	3.1	Ln (baobab income)	1.7 – 1.8
					HDDS	1.5 – 1.6
					FCS	1.2 – 1.3

APPENDIX C: Comparison of outcome variables by group membership

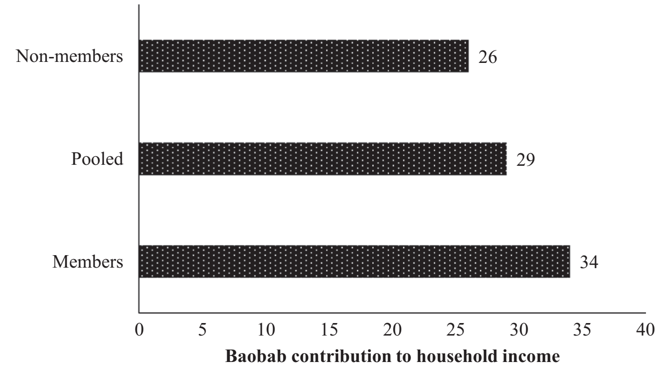

FIGURE A1 Baobab contribution to household income.

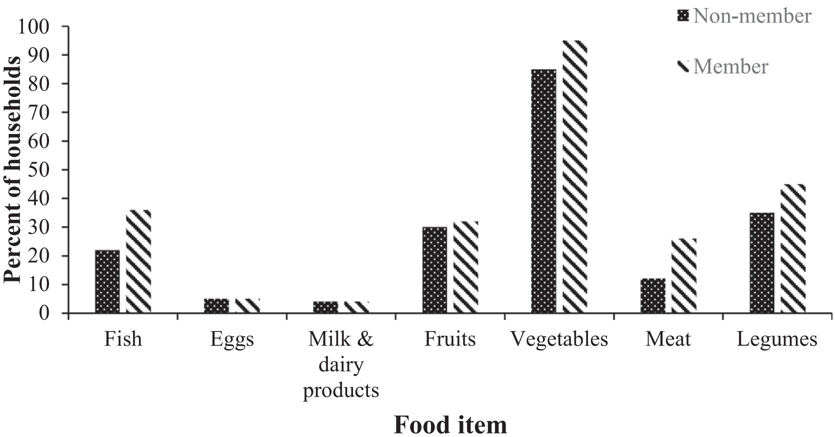

FIGURE A2 Food item consumption by cooperative membership.