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Cultivating Change:
Exploring the Link between Certification, Dietary Quality and Women's Empowerment among Coffee Farmers in Rwanda

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Abstract

Sustainability standards promise not only to promote environmentally friendly production, but also to improve farmers' livelihoods by linking them to high-value markets. While there has been extensive research on how sustainability standards affect farmers' incomes, much less attention has been paid to whether sustainability standards can help improve smallholders' diets. In addition, the link between the gender effects of sustainability standards and nutrition has remained largely unexplored. Using data from certified and non-certified coffee farmers in different districts of Rwanda, we assess the impact of certification on dietary quality. In addition, we examine women's empowerment as a potential pathway for the impact of sustainability standards on farmers' nutrition. We use inverse probability weighting regression adjustment and mediation analysis to estimate our results. We find positive associations between certification and dietary quality. Our results further suggest that women's empowerment is indeed a mediator of dietary quality, but that there may be other potential impact channels that need to be investigated. We conclude that efforts to improve women's empowerment within certification schemes can improve farmers' nutrition, but other complementary pathways need to be better understood.

Keywords: Sustainability standards, Nutrition, Women's empowerment, Coffee, Rwanda

JEL codes: F63; I15; Q18

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1. Introduction

Sustainability standards such as Fairtrade, Organic, and Rainforest Alliance have gained importance over recent years, partly because of growing consumer concerns for environmental and social consequences of agricultural production (Chiputwa & Qaim, 2016; Mergenthaler et al., 2009; Narrod et al., 2009). In Western countries, the demand for products with sustainability labels is rising, especially for foods like coffee, tea, and cocoa imported from developing countries. Since sustainability standards involve smallholder farmers, this consumption shift may contribute to rural development and poverty reduction in developing countries (Chiputwa & Qaim, 2016; Meemken & Qaim, 2018). The importance of this topic is also reflected in recent literature. Many studies explore the income effects of certification schemes, but findings are often mixed. Some studies find significant farmer income gains (Barham & Weber, 2012; Chiputwa et al., 2015; Mitiku et al., 2017), while other studies show that higher and more stable prices and improved practices do not always translate into higher household incomes (Akoyi & Maertens, 2018; Gather & Wollni, 2022). Additionally, results tend to depend heavily on the country context due to differences in yield, quality, and different stages of market development (Chiputwa & Qaim, 2016).

Beyond income, other measures of farmers' welfare, like nutrition, have received much less attention. In developing countries, many of the undernourished population are smallholder farmers. Hence, it is crucial to better understand the effects of agricultural production on nutrition (Haddad et al., 2015). Sustainability standards might play an important role in nutrition among smallholder farmers. They link farmers to high-value markets and simultaneously have the potential to offset the adverse effects of agricultural commercialization on gender roles by focusing on empowering women in the value chain. Focusing on gender equity in agricultural commercialization is especially important for nutrition because female-controlled income is often more important for household nutrition (Doss, 2013; Hoddinott & Haddad, 1995; Malapit & Quisumbing, 2015). Although there are studies investigating the gender implications of certifications (Meemken & Qaim, 2018; Mehraban et al., 2022), the link between gender effects and nutrition has remained largely unexplored. We are aware of only one other study by Chiputwa and Qaim (2016), which explicitly looks at women's empowerment as a pathway of the impact of sustainability standards on household nutrition among coffee farmers in Uganda. However, the authors use a very narrow definition of women's empowerment, only considering women's control over coffee revenues. Research on women's empowerment suggests that much more nuanced insights into different domains of empowerment are needed to fully understand its impact on household welfare (Alkire et al., 2013; Kabeer, 1999). We intend to add to the sparse literature on the impacts of sustainability standards on farmers' nutrition and give new insights into women's empowerment as a potential pathway by using a more differentiated assessment of women's empowerment inspired by the Women's Empowerment in Agriculture Index (WEAI). Employing inverse probability weighted regression adjustment (IPWRA) (Wooldridge, 2010) and mediation analysis using primary data from 711 coffee farmers in Rwanda, we analyze the impacts of certification on farmers' nutrition and investigate women's empowerment as a potential impact pathway. Our results show that there is a positive association between certification and dietary quality, especially for the consumption of food groups associated with meeting global dietary recommendations (GDRs). We also find that women's empowerment is indeed a pathway for improving farmers' nutrition through certification, but still there might be other potential mediators which should be investigated.

This article proceeds as follows. Section 2 introduces the conceptual framework and the study context. Section 3 describes the main variables used in the analysis and Secition 4 presents the data and econometric framework. Sections 5 and 6 present and discuss the empirical results. The last section concludes.

2. **Background**

2.1. Conceptual Framework

Agricultural commercialization and participation in high-value markets is seen as a promising way of lifting smallholder farmers and their families out of poverty (Maertens & Swinnen, 2009). However, commercialization can affect gender roles within farm households, with potentially adverse effects on women's empowerment and gender equality (Meemken & Qaim, 2018). Although gender roles in agricultural production are often less rigid in practice (Doss, 2002), cash crops are still considered a male domain (Fischer & Qaim, 2012; Njuki et al., 2011). This societal perception may inhibit women's access to cash crop production and marketing and limit them to the production of food crops (Handschuch & Wollni, 2016; Orr et al., 2016). Hence, women may lose decision-making power when farm households become more market-oriented (Chege et al., 2015). This may exacerbate their already disadvantaged positions, given the gender disparities in terms of access to land, farm inputs, and rural services (Oduol et al., 2017; Quisumbing et al., 2015). Certification through sustainability standards can play an important role in mitigating the negative effects of agricultural commercialization on gender equality (Meemken & Qaim, 2018). Besides farmers' welfare, labor conditions, and environmental conservation, numerous standards also include specific components aimed at promoting women's empowerment and gender equality. Certificate holders need to adhere to anti-discrimination policies and are also often required to keep separate data for women and men to visualize gender gaps (Rainforest Alliance, 2020). Additionally, they are encouraged to enhance awareness of power relations through workshops, influence and change norms about productive roles through implementing initiatives aimed at enhancing women's empowerment in value chains, and promote female participation in agricultural training sessions and farmers groups (Fairtrade, 2016).

The conceptual framework in Figure 1 depicts the expected relationships between certification, women's empowerment, and dietary quality.

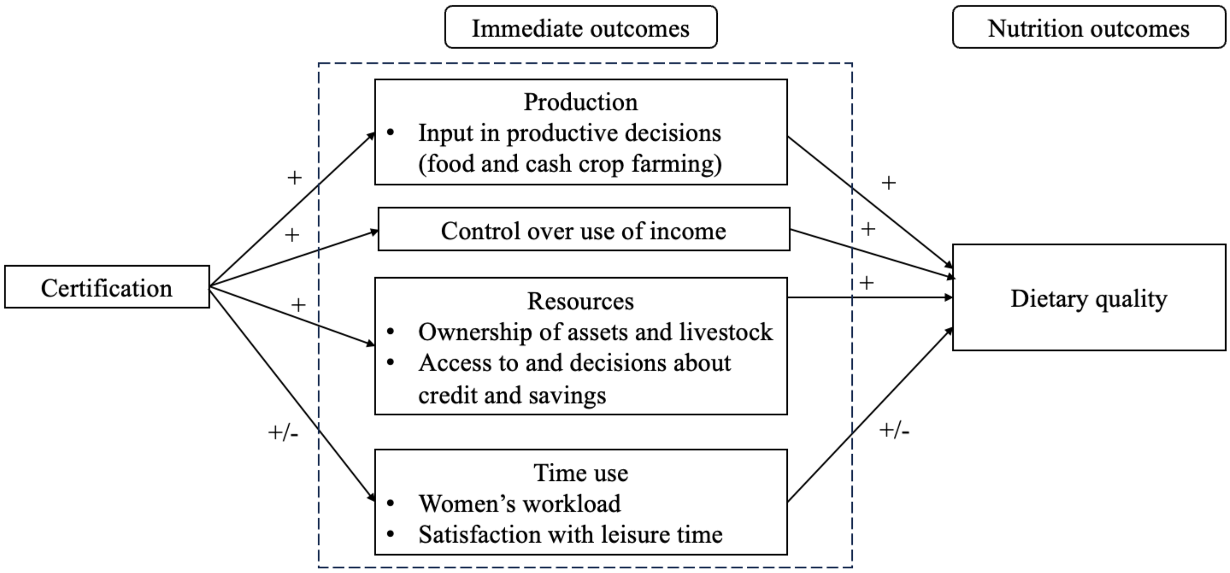

Figure 1 Conceptual framework

As described previously, certification may be an important driver of women's empowerment in agriculture, especially in cash crop production like coffee (Bassett, 2010; Chiputwa & Qaim, 2016; Kloos & Renaud, 2014). To investigate these potential effects, we look at four different domains of women's empowerment, namely (1) production, (2) income, (3) resources, and (5) time.

We hypothesize that certification positively influences women's decision-making power in agricultural production, specifically coffee production, through changing social perceptions of gender roles and thereby promoting their involvement in production and marketing (Kloos & Renaud, 2014; Lyon et al., 2010). We further expect that certification enhances women's empowerment by increasing their control over income. Most certified crops produced by smallholder farmers are traditional cash crops. The income generated from the sale of these crops is often controlled by men (Fischer & Qaim, 2012; Njuki et al., 2011). By increasing women's market access and enabling them to participate in the value chain, they may be able to exercise greater control over productive resources and income generated from cash crop production (Chiputwa & Qaim, 2016; Meemken & Qaim, 2018). Certification may also facilitate access to rural services, which can improve their access to credit and saving institutions through extension services provided through the scheme (Meemken & Qaim, 2018). Lastly, we expect certification to influence women's time use. To be able to acquire certification, farmers must fulfill specific requirements regarding their agricultural practices. This may affect women's and men's time use differently (Lyon et al., 2010). Women are more often involved in labor-intensive tasks like pest control, and some standards may prohibit the use of chemical pesticides, which increases the need for, for example, weeding and, consequently, the workload of women (Bolwig, 2012). The effect of increased workload on women's empowerment might be twofold. On the one hand, higher involvement of women in agriculture may strengthen their decision-making power (Orr et al., 2016). On the other hand, women often work longer hours than men due to their role as care providers in their household (Meemken & Qaim, 2018). Consequently, increased workload may take away their time to engage in other economic, social, or leisure-time activities.

As shown in Figure 1, we hypothesize a positive association between certification and dietary quality through women's empowerment as an impact pathway. Women are usually the caretakers in the household. They are the ones who produce or buy and prepare the food and, therefore, play important roles in the nutritional status of their household (Kurz & Johnson-Welch, 2001). Additionally, previous research has shown that female-controlled income is more important for household nutrition than male-controlled income (Hoddinott and Haddad 1995; Doss 2013; Malapit and Quisumbing 2015). With an increase in women's empowerment, women are more likely to take on meaningful roles in coffee production, allowing them to exercise control over income and other resources, which then positively influences dietary quality in the household.

2.2. Study Context

Our study is located in Rwanda, an emerging market for specialty coffee. In Rwanda, agriculture is the foundation of the domestic economy, with 89% of rural households practicing small-scale farming. Coffee is, besides tea, the most important traditional cash crop and accounts for 24% of domestic agricultural production (Rayan, 2002). Coffee plants were first introduced to Rwanda by German missionaries in 1904, and in 1933, Belgian rulers made cultivation compulsory (Guariso & Verpoorten, 2018). When Rwanda became independent in 1962, the post-colonial government prohibited uprooting coffee trees. Today, about 400,000 small-scale farmers produce an average of 16,000 to 21,000 metric tons of coffee every year (NAEB, 2019). Coffee is also the country's most important export crop; only a small portion is roasted and consumed locally (AgriLogic, 2018). Most of the coffee grown in Rwanda is Arabica. The harvest season in Rwanda falls between March and July. In Rwanda, coffee is either home-processed and sold to traders or fully washed in wet mills, so-called Coffee Washing Stations (CWSs), where farmers can deliver their coffee (Macchiavello & Morjaria, 2022). Fully washed coffee is of higher and more consistent quality and, therefore, associated with price premiums in international markets. After being processed in the wet-mill, coffee is then sold to dry mills, which prepare the green coffee beans for export or local roasting. CWSs are either privately or cooperatively owned and often provide extension and support to farmers within their operational area (Gather & Wollni, 2022). They distribute seedlings, fertilizer, and other inputs on receipt of coffee cherries from farmers.

Since 2014, voluntary sustainability standards have become increasingly important in the Rwandan coffee market. Rainforest Alliance represents the most prevalent scheme, with an estimated certified production of 5,590 metric tons of coffee in 2020 (Rainforest Alliance, 2021). It is followed by Fair Trade, 4C (The Common Code for the Coffee Community), and finally Organic (Larrea & Balino, 2018). CWSs play an integral part in certification, as farmers are certified through the CWS that they deliver their coffee to. The situation in Rwanda is unique in that the government implemented a zoning policy in 2016, aiming to reduce competition between CWSs and improve services for farmers. The zoning policy assigns coffee farmers to a particular CWS based on geographical location and obliges famers to sell their coffee cherries only to the designated CWS. The zoning policy was revoked in June 2023 but was still in place when our study was contducted.

Rwanda has had a period of impressive economic growth and development, but still household food insecurity and undernutrition remain a challenge, especially in rural areas (USAID, 2018). Concerning gender roles, Rwanda has been a world leader in its commitment to gender equality. The country is leading in the representation of women among decision-makers and Parliament; 61.3% of the Chamber of Deputies and 36% of the Senate are women (Government of the Republic of Rwanda, 2022). This makes Rwanda the first country in the world with a female majority in Parliament. Rwanda has also implemented progressive legal and institutional reforms focusing on giving women a representative voice in public policy and ensuring accountability for gender-sensitive policies (Randell, 2014). Despite these efforts, women’s effective participation in programs targeting development in the agricultural sector has lagged behind, and gender roles remain largely unchallenged. Often, men are perceived as the primary decision-makers and breadwinners in the household (Stern et al., 2018), even if women are consistently involved in agricultural production and decisions are made jointly (Okonya et al., 2019).

3. Measurement of Key Variables

3.1. Measuring Women's Empowerment

The key variables chosen to measure women's empowerment reflect four domains of empowerment, namely (1) decisions about agricultural production, (2) access to and decision-making power about productive resources, (3) control over the use of income, and (4) time allocation (Alkire et al., 2013). Whereby the first three domains capture women's decision-making power and their ability to act on these decisions (Doss & Quisumbing, 2020; Haddad et al., 1998; Rangel, 2006). All four domains are also found in the WEAI and reflect aspects of women's empowerment considered in the literature. The first domain follows the definition of empowerment as the ability to make choices (Kabeer, 1999), in this case, in agricultural production. Control over assets and income, as reflected in the second and third domains, respectively, allow women to act on those decisions (Alkire et al., 2013). Lastly, the fourth domain shows women's time use and provides insights into their workload and ability to enjoy leisure time.

Table 1 gives a detailed overview of all dummy variables included in the aggregated empowerment score. Each dummy variable is designed to measure whether the woman, who is either the female respondent or, in the case of male respondents, their female spouse, has adequate achievement. The dummy variables are then equally weighed and added up to an aggregated empowerment score. The score ranges between 0 and 11, where a higher score reflects being more empowered.

Table 1 Dummy variables included in the aggregated women's empowerment score

Domain	Variable name	Variable definition
Production	Cropping activities coffee	=1 if woman makes decisions regarding coffee cropping activities solely or jointly
	Cropping activities other crops	= 1 if woman makes decisions regarding crops other than coffee solely or jointly
Resources	Asset ownership	=1 if woman reports having sole or joint ownership of at least one major asset (that is, not including poultry, nonmechanized equipment, or small consumer durables)
	Credit	= 1 if woman makes decisions on credit solely or jointly
	Savings	= 1 if woman makes decision on savings solely or jointly
Income	Employment income	= 1 if woman makes decisions on income from employment solely or jointly
	Coffee income	= 1 if woman makes decisions on income from coffee production solely or jointly
	Crop income	= 1 if woman makes decisions on income from crops other than coffee solely or jointly
	Livestock income	= 1 if woman makes decisions on income from livestock solely or jointly
Time	Workload	=1 if woman works less than 10.5 hours every day (productive and domestic work)
	Leisure	= 1 if woman indicates that satisfaction with leisure time is 5 or higher

3.2. Measuring Dietary Quality

To analyze the nutritional impacts of certification, we need to identify appropriate indicators for measuring nutrition. We decided to use the Dietary Quality Questionnaire (DQQ), a standardized assessment tool for dietary quality which has been implemented in 55 countries in the Gallup World Poll in 2021-2022 (Global Diet Quality Project, 2022c, 2022a; Herforth et al., 2019). The DQQ was designed to be a low-burden tool that enables feasible measurement and monitoring of dietary quality (Global Diet Quality Project, 2022c). Dietary quality is an often-overlooked component of food security and nutrition. Even households classified as food secure might still experience a lack of micro-nutrients, which can lead to short- and long-term health and development consequences (Iannotti et al., 2009). Understanding the positive and negative features of diets is thus crucial to investigating the causes of poor health and nutrition outcomes.

The DQQ comprises yes/no questions about foods consumed the previous day or night. Food items are adapted to the country-specific context and correspond to 29 food groups (Uyar et al., 2023). In order to receive a representative overview of food groups consumed, respondents are first asked whether yesterday was a festivity. Those who confirm that yesterday was a festivity are excluded from the sample, as their consumption during the recall period is not representative of their general diet. The food groups defined by the Global Diet Quality Project (2022c) are as follows: 1) foods made from grains; 2) whole grains; 3) white roots, tubers, and plantains; 4) legumes; 5) vitamin A–rich orange vegetables; 6) dark green leafy vegetables; 7) other vegetables; 8) vitamin A–rich fruits; 9) citrus; 10) other fruits; 11) baked/grain-based sweets; 12) other sweets; 13) eggs; 14) cheese; 15) yogurt; 16) processed meats; 17) unprocessed red meat (ruminant, for example, beef, lamb, and goat); 18) unprocessed red meat (nonruminant, for example, pork); 19) poultry; 20) fish and seafood; 21) nuts and seeds; 22) packaged ultra-processed salty snacks; 23) instant noodles; 24) deep fried foods; 25) fluid milk; 26) sugar-sweetened beverages (soft drinks);

27) fruit juice and fruit-flavored drinks; 28) sweet tea/ coffee/cacao; and 29) fast food. These food groups are used to construct the DQQ indicators, which give insights into micro-nutrient and food group adequacy and adherence to GDRs. Indicators used in our study according to the Global Diet Quality Project (2022c) are detailed in Table 2.

Table 2 Dietary quality variables

Variable name	Variable definition	Food Groups	Scale
Minimum Dietary Diversity for Women (MDDW)	Binary variable which is considered adequate for women of reproductive age (15-49) in the sample that consumed 5 or more out of 10 food groups.	1) grains, white roots and tubers, and plantains; 2) pulses (beans, peas, and lentils); 3) nuts and seeds; 4) milk and milk products; 5) meat, poultry, and fish; 6) eggs; 7) dark green leafy vegetables; 8) other vitamin A–rich fruits and vegetables; 9) other vegetables; and 10) other fruits.	0/1
Food Group Diversty Score (FGDS)	Proxy indicator of dietary diversity in the sample population expressed as the number of food croups consumed. A higher score indicates the inclusion of more food groups in the diet.		0-10
All5	Binary variable which is considered adequate for respondents that consumed all 5 food groups typically recommended for daily consumption in food-based dietary guidelines	At least one vegetable, at least one fruit, at least one nut, pulse or seed, at least one animal-source food, and at least one starchy staple	0/1
NCD-P	NCD-P is an indicator of dietary factors protective against NCDs. It includes nine food groups associated with meeting World Health Organization (WHO) recommendations on fruits, vegetables, whole grains, pulses, nuts and seeds, and fiber	1) whole grains; 2) legumes; 3) vitamin A–rich orange vegetables; 4) dark green leafy vegetables; 5) other vegetables; 6) vitamin A–rich fruits; 7) citrus; 8) other fruits; 9) nuts and seeds	0-9
NCD-R	NCD-R is an indicator of dietary risk factors for NCDs, based on 8 food groups that are negatively associated with meeting WHO recommendations on free sugar, salt, total and saturated fat, and red and processed meat.	1) soft drinks (sodas); 2) baked/grain-based sweets; 3) other sweets; 4) processed meat (double weighted); 5) unprocessed red meat; 6) deep-fried food; 7) fast food and instant noodles; and 8) packaged ultra-processed salty snacks	0-9
Global dietary recommendations score (GDR)	The GDR score (ranging from 0 to 18) has two components, NCD-P and NCD-R. The higher the GDR score, the more likely GDRs on healthy diets are to be met.		0-18
Zero fruit and vegtables (ZVEGFR)	Binary variable which is considered adequate for respondents that consumed neither fruit nor vegtables during the recall period	At least one vegetable, at least one fruit	0/1

4. **Methods**

4.1. Sampling and Data

Data for this study were collected through a household survey of coffee-producing farmers in Rwanda between November 2022 and February 2023. We collected data across 2 provinces and 5 districts, namely Huye, Rusizi, Nyamasheke, Karongi, and Rutsiro, to account for regional differences in coffee production. Farmers in all districts were selected through multi-stage random sampling. First, we randomly selected certified and non-certified CWSs from a list obtained from local authorities. Subsequently, we randomly selected farmers from a complete list provided by each CWS. Certified CWSs were certified under either Rainforest Alliance, Fairtrade, Organic, or Café Practice. Some CWSs were also certified by multiple sustainability standards. For this paper, we consider farmers as certified who supply coffee to a CWS holding at least one certification.

In total, we interviewed 842 farmers. Of these, 515 farmers were certified, and 327 were non-certified. The reduced sample used for the main analysis excludes farmers who indicated they attended any festivity the day before. We exclude these farmers as their food consumption during the recall period is not representative of their daily consumption. Excluding these respondents leaves us with a sample of 711, including 428 certified and 283 non-certified farmers (for more details see Table 3).

4.2. Econometric Framework

To assess the relationship between certification and the dietary quality of coffee farmers, we need to compare certified farmers to a suitable counterfactual. As mentioned in Section 2.2, in Rwanda, certification is implemented at the CWS level, implying that the certified CWS have to operationalize certification criteria with their farmes. Accordingly, farmers' certification status is determined exogenously at the CWS level, and individual households do not have the option to opt out of certification. Therefore, we expect little to no self-selection into certification on the household level. Still, self-selection into certification at CWS and regional level could be an issue given that certification is not randomly assigned. Thus, certification may be influenced by various observed and unobserved CWS-level and regional characteristics that may also correlate with dietary quality outcomes.

In order to reduce selection bias, we follow the example of Gather and Wollni (2022) and Hörner and Wollni (2021) and apply the IPWRA method (Wooldridge 2010). The approach combines inverse probability weighting (IPW) with regression adjustment (RA): IPW focuses on modelling the certification decision, whereas RA models the outcomes. The method allows controlling for selection bias and confounding factors at both stages. Wooldridge (2010) refers to the property as 'doubly robust', since only one of the two models must be correctly specified to obtain consistent estimates.

The RA method fits separate linear regression models for certified and non-certified farmers. Covariate-specific outcomes are then predicted for each subject under each certification status. Based on this, the method constructs the average differences between predicted outcomes (ADPO)[1] for certified female farmers under certification and hypothetical non-certification ($ADPO^{C}_{IPWRA}$) while taking into account differences in characteristics between certified and non-certified farmers. The IPWRA estimator is then constructed by combining the RA method with IPW and can be expressed as (Manda et al., 2018):

$$ADPO^{C}_{IPWRA} = n_C^{-1} \sum_{i=1}^{n} T_i [r_C^*(X, \delta_C^*) - r_N^*(X, \delta_N^*)]$$

where n_C is the number of certified farmers and $r_C^*(X)$ represents the weighted regression models for certified (C) and non-certified (N) coffee farmers with covariates X and estimated parameters,

[1] In the cited literature the authors use the more common terminology 'average treatment effect on the treated'. Hörner and Wollni (2021) suggest to use ADPO instead in order to avoid using experimental language which suggests a clear casual identification strategy.

δ_C^* and δ_N^*, which are obtained from the weighted regression procedure. An underlying assumption of IPWRA is the overlap assumption. It requires that, conditional on covariates, each farmer has a positive probability of obtaining certification. The overlap assumption ensures that for each certified farmer, a non-certified farmer with similar characteristics exists. In case of a violation of the assumption, inferences would be made off-support of the data, and thus, conclusions would be model-dependent. To meet this condition, we set a tolerance level between $\hat{p} = 0.001$ and $\hat{p} = 0.999$ for the estimated probability of certification.

It is important to note that the IPWRA method relies on observable covariates to reduce selection bias and confounding. Thus, estimates are vulnerable to systematic bias in unobserved characteristics. In the context of certification, unobserved heterogeneity is likely to play a role. We control for observable covariates like education, experience in coffee production, land devoted to agriculture, ownership of CWS, and remoteness that may influence both certification and dietary quality outcomes. Conditioning on a broad set of observable covariates may help reduce selection bias resulting from unobservables (Imbens & Wooldridge, 2009). Still, our results should be interpreted as associations rather than causal effects.

4.3. *Causal Mediation Analysis on the Mechanisms of Certification*

In addition to exploring the effect of certification on the dietary quality of female farmers, we are interested in examining women's empowerment as one potential mechanism behind the effect of certification on dietary quality outcomes. A mechanism is defined as a causal process in which a treatment variable influences an outcome of interest through an intermediary variable, known as a mediator, which lies on the causal pathway connecting the treatment and outcome variables (Liao et al., 2020). Causal mediation analysis dissects the overall causal impact into two components: the indirect or mediation effect, which represents the proposed causal process through the mediator of interest, and the direct effect, which encompasses all other potential causal mechanisms (Imai et al., 2011).

In this study, the treatment variable is certification, the dietary quality indicators, as specified in Section 3.2, are the outcomes of interest, and women's empowerment, more specifically, the aggregated empowerment score, is the mediator in accordance with our conceptual framework. Figure 2 shows a graphic representation of the decomposition method (Hayes, 2022), where certification affects dietary quality directly or indirectly via the chosen mediator, the aggregated empowerment score. We decompose the total effect of certification into the indirect (mediation) effect, i.e., the effect of certification on dietary quality that is carried through women's empowerment, and the direct effect, i.e., the remaining effect of certification on dietary quality that is not explained by women's empowerment.

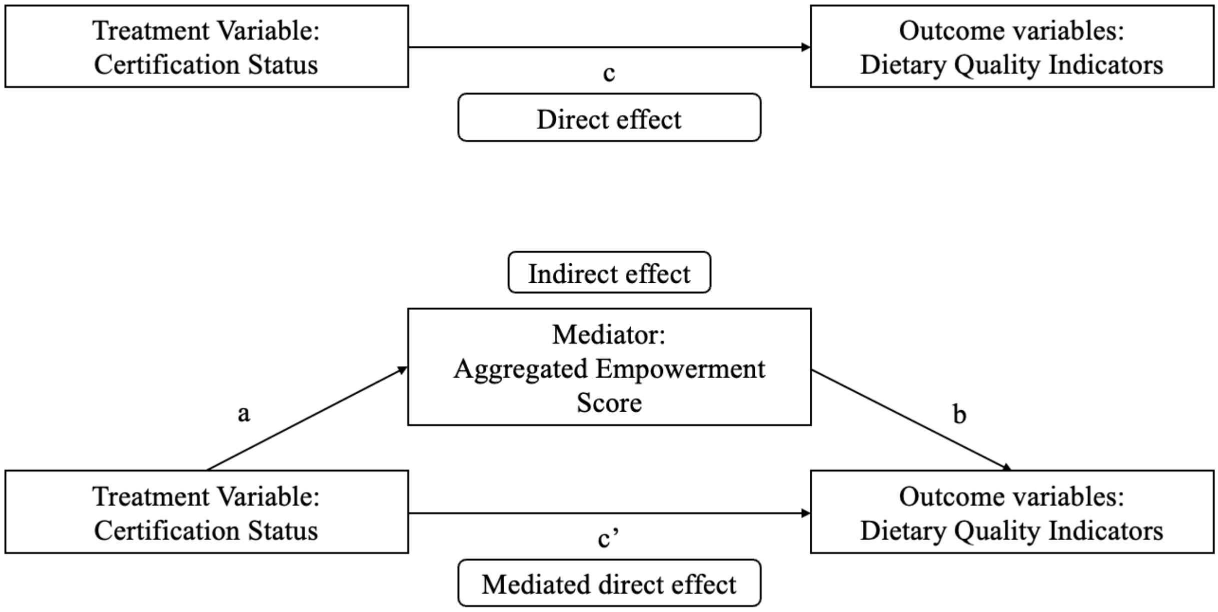

Figure 2 The framework of the causal mediation analysis (adapted from Hayes (2017))

Table 3 Descriptive statistics of all outcome and control variables used in analysis

	Total Sample		Certified		Non-certified		
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	
Women's empowernment							
Aggregated empowerment score (0-11)	5.501	0.089	5.659	0.116	5.261	0.139	**
Makes decisions about coffee (1=yes)	0.356		0.365		0.342		
Makes decisions about other crops (1=yes)	0.789		0.798		0.777		
Makes decisions about income from coffee (1=yes)	0.758		0.757		0.760		
Makes decisions about income from employment (1=yes)	0.592		0.551		0.648		*
Makes decisions about income from other crops (1=yes)	0.454		0.487		0.403		**
Makes decisions about income from livestock (1=yes)	0.578		0.642		0.478		***
Owns at least two small or one large asset (1=yes)	0.989		0.988		0.989		
Makes decisions about savings (1=yes)	0.754		0.758		0.747		
Makes decisions about credit (1=yes)	0.339		0.361		0.303		
Workload is < 10.5 hrs (1=yes)	0.531		0.520		0.550		
Satisfied with leisure time (1=yes)	0.751		0.772		0.715		
Dietary Quality indicators							
FGDS (0-10)	4.339	0.063	4.444	0.078	4.180	0.105	**
NCD-P (0-9)	3.406	0.061	3.561	0.077	3.173	0.099	***
NCD-R (0-9)	0.135	0.017	0.124	0.020	0.152	0.029	
GDR (0-18)	12.541	0.066	12.685	0.082	12.325	0.108	***
ZVEGFR (1=yes)	0.903		0.909		0.894		
ALL-5 (1=yes)	0.203		0.222		0.173		
MDD-W[a] (1=yes)	0.394		0.453		0.317		
Control variables							
Male HH head (1=yes)	0.734		0.729		0.742		
No. of HH members	4.927	0.081	4.918	0.103	4.940	0.131	
Age of respondent (in years)	54.293	0.496	54.568	0.613	53.876	0.834	
Literacy respondent (1=yes)	0.795		0.818		0.760		*
Coffee experience respondent (in years)	40.255	4.114	39.893	5.097	40.802	6.896	
Farming experience respondent (in years)	33.503	0.565	34.169	0.697	32.491	0.950	
Income without coffee income (RWF)	890,337.653	43,827.096	942,862.064	58,205.359	810,901.442	65,989.785	
Coffee income (RWF)	395,157.714	19,586.090	423,103.729	25,416.281	352,893.071	30,605.664	*
Land devoted to agriculture (>50%=1)	2.713		2.738		2.675		
Respondent is member of coffee cooperative (1=yes)	0.539		0.645		0.378		***
CWS is cooperatively owned (1=yes)	0.294		0.446		0.064		***
Distance to food market (in km)	3.929	0.146	4.237	0.190	3.463	0.224	***
Distance to input market (in km)	3.738	0.108	4.067	0.140	3.241	0.164	***
Sample Size	711		428		283		

Source: Author's calculations from survey data

Note: HH stands for household, RWF stands for Rwandan Francs. a Includes only female farmers of reproductive age (N=94, of which N=53 are certified and N=41 are non-certified). Significant levels for differences in means: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. *Results*

In the following section, we present results from the IPWRA estimations (

Table 4) and our causal mediation analysis (Table 5). For our IPWRA results to be valid, we must first ensure that the overlap assumption is fulfilled. To do so, we only include observations with a probability of being certified of at least $\hat{p}$ = 0.0001 and maximum $\hat{p}$ = 0.999. Furthermore, after applying inverse probability weights, our sample should be balanced between certified and non-certified female farmers. Over-identification tests show that the null hypothesis (H_0: sample is balanced) cannot be rejected for our sample. For our sample, test statistics are $\chi^2(15) = 22.947$ with $p > \chi^2 = 0.085$, suggesting that we cannot reject the H_0 at the 5%-level. Results from the probit model on the certification decision that are used to derive IPW are presented in Table A 1Probit regression on the certification decision to derive inverse probability weights Table A 1 in the Appendix.

5.1. Descriptive Statistics

Table 3 provides an overview of summary statistics for all outcome and control variables differentiated by certification status.

Comparing summary statistics of women's empowerment, we observe that on average women in our sample have an aggregated empowerment score of 5.501. The average aggregated empowerment score for certified women is significantly higher than for non-certified women. Certified female farmers were also, on average, significantly more likely to make decisions regarding income earned from employment, crops other than coffee, and livestock. Summary statistics of dietary quality indicators presented in Table 3, confirm that dietary quality is a issue among coffee farmers in Rwanda. The average FGDS is 4.339, indicating that out of 10 food groups only 4 were on average included in farmers' diets during the previous day or night. Additionally, only 20% of female farmers consumed all five food groups typically recommended for daily consumption. Still, on average certified farmers seem to be better off in terms of their dietary quality which is indicated by their higher FGDS, NCD-P, and GDR scores.

5.2. Impact of Certification on Dietary Quality

Column 1 of

Table 4 shows the predicted outcomes for certified female farmers under hypothetical non-certification (the counterfactual), and Column 2 shows the $ADPO^{C}_{IPWRA}$ for certified farmers under certification and hypothetical non-certification. The $ADPO^{C}_{IPWRA}$ can be interpreted as a measure of the association between certification and the respective outcome variables. We show both p-values and sharpened q-values, presented in columns 3 and 4, respectively. Sharpened q-values are considered to be more reliable in the context of multiple-hypothesis testing (Anderson, 2008).

Table 4 Association of certification with dietary quality outcomes and women's empowernment

	non-certified PO	$ADPO^{C}$	p-value	Sharpened q-value	Obs
FGDS(0-10)	4.248	0.190	0.139	0.106	708
NCD-P (0-9)	3.220	0.338	0.003	0.006	708
NCD-R (0-9)	0.168	-0.044	0.055	0.058	708
GDR(0-18)	12.388	0.294	0.003	0.006	708
ZVEGFR(1=yes)	0.921	-0.013	0.370	0.188	708
ALL-5 (1=yes)	0.148	0.073	0.000	0.001	708
MDD-W	0.299	0.154	0.182	0.106	94

PO stands for 'predicted outcome'. $ADPO^{C}$ stands for 'average difference in predicted outcomes' for certified farmers under certification and hypothetical non-certification.

Overall, certification is associated with a significant effect on four out of six dietary quality indicators, namely NCD-P, NCD-R, GDR, and ALL5. Our IPWRA results suggest that certification is associated with an increase of 0.338 in the NCD-P score and 0.294 in the GDR score compared to the hypothetical counterfactual. These estimated effects of certification point towards a positive effect of certification on dietary quality. Our estimates suggest that certified farmers have a diet that is more likely to meet global dietary recommendations (GDR) and that their diets are protective against diet-related non-communicable diseases. Certification is also associated with a 7.3 percentage point increase in the likelihood of consuming all 5 food groups typically recommended for daily consumption. Furthermore, certification is associated with a decrease of 0.044 points in the NCD-R score. This suggests that certified farmers consume fewer food groups that are dietary risk factors for non-communicable diseases.

Our results further show a 15.4 percentage point increase in the likelihood of women of reproductive age consuming at least 5 out of the 10 recommended food groups per day (MDD-W) and a 1.3 percentage point decrease in the likelihood of consuming neither fruits nor vegetables during the 24-hour recall period. Yet, these estimates are not statistically significant.

5.3. Impact Pathway

As previously shown in Table 3, we observe differences in women's empowerment between certified and non-certified farmers. Generally, levels of women's empowerment are higher for certified farmers as indicated by the overall women's empowerment score. Based on these results we now turn to the analysis of women's empowerment as a possible impact pathway for changes in dietary quality. Table 5 reports the estimated total effects as well as the indirect effects for those DQQ indicators for which we identified associations between certification and dietary quality according to our IPWRA results.

Table 5 Causal mediation analysis results for the role of women's empowerment in dietary quality outcomes

	NCDP	NCDR	GDR	ALL5
Indirect (mediation) effect	0.041*	-0.001	0.040*	0.006
	(0.022)	(0.003)	(0.022)	(0.004)
Direct effect	0.347***	-0.027	0.320**	0.043
	(0.123)	(0.036)	(0.038)	(0.030)
Total effect	0.388	-0.028	0.360	0.049

Robust standard error in paranthesis. Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01.

We observe a significant mediation effect of certification on two of four investigated dietary quality indicators through women's empowerment. This is indicated by the significant indirect effects shown in Table 5 for NCD-P and GDR. The total effect of certification on the NCD-P score resulting from the causal mediation analysis is 0.388. Of this effect, an increase of 0.041 is attributable to the indirect (mediation) effect, and 0.347 to the direct effect of certification. For the GDR score, the indirect effect takes the value of 0.040, suggesting that part of the certification effect on the likelihood to meet global dietary recommendations is attributable to an increase in the aggregated empowerment score. Our results indicate that for NCD-P and GDR, women's empowerment acts as an impact pathway, explaining about 10 percent of the total effect of certification on these nutrition outcomes.

5.4. Robustness Check

Women are more likely to suffer from malnutrition due to their reproductive biology, lower social status, poverty and lack of education (Diamond-Smith et al., 2022; Galiè et al., 2019). Additionally, they often act as shock absorbers, redistributing their food intake to other household members, particularly children, in times of economic hardship (FAO, 2023). Furthermore, recent research has shown that spouses' responses to questions on control over assets and participation in household decisions often differ (Ambler et al., 2021). Also, interpretations of what it means to make a sole or joint decision may vary depending on the context (Acosta et al., 2020; Seymour & Peterman, 2018). To ensure that these factors do not drive our results, we perform a robustness check where we only consider female respondents in our analysis. The IPWRA results (Table A 3 in the Appendix) show that when considering only female respondents, the association between certification and dietary quality remains positive. Compared to non-certified female farmers in our sample, certified female farmers have a more diverse diet that is more protective against risk factors related to NCDs. Their diet is also more in line with global dietary recommendations (GDR). Apart from the NCD-P, NCD-

R, and GDR scores, which were also significantly affected in our full sample, we also observe a significant positive effect of certification on the FGDS. When exploring women's empowerment as a possible impact pathway for changes in dietary quality in our reduced sample of only female respondents (Table A 4 in the Appendix), we observe significant mediation effects of certification on the NCD-P, GDR, and the ALL5 indicators.

6. *Conclusion*

With this study, we extend the literature on the impacts of sustainability standards on household nutrition by assessing the associations between coffee certification and dietary quality. In addition, we look at women's empowerment as a potential impact pathway of sustainability standards' influence on dietary quality. We use primary data from certified and non-certified Rwandan coffee farmers from five districts to account for regional differences in coffee production.

Our results show a positive association between certification and dietary quality. The diets of certified farmers are richer in food groups like fruits and vegetables (including Vitamin A-rich fruits and vegetables), whole grains, pulses, and nuts and seeds, which are also protective against diet-related non-communicable diseases. We further observe that certified farmers are more likely to meet global dietary recommendations on healthy diets. These findings align with Chiputwa and Qaim (2016), who find that certification positively affects dietary quality by increasing the consumption of foods providing iron, zinc, and vitamin A. We also find that certification negatively affects farmers' consumption of food groups associated with dietary risk factors like consumption of free sugar, salt, saturated fat, and processed meats. In our mediation analysis, we aim to explore women's empowerment as a potential pathway of certification's impact on nutrition. We expect women's empowerment to be a potential pathway of certification's impact on nutrition as female-controlled income is considered more important for household nutrition than male-controlled income. Certification may promote women's empowerment by increasing their participation in cash crop farming as well as their control over income and productive assets (Chiputwa & Qaim, 2016; Fischer & Qaim, 2012; Meemken & Qaim, 2018; Njuki et al., 2011). Our mediation analysis shows a significant positive association between certification and women's empowerment; however, the empirical evidence for women's empowerment as a mediator on the pathway between certification and dietary quality is limited in our overall sample. Women's empowerment has a significant mediating effect in the case of only two out of four tested dietary quality outcomes: dietary factors protective against diet-related non-communicable diseases and adherence to diets meeting global dietary recommendations. Furthermore, the mediation effect is relatively small, explaining only 10% of the total effect of certification on the dietary quality indicators. Our results hold, and even become a bit stronger, when considering only female respondents in our sample for the analysis. In that case, women' empowerment is also found to be a significant mediator of the effect of certification on ALL5. Considering only the data obtained from female respondents is likely to render more reiliable results for the aggregated empowerment score, where previous research has shown discrepancies between male and female perceptions.Our results indicate that women's empowerment is not the only impact pathway of certification status on the dietary quality outcomes of farmers. Clearly, other factors like income increases, agricultural diversification, and market access may be important impact pathways not explicitly considered here, but summarized under the total effect of certification. It is, however, notable that certification in our research area does contribute to challenging gender roles and increasing women's empowerment. Our results also confirm that women's empowerment does play a non-neglible role in improving some dietary quality outcomes among Rwandan coffee farmers, emphasizing the key role of women in household nutrition. Thus, empowering women is critical to allow them to harness the benefits of other certification pathways, including income increases and cooperative support, for improved nutrition outcomes.

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Appendix

Table A 1Probit regression on the certification decision to derive inverse probability weights

	Full Sample	Women only	Women of reproductive age
Age (years)	-0.003	-0.011	-0.007
	(0.005)	(0.009)	(0.026)
Experience in coffee production (years)	0.000	0.001	0.011
	(0.000)	(0.001)	(0.021)
Literacy (dummy)	0.328*	0.513*	0.176
	(0.145)	(0.218)	(0.546)
Gender respondent (dummy)	0.034	0.000	0.000
	(0.139)	(.)	(.)
Male HH head (dummy)	-0.082	-0.229	-0.095
	(0.169)	(0.211)	(0.415)
No. of HH members	0.021	0.047	-0.031
	(0.029)	(0.054)	(0.110)
Prop land devoted to agriculture (dummy)	0.137	-0.062	-0.090
	(0.086)	(0.135)	(0.214)
Form of ownership of CWS (dummy)	1.577***	1.602***	1.265**
	(0.148)	(0.227)	(0.470)
Cooperative membership (dummy)	0.299**	0.488*	0.731*
	(0.115)	(0.198)	(0.350)
Distance to agricultural input market (km)	0.068***	0.056	0.118*
	(0.020)	(0.031)	(0.057)
Constant	-0.659	0.072	0.595
	(0.479)	(0.847)	(1.409)
District effects	Yes	Yes	Yes
Observations	711	294	94
Pseudo R^2	0.207	0.251	0.230
chi2	170.286	82.405	28.462
p	0.000	0.000	0.008

Standard errors in parentheses
Robust standard errors in parantheses clustered at the district level. HH stands for household, CWS stands for coffee washing station
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A 2 Association of certification with dietary quality outcomes (total sample)

	(1) Food Group Diversity Score (0-10)	(2) NCD-Protect (0-9)	(3) NCD-Risk (0-9)	(4) Global Dietary Recommendations Score (0-18)	(5) Zero fruit vegtables (dummy)	(6) All-5 (dummy)	(7) Minimum Dietary Diversity Women (dummy)
ADPO^{C}	0.190	0.338***	-0.044*	0.294***	-0.013	0.073***	0.154
	(0.128)	(0.113)	(0.023)	(0.098)	(0.014)	(0.017)	(0.115)
Non-certified PO	4.248***	3.220***	0.168***	12.388***	0.921***	0.148***	0.299**
	(0.124)	(0.105)	(0.028)	(0.112)	(0.009)	(0.021)	(0.150)
OME0							
Male HH head (dummy)	0.578***	0.663***	-0.053**	0.611***	-1.681***	1.470**	6.901***
	(0.145)	(0.124)	(0.027)	(0.127)	(0.559)	(0.585)	(2.318)
No. of HH members	-0.139***	-0.095***	-0.033***	-0.128***	-0.125	-0.106	-0.340
	(0.018)	(0.013)	(0.012)	(0.009)	(0.101)	(0.073)	(0.267)
Gender respondent (dummy)	0.202	0.034	0.215***	0.249	1.223**	-0.064	
	(0.258)	(0.247)	(0.073)	(0.296)	(0.504)	(0.443)	
Literacy (dummy)	0.128	-0.028	0.070	0.042	0.301	0.980**	3.709*
	(0.292)	(0.174)	(0.083)	(0.178)	(0.607)	(0.474)	(2.105)
Age (years)	-0.008	-0.014***	0.004***	-0.010**	-0.042***	0.027**	0.041
	(0.010)	(0.005)	(0.001)	(0.004)	(0.010)	(0.014)	(0.094)
Distance to food market (km)	-0.003	0.008	-0.015***	-0.008	0.322***	-0.022	-0.416***
	(0.021)	(0.019)	(0.005)	(0.019)	(0.069)	(0.047)	(0.114)
Income w.o. coffee (RWF)	0.000**	0.000**	0.000***	0.000***	0.000***	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Farming experience (years)	-0.006	-0.000	-0.004***	-0.004	-0.018	-0.021	0.015
	(0.007)	(0.003)	(0.001)	(0.004)	(0.015)	(0.018)	(0.089)
Constant	4.652***	3.756***	-0.023	12.734***	5.270***	-4.382***	-8.981**

	(0.443)	(0.267)	(0.130)	(0.231)	(0.661)	(0.875)	(4.393)
OME1							
Male HH head (dummy)	0.106	0.110	-0.007	0.103	0.059	0.391	-0.286
	(0.212)	(0.152)	(0.042)	(0.181)	(0.406)	(0.402)	(0.765)
No. of HH members	-0.031	-0.013	0.001	-0.012	0.195	-0.120**	-0.128
	(0.031)	(0.042)	(0.012)	(0.051)	(0.149)	(0.053)	(0.276)
Gender respondent (dummy)	0.177	0.044	0.065	0.109	-0.157	0.038	
	(0.140)	(0.163)	(0.051)	(0.129)	(0.436)	(0.355)	
Literacy (dummy)	0.591***	0.576***	0.021	0.598***	0.902**	0.729***	0.331
	(0.070)	(0.139)	(0.027)	(0.136)	(0.454)	(0.122)	(1.295)
Age (years)	-0.021*	-0.028*	0.003	-0.025	-0.011	-0.003	-0.062**
	(0.012)	(0.015)	(0.005)	(0.019)	(0.011)	(0.018)	(0.030)
Distance to food market (km)	-0.067***	-0.069***	0.009	-0.061***	-0.040*	-0.053	-0.042
	(0.012)	(0.013)	(0.008)	(0.019)	(0.024)	(0.038)	(0.037)
Income w.o. coffee (RWF)	0.000***	0.000***	0.000	0.000***	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Farming experience (years)	0.018*	0.027**	-0.006*	0.021	0.035**	-0.003	0.054*
	(0.011)	(0.014)	(0.003)	(0.015)	(0.014)	(0.012)	(0.030)
Constant	4.555***	3.724***	0.043	12.767***	0.078	-1.330	1.146
	(0.330)	(0.556)	(0.226)	(0.746)	(1.468)	(0.887)	(2.106)
Observations	708	708	708	708	708	708	94

PO stands for 'predicted outcome'. ADPOC stands for 'average difference in predicted outcomes' for certified female farmers under certification and hypothetical non-certification. Robust standard errors, clustered at district level in paranthesis. *: * p < 0.1, ** p < 0.05, *** p < 0.01.*

Table A 3 Association of certification with dietary quality outcomes (female respondents only sample)

	non-certified PO	ADPO^{C}	p-value	Sharpened q-value	Obs
FGDS(0-10)	3.946	0.282	0.039	0.030	289
NCDP(0-9)	3.019	0.384	0.016	0.018	289
NCDR(0-9)	0.027	0.055	0.001	0.008	289
GDR(0-18)	12.046	0.439	0.007	0.013	289
ZVEGFR(1=yes)	0.916	-0.021	0.636	0.222	289
ALL-5 (1=yes)	0.129	0.070	0.002	0.008	289
MDD-W (1=yes)	0.299	0.154	0.182	0.065	94

PO stands for ‘predicted outcome’. ADPOC stands for ‘average difference in predicted outcomes’ for certified female farmers under certification and hypothetical non-certification.

Table A 4 Causal mediation analysis results for the role of women’s empowerment in dietary quality outcomes (female respondents only sample)

	FGDS	NCD-P	NCD-R	GDR	ALL5
Indirect (mediation) effect	0.071	0.084*	-0.009	0.075	0.021*
	(0.046)	(0.052)	(0.007)	(0.049)	(0.012)
Direct effect	0.340	0.442**	0.030	0.472**	0.064
	(0.180)	(0.173)	(0.042)	(0.184)	(0.040)
Total effect	0.411	0.526	0.021	0.548	0.084

Robust standard error in paranthesis. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A 5 Association of certification with dietary quality outcomes (female respondents only)

	(1) Food Group Diversity Score (0-10)	(2) NCD-Protect (0-9)	(3) NCD-Risk (0-9)	(4) Global Dietary Recommendations Score (0-18)	(5) Zero fruit vegtables (dummy)	(6) All-5 (dummy)	(7) Minimum Dietary Diversity Women (dummy)
ADPO^C	0.282**	0.384**	0.055***	0.439***	-0.021	0.070***	0.154
	(0.137)	(0.160)	(0.017)	(0.163)	(0.044)	(0.023)	(0.115)
non-certified PO	3.946***	3.019***	0.027***	12.046***	0.916***	0.129***	0.299**
	(0.053)	(0.077)	(0.008)	(0.079)	(0.019)	(0.008)	(0.150)
OME0							
Male HH head (dummy)	0.107	0.216	-0.023	0.193	-2.279***	0.934*	6.901***
	(0.182)	(0.212)	(0.018)	(0.224)	(0.456)	(0.509)	(2.318)
No. of HH members	0.091***	-0.000	-0.001	-0.002	0.189	0.655***	-0.340
	(0.027)	(0.012)	(0.008)	(0.011)	(0.210)	(0.197)	(0.267)
Literacy (dummy)	0.134	0.095	-0.006	0.089	0.307	0.943*	3.709*
	(0.432)	(0.381)	(0.020)	(0.366)	(0.697)	(0.496)	(2.105)
Age (years)	-0.002	-0.011	-0.001	-0.012	0.001	0.133**	0.041
	(0.026)	(0.015)	(0.001)	(0.015)	(0.024)	(0.053)	(0.094)
Distance to food market (km)	0.016	0.008	0.003	0.011	0.263***	0.110	-0.416***
	(0.027)	(0.029)	(0.007)	(0.034)	(0.086)	(0.091)	(0.114)
Income w.o. coffee (RWF)	0.000	0.000**	-0.000**	0.000**	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Farming experience (years)	-0.006	-0.001	0.000	-0.001	-0.042	-0.043	0.015
	(0.012)	(0.004)	(0.001)	(0.005)	(0.035)	(0.034)	(0.089)

Constant	3.584**	3.296***	0.115***	12.411***	2.674**	-13.361***	-8.981**
	(1.538)	(1.094)	(0.035)	(1.079)	(1.212)	(3.464)	(4.393)
OME1							
Male HH head (dummy)	0.352	0.257	0.007	0.264	1.210***	0.477	-0.286
	(0.299)	(0.201)	(0.040)	(0.210)	(0.361)	(0.600)	(0.765)
No. of HH members	-0.070	-0.001	-0.011	-0.012	-0.011	-0.137*	-0.128
	(0.065)	(0.070)	(0.011)	(0.077)	(0.085)	(0.077)	(0.276)
Literacy (dummy)	0.471***	0.619**	-0.096**	0.523*	0.228	0.686	0.331
	(0.179)	(0.251)	(0.038)	(0.269)	(0.261)	(0.709)	(1.295)
Age (years)	-0.015	-0.029	0.001	-0.028	-0.027	0.032	-0.062**
	(0.030)	(0.025)	(0.008)	(0.032)	(0.021)	(0.023)	(0.030)
Distance to food market (km)	-0.111***	-0.100***	-0.005***	-0.104***	-0.143***	-0.184**	-0.042
	(0.013)	(0.014)	(0.001)	(0.014)	(0.053)	(0.078)	(0.037)
Income w.o. coffee (RWF)	0.000	0.000	-0.000***	0.000	0.000	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Farming experience (years)	0.016	0.032	-0.006	0.026	0.052	-0.041*	0.054*
	(0.028)	(0.023)	(0.005)	(0.027)	(0.035)	(0.022)	(0.030)
Constant	4.757***	3.642***	0.387	13.029***	1.812	-1.422	1.146
	(0.911)	(0.915)	(0.351)	(1.238)	(1.212)	(1.835)	(2.106)
Observations	289	289	289	289	289	289	94

PO stands for 'predicted outcome'. ADPOC stands for 'average difference in predicted outcomes' for certified female farmers under certification and hypothetical non-certification. Robust standard errors, clustered at district level in paranthesis. : * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.