

RESEARCH

Open Access



Does linking women farmers to markets improve food security? Evidence from rural Bangladesh

Han Bum Lee^{1*}, Paul E. McNamara² and Kamal Bhattacharyya³

Abstract

Background: This study examined the effect of linking small-scale women farmers to markets, referred to as community marketing, and homestead food production extension services in two districts of rural Bangladesh.

Method: We particularly focused on identifying the relationship between treatment and food security, monthly expenditure patterns, and food production and marketing by adopting a doubly robust method that mediated bias from project site selection and potential misspecification of the postulated outcome or treatment model.

Results: The main results showed that establishing community marketing sites along with extension services provided women farmers a secured marketing outlet for food production, plausibly associated with a decreased likelihood of a reduction in monthly expenditures on healthcare (12.7 percentage points), child education (19.4 percentage points), and transportation (51.5 percentage points) during the lean season. However, if farmers did not spend extra income generated from marketing on food purchases, it would be difficult to anticipate an improvement in food security.

Conclusion: Community marketing was devised to link women smallholders to the markets without conflicting with social and cultural norms for which women were responsive, and our research findings supported the claim that they benefited from community marketing participation. Therefore, government, NGO, or other extension providers looking for a culturally appropriate approach to address women farmers' limited mobility may consider using or modifying community marketing.

Keywords: Agricultural extension services, Collective action, Marketing, Food security, Small-scale women farmer, Rural Bangladesh

Introduction

Over the past several decades, we have witnessed that agricultural growth and development are recognized as an important strategy to reduce poverty in most developing countries, and agricultural development does not occur without engaging small-scale farmers [30, 52]. Besides building up farmers' production capabilities,

more recently linking small-scale farmers to markets has gained popularity as an emerging policy. Proponents of market-oriented interventions suggest that small-scale farmers, by acting collectively, can reduce transaction costs and information asymmetry in markets.

More specifically, collective action refers to action taken by a group either directly or indirectly to pursue members' shared objectives, and it arises when individuals who share the common interest decide to collaborate on joint action to accomplish the objects [17, 24]. Farmer organizations are an example of collective action that mediates various asymmetries in access to

*Correspondence: hanbum.lee@utsa.edu

¹ Urban Education Institute, University of Texas at San Antonio, 501 W.

Cesar Chavez Blvd., San Antonio, TX 78207, USA

Full list of author information is available at the end of the article



© The Author(s) 2022. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

agricultural extension services, input provision and distribution, bulking and transportation, processing, and marketing, thus helping to achieve the economies of scale that are merely realized in a small-family farm setting as well as allowing to compete with larger farmers and agribusiness [12, 24]. Previous studies showed that farmers' collective action in marketing enhanced their bargaining power over buyers, income opportunities, and food security [6, 12, 18, 24, 49]. Moreover, collective action could also benefit buyers by reducing transaction costs through obtaining stable supplies of quality products [33, 43, 48].

On the other hand, studies also pointed out that the poorest farmers tended to be excluded from participation in farmer organizations due to the lack of educational and managerial skills and financial capacities to meet the quality demands of local supermarkets [10, 34, 41, 42, 44]. For example, entry and membership fees were often considered as main barriers, precluding the poor from participating in the marketing groups, and this phenomenon tended to be worse for more profitable markets (see, e.g., [2, 25, 33]). In addition, free-rider problems challenged collective action when members of farmer groups enjoyed group benefits without participating in all collective activities necessary to keep the group viable [14]. Moreover, mistrust and challenges in implementation such as establishing multilaterally agreed rules by group members and enforcing and monitoring compliance with the rules were also perceived as major reasons for the failure of sustainable collective action in marketing [16, 20, 43, 45].

Another concern is that collective action in marketing has mostly been considered for cash crops for which male farmers often dominate; hence, group membership tended to be inclusive toward male farmers. In light of the extensive literature, demonstrating the important role of women in agriculture (e.g., [8, 9, 21, 35]), encouraging women farmers' participation in collective action can yield substantial improvements in many aspects of households and society-wide economic development [13, 36].

However, in reality, many women face socioeconomic and cultural constraints that impede them from taking advantage of group participation. For example, previous agricultural extension studies provided consistent evidence of gender-specific constraints in access to extension services [7, 38–46]. Women have higher opportunity costs of time due to their various livelihood activities and responsibilities in the household that would reduce their incentives for group participation [15, 29], 53]. Moreover, in Bangladesh, many women experience restrictions on physical mobility beyond their communities, described as main barriers that limit women's access to and adoption

of agricultural innovations and marketing engagement [37, 39].

To strengthen farmers' homestead food production capacities and food security through addressing aforementioned gender-specific barriers, two projects, referred to as Egiye Jai (EJ) and Nigera Gori (NG), were implemented in vulnerable villages in two districts of rural Bangladesh. EJ and NG meant "Move Forward" and "We Build It Ourselves" in Bengali, respectively. These projects aimed at promoting women farmers' access to agricultural extension services by adopting a cluster-level training approach as well as encouraging their participation in training by focusing more on vegetable cultivation and chicken rearing, for which women were usually responsible. In addition, the NG project implemented a community marketing strategy to overcome women's marketing barriers. Community marketing was an application of collective action where small-scale women farmers gathered and sold agricultural produces at a pre-arranged place and time to local traders. Additionally, while prior applications of collective action have focused on cash crops, community marketing focused on homestead food (i.e., vegetable, poultry, and eggs) as well as attempted to ease participatory conditions in marketing.

This study examined the impact of linking small-scale women farmers to markets and homestead food production extension services on various dimensions of households' livelihoods, classified into three categories: (i) food security and dietary diversity; (ii) homestead food production and marketing, and (iii) household's monthly expenditure and its' patterns.

Background

Homestead food production extension services

Implemented between January 2013 and December 2016, the EJ (Barisal district) and NG (Dinajpur district) projects delivered similar food production extension services that provided a strong basis for sustainable and quality homestead production of vegetable, livestock, and fishery as well as post-harvest management and financial skills. Since the primary objective of the projects was to increase dietary diversity and food security through the consumption of food produced at home, many farmers were encouraged to cultivate vegetables and rear poultry often on a smaller scale.

The projects used a cluster-level training approach to promote women farmers' participation in agricultural training programs by overcoming women's physical mobility restrictions beyond their communities. Specifically, in each village, the projects defined geographical boundaries for each cluster of households (usually 15 to 20 households), ensuring that households within proximity to each other were in the same cluster and then

brought extension agents to a gathering space close to two or three village clusters. Project participation was voluntary for all farmers in the treated areas, but the delivered technologies were displayed to farmers in the cluster through organized demonstration plots and field days. This approach facilitated replicating improved agricultural practices by sharing knowledge and experiences among farmers in a neighborhood, thereby strengthening the effects that extension services had on the targeted clusters and villages [4].

According to the project's monitoring data, the Egiye Jai (EJ) project served 118 village clusters in eight project villages, reaching 3018 households, and the NG project served 119 village clusters in eight villages and reached 3633 households. The report also showed that 2090 households (69.3%) had attended EJ's cluster-level training between June 2013 to June 2014, and 92% were women. Similarly, 1916 households (52.7%) attended NG's cluster-level training between February 2014 and July 2014, and 88% were women.¹ These results indicated that the cluster-level training approach appeared to be an effective way to reach women farmers with improved farm practices. Conversely speaking, the projects were not successful in reaching male farmers. The key informant interviews showed that male farmers considered that training was for women due to women's high participation in training. Additionally, some respondents mentioned that training was provided when male farmers were out in the fields [4].

Community marketing

Many women in Bangladesh have structural and cultural constraints. Specifically, cultural norms do not favor women's marketing activities. In addition, women face particularly severe time constraints on marketing because, for example, some regions open a local market from 4 to 8 pm, but it is a woman's busy time of the day for cooking, childcare, and house chores. Furthermore, markets lack women-only sanitation facilities. Information from key informant interviews showed that the majority of women respondents preferred buying/selling products from/to local traders rather than going to local markets to avoid market fees (market taxes, stall rentals, etc.) and cultural conflicts within the household and community. However, when women sell agricultural produces to a local trader, they will face the 'unjust price' issue, receiving a lower price than what it could be sold for at the local market [4, 32].

Since March 2016, the NG project implemented community marketing that linked small-scale farmers to markets via local traders. The project first established a marketing site, proximity to multiple clusters in the village, and then brought a local trader to the marketing site twice a week to buy collected homestead food produce (mostly vegetables, poultry, and eggs). Also, community marketing reduced barriers to engaging in marketing even for the poorest among the small-scale farmers by requiring no group membership or a certain level of product quantities. On the other hand, the higher quality of the produce—implicitly agreed between local traders and producers—increased the local traders' likelihood of buying the produce. Market price information was shared in all community marketing sites, and the payment was made on the spot.

Moreover, to incentivize local traders' participation, farmers agreed to receive two takas less per kilogram of the produce, mostly vegetables, than the local market prices, so that traders earned the difference, varying with the sale's quantity. Indeed, prior to community marketing, the local traders had to visit door-to-door to buy homestead products, and it often took much time and effort to collect the targeted amount of the products. The traders might also take advantage of women's cultural norms—restrictions on mobility—by suggesting lower prices for products than what women would receive from the local market. After community marketing, the traders were able to reduce transaction costs by obtaining a stable supply of quality homestead produce; however, they could also lose bargaining power over small-scale producers since a price was already determined under the project control.

Data

Survey design

We collected the survey data between September and October 2016, a couple of months before the projects ended. Using a list of all farm households in the cluster, survey respondents were randomly selected at the cluster level within the treatment villages, based on the population size. Some survey respondents actively adopted the improved farm practices and sold their products in the community marketing sites, while others neither adopted the practices nor sold them in the community marketing sites. The survey was collected from 36 villages in two districts, including eight villages in Rajihar Union of Barisal district where the EJ project was implemented and ten nearby villages, serving as a comparison group, and another eight villages in Dinajpur Sadar and Birgonj Upazilas in Dinajpur district where NG was implemented and ten nearby comparison group villages.

¹ The number of NG training attendees (and percent reaching project population) was recorded relatively less than EJ training attendees due to the short data collection period. Also, the cumulated number of training attendees had grown throughout the life of the projects.

Table 1 Distribution of study samples and treatment status by village and district

EJ (extension services)				NG (extension services and community marketing)			
Treatment group	N	Comparison group	N	Treatment group	N	Comparison group	N
Boro Bashail	71	Ahuti Battra	18	Dabra Jineshwari	82	Badla Para	50
Coto Bashail	57	Ambari	38	Fajilpur	12	Bashudebpur	50
Coto Dumuria	29	Bahadupur	36	Khorikadam	41	Bochapukur	47
Paschim Goail	16	Bakal	49	Mohadebpur	66	Dakeswari	47
Paschim Razihar	64	Battra	39	Nagri Sagri	83	Durlovpur	49
Razihar	82	Chengutia	39	Salbari Dabra	63	Kathgor	39
Sutar Bari	26	Dumuria	27	Pochwim Paragon	26	Koikuri	50
Valuksi	66	Kandirpar Cenguitia	40	Sundori Hatgachh	39	Mahatabpur	49
		Noapara	44			Moricha	48
		Uttor Sajuria	26			Satkhamar	46
Total	411	Total	356	Total	414	Total	475

EJ—Egiye Jai (Barisal District). NG—Nijera Gori (Dinajpur District)

Unlike the project group's sampling scheme, comparison group respondents were randomly chosen at the village-level, based on an ad hoc list of village households with the help of local NGOs and community representatives. We chose comparison villages that (i) were close to the project areas and located in the same upazila, and (ii) shared similar residents' livelihoods and village attributes.² We randomly chose 50 respondents from each control village. Altogether, we collected 1000 surveys in each project, including 500 surveys from the project villages and 500 surveys from the comparison villages. In this study, we limited our analysis samples to married households (dropped 7.4% of the entire sample) and excluded surveys completed by son, daughter, parents, or other relationships to the head of the household (1%) since they would increase the likelihood of measurement errors in data. Additionally, 8.9% of the sample were excluded from the analyses due to missing responses for the outcome and independent variables. The number of sampled households and their treatment status by village and district are detailed in Table 1.³

Survey quality

The survey used computer-assisted personal interviewing on tablet computers to reduce potential measurement errors and to facilitate day-to-day monitoring of the data collection. The survey was reviewed by UIUC's AgReach researchers and other stakeholders on a daily basis. The survey primarily targeted to interview women farmers who were either heads of households or the

spouse of heads of households. If women farmers were not available at the time of interviews, men farmers who were either heads of households or the spouse of heads of households completed the survey. If both the head of the household and the spouse were not available, son or daughter, whoever was available, completed the survey. Also, both male and female enumerators were paired to interview farmers. All enumerators were Bangladeshi and were able to speak the local language. Therefore, we confirmed that there was no case that an interviewee could not answer due to their limited literacy skills. Once the respondents answered the questions, enumerators recorded them using tablet computers. Additionally, we made female enumerators available to interview women in accordance with local norms.

For the purpose of this study, we limited our study sample to married households, but the original sampling was based on all households in each village. The survey contained information on whether women were involved in agricultural activities including food crop production, cash crop production, livestock rearing, and fishing or fishpond cultures, and it showed that 96.2% of women in the study sample were involved in at least one of these activities. On the other hand, we did not know their participation level in each agricultural production.

Description of key outcome variables

For outcome variables, we included self-reported changes in monthly expenditure patterns on food, healthcare, education, and transportation. We constructed a binary variable, assigning 1 if a household decreased corresponding expenditures, and 0 if otherwise. This survey was collected during the lean season, and the majority of rural households often face seasonal food deprivation

² Due to the lack of the secondary data at this detailed level, we had to rely on NGOs' experience in the field to choose the comparison villages.

³ The term 'project' and 'treatment' are interchangeably used in this study.

and economic inactivity, which would reduce the overall food consumption and expenditures [19]. Therefore, examining differences in the level of expenditures on food and others can deliver important insight into how treatment group households could cope with seasonal deprivation relative to comparison group households.

We also included Household Food Insecurity Access Score (HFIAS) [5] and Household Dietary Diversity Score (HDDS) [47]. HFIAS was a continuous measure of the degree of food insecurity in the household in the past 4 weeks (30 days). HFIAS consisted of two sets of questions that first asked an occurrence question—whether the condition in the question happened at all in the past 4 weeks. If the respondent answered “yes” to an occurrence question, a frequency-of-occurrence question was asked to determine whether the condition rarely happened, sometimes, or often in the past 4 weeks. HFIAS ranged from 0 to 27, and the higher the score, the more food insecurity the household experienced. HDDS measured the number of different food groups (a total of 12 food groups) consumed over 24 h. HDDS ranged from 0 to 12, and the higher the score, the more diversified food groups the household consumed over 24 h.

To measure homestead food production and marketing, we included six variables: (i) whether a household raised chickens or not; (ii) the total number of chickens that a household had at the time when the survey was taken and sold in the past 4 weeks; (iii) whether a household cultivated vegetables or not; (iv) total vegetable production in kilogram during the previous growing season (March–June); (v) whether a household sold chicken during the past 4 weeks; and (vi) whether a household sold vegetables during the previous growing season. The description of variables used in this study is detailed in Table 2.

Differences in resident and village characteristics between the treatment and comparison groups

The independent variables included a set of household socioeconomic characteristics, including husband and wife’s age and educational attainment, household size, religion, wealth index, total monthly expenditure, and on- and off-farm income activities.⁴ We also used six village characteristics, including population size, distance to the nearest upazila market, having a health clinic, primary school, secondary school, and post office.⁵

⁴ We constructed an overall household wealth index value, estimated by the principal component analysis (PCA) with 13 types of assets, which provides plausible and defensible weights for an index of assets to serve as proxy for wealth [11, 22, 26].

⁵ We also collected the availability of credit institutions in the village; however, we found no variation between the treatment and comparison vil-

Table 3 presents descriptive statistics and balance test results (two-tailed *t*-test statistics) that compared the difference in means of independent variables—statistical significance tests on equality of means for continuous variables and equality of proportion for binary variables—between the treatment and comparison groups. If the comparison group was well established, none of the coefficients would statistically differ from zero. The balance test results showed that, on average, the EJ treatment group tended to have a higher proportion of households with Muslim religion and households that engaged in off-farm income activities compared to those of the comparison group. In addition, the treatment group was reported to have a higher level of wealth, and women in the treatment group tended to be older than their counterparts. Similarly, the NG treatment group tended to have a higher level of wealth and total monthly expenditures, while it had a relatively lower proportion of households that engaged in off-farm income activities. Furthermore, the results showed notable differences in included village attributes between the treatment and comparison groups in both projects. Such group differences indicated that selection existed in the search process of project sites, requiring a statistical adjustment for group differences to mitigate selection bias in treatment effect estimates.

Conceptual model

To estimate the treatment effects, we base our analysis on the potential outcome framework. Let Y_1 and Y_0 denote the potential outcomes for a household that received treatment ($T = 1$) and a household that did not receive treatment ($T = 0$), respectively. The observed outcome for a household i can be written as: $Y_i = Y_{1i} \cdot T_i + (1 - T_i) \cdot Y_{0i}$; hence the average treatment effect (ATE) is defined as: $\tau_{ATE} = E(Y_1) - E(Y_0)$. The difficulty in estimating the ATE is that we can only observe Y_1 or Y_0 because an individual cannot be in both states. Under the unconfoundedness (or ignorability) assumption, which asserts that conditional on observed characteristics X_i , the treatment indicator T_i is independent of the outcomes (Y_0, Y_1). Unfortunately, unconfoundedness is fundamentally ‘untestable’ and perceived as a strong assumption in observational studies. Particularly, most community development projects allowed residents to determine whether they received new agricultural technologies and practices, and their decisions might be correlated to the benefits from participation (or referred

Footnote 5 (continued)

lages—all treated and non-treated villages had village lending groups and NGOs (as a lending institution), while no village had a commercial bank.

Table 2 Description of key variables

Variable	Description
Outcome variables	
<i>Monthly expenditure patterns</i>	
Decrease in food expenditures	= 1 if a household reports that monthly expenditures on food and beverage have been decreased, compared to 6 months ago; 0 if otherwise
Decrease in healthcare expenditures	= 1 if a household reports that monthly expenditures on healthcare have been decreased, compared to 6 months ago; 0 if otherwise
Decrease in education expenditures	= 1 if a household reports that monthly expenditures on child education have been decreased, compared to 6 months ago; 0 if otherwise
Decrease in transportation expenditures	= 1 if a household reports that monthly expenditures on transportation have been decreased, compared to 6 months ago; 0 if otherwise
<i>Food security and dietary diversity</i>	
HFIS	= Household Food Insecurity Score measured with 18 items
HDDS	= Household Dietary Diversity Score measured with 12 items
<i>Homestead food production and marketing</i>	
Chicken rearing	= 1 if a household raises poultry (chicken or duck); 0 if otherwise
Chicken production	= Total number of chickens that a household currently has and sold in the past 4 weeks
Sale of chicken	= 1 if a household sold chicken during the past 4 weeks; 0 if otherwise
Vegetable cultivation	= 1 if a household cultivates vegetables; 0 for otherwise
Vegetable production	= Total vegetable production in kilogram during the previous growing season (March–June)
Sale of vegetable	= 1 if a household have sold vegetables during the growing season (March–June); 0 if otherwise
Independent variables	
Husband age	= Husband's age
Wife age	= Wife's age
Husband primary education	= 1 if a husband had some primary education or less (0–5 years of education)
Wife primary education	= 1 if a wife had some primary education or less (0–5 years of education)
Muslim	= 1 for having Muslim religion; 0 for otherwise
Household size	= Number of household members
<i>Economic activity</i>	
Wealth	= Wealth index value estimated by the principal component analysis (PCA) with 13 types of assets (radio, cell phone, bicycle, motorcycle, refrigerator, camera, fans, television, sewing machine, clock, individual housing structure, earth and sand floor, and firewood as cooking fuel)
Monthly expenditure	= Household's total monthly expenditure in taka
Non-agricultural day labor	= 1 if a household member is involved in non-agricultural day labor activity; 0 if otherwise
<i>Village characteristics</i>	
Population	= Total number of people in the village
Access to market	= Distance to the nearest Upazila market in kilometer
Health clinics	= 1 if there is a health clinic in the village; 0 if otherwise
Primary school	= 1 if there is a primary school in the village; 0 if otherwise
Secondary school	= 1 if there is a secondary school in the village; 0 if otherwise
Post office	= 1 if there is a post office in the village; 0 if otherwise

to as self-selection problem). Additionally, the interventions were often implemented in areas, considering residents' interest in technologies and extension services, site accessibility, and relationships that implementing organizations, mostly NGOs, have maintained with the sites [1]. In this case, the presumed independence assumption in randomized control trials (RCTs) would be violated, $E(Y_1|X) \neq E(Y_1)$ and $E(Y_0|X) \neq E(Y_0)$; hence τ_{ATE} yields a biased estimator.

To address selection bias, the regression adjustment (RA) and inverse probability weighting (IPW) methods have been widely used in impact evaluation literature. Specifically, IPW calculates the ATE by differencing inverse-propensity-score-weighted averages as:

$$\tau_{IPW} = \frac{1}{N} \sum_{i=1}^N \left[\frac{T_i Y_i}{p(\mathbf{X}_i, \hat{\boldsymbol{\gamma}})} - \frac{(1 - T_i) Y_i}{(1 - p(\mathbf{X}_i, \hat{\boldsymbol{\gamma}}))} \right], \quad (1)$$

Table 3 Descriptive statistics of study's key characteristics and balance test results between the treatment and comparison group by project

	EJ (extension services)			NG (extension services and community marketing)		
	Treatment group (1)	Comparison group (2)	Difference (1)–(2) (3)	Treatment group (4)	Comparison group (5)	Difference (4)–(5) (6)
Husband age	48.119 (11.611)	46.728 (13.628)	1.392 (0.911)	43.596 (12.859)	43.979 (11.709)	-0.382 (0.824)
Wife age	38.304 (9.763)	36.775 (11.375)	1.529** (0.763)	35.408 (10.869)	36.175 (10.079)	-0.767 (0.703)
Husband primary education	0.487 (0.500)	0.472 (0.500)	0.015 (0.036)	0.717 (0.451)	0.752 (0.433)	-0.034 (0.030)
Wife primary education	0.487 (0.500)	0.469 (0.500)	0.018 (0.036)	0.700 (0.459)	0.682 (0.466)	0.018 (0.031)
Muslim	0.526 (0.500)	0.281 (0.450)	0.245*** (0.035)	0.500 (0.501)	0.482 (0.500)	0.018 (0.034)
Household Size	5.209 (1.852)	5.065 (1.714)	0.145 (0.130)	4.524 (1.464)	4.672 (1.504)	-0.147 (0.100)
Wealth	0.543 (1.521)	0.336 (1.728)	0.206* (0.117)	0.003 (1.554)	-0.708 (1.093)	0.711*** (0.089)
Monthly Expenditure ^a	8.939 (0.454)	8.982 (0.539)	0.044 (0.036)	8.773 (0.535)	8.696 (0.324)	0.077*** (0.029)
Non-agricultural day labor	0.652 (0.477)	0.343 (0.475)	-0.137*** (0.032)	0.734 (0.442)	0.884 (0.236)	-0.150*** (0.026)
Population ^a	7.189 (0.943)	7.129 (0.879)	0.061 (0.066)	7.893 (0.559)	7.098 (0.706)	0.795*** (0.043)
Access to market	9.324 (3.570)	7.472 (3.377)	1.852*** (0.252)	14.114 (3.371)	12.006 (2.582)	2.107*** (0.200)
Health clinics	0.689 (0.464)	0.247 (0.432)	0.441*** (0.033)	0.403 (0.491)	0.305 (0.461)	0.098*** (0.032)
Primary school	0.937 (0.244)	0.851 (0.356)	0.086*** (0.022)	0.971 (0.168)	0.895 (0.307)	0.076*** (0.017)
Secondary school	0.603 (0.490)	0.475 (0.500)	0.129*** (0.036)	0.597 (0.491)	0.385 (0.487)	0.211*** (0.033)
Post office	0.333 (0.472)	0.138 (0.345)	0.196*** (0.030)	0.266 (0.442)	0.200 (0.400)	0.066** (0.028)
N	411	356	767	414	475	901

Descriptive statistics are reported in columns (1), (2), (4), and (5). The balance test results (two-tailed *t*-test statistics) are reported in columns (3) and (6). Standard deviations are reported in parenthesis, and standard errors are reported in bracket. * denotes significance at 10 percent, ** at 5 percent, and *** at 1 percent level

^a Values are expressed in logarithm term

where $p(X_i, \hat{\gamma})$ is estimated propensity scores, indicating the probability of being in the treatment group, conditional on X_i and estimated parameters $\hat{\gamma}$. Under the unconfoundedness and overlap conditions, $\hat{p}(X_i)$ converges to the true propensity scores, thereby yielding a consistent estimator. Also, under the unconfoundedness condition, one can perform RA by regressing Y_i on T_i and X_i , of which $m_1(X) \equiv E[Y|T = 1, X]$ and $m_0(X) \equiv E[Y|T = 0, X]$ are obtained separately from the subsamples of treated and untreated units, respectively. Specifically, $m_1(X_i, \hat{\delta}_1)$ and $m_0(X_i, \hat{\delta}_0)$ denote the outcome (or regression) models with covariates X_i and estimated parameters $\hat{\delta}$. If these estimators are consistent,

using the random sample of N , the ATE for the RA model can be written as follow:

$$\tau_{RA} = \frac{1}{N} \sum_{i=1}^N [m_1(X_i, \hat{\delta}_1) - m_0(X_i, \hat{\delta}_0)]. \tag{2}$$

However, the IPW and RA estimators will be biased if the postulated outcome or treatment model is incorrectly specified. On the other hand, the doubly robust (DR) method combines weighting and regression adjustment, and it offers protection against the model misspecification, demonstrating that as long as only one of these models is correctly specified, the resulting estimator becomes consistent [51]. We use the IPWRA

estimator, proposed by Wooldridge [51] that can be expressed as:

$$\tau_{IPWRA} = \frac{1}{N} \sum_{i=1}^N [m_1^*(X_i, \delta_1^*) - m_0^*(X_i, \delta_0^*)]. \quad (3)$$

It looks the same formula as the RA estimator, but the model uses different estimates of (δ_1^*, δ_0^*) , obtained from solving weighted least squares (for a continuous outcome) and quasi-likelihood (for a binary outcome) problem. More specifically, δ_1^* minimizes $\frac{1}{N} \sum_{i=1}^N \frac{T_i q(X_i, \delta_1)}{p(X_i, \hat{\gamma})}$, using the treated sample, and δ_0^* minimizes $\frac{1}{N} \sum_{i=1}^N \frac{(1-T_i) q(X_i, \delta_0)}{(1-p(X_i, \hat{\gamma}))}$, using the untreated sample, where $q(X_i, \bullet)$ is a function of random variable X_i with corresponding parameters. For a through discussions of estimator's functional forms of linear or non-linear conditional means, we refer to chapter 21.3.4 by Wooldridge [51].

To describe the double robustness properties, suppose that the outcome models are correctly specified. Then, the estimated parameters (δ_1^*, δ_0^*) are consistent, and even if the treatment model $p(X_i, \hat{\gamma})$ is misspecified, the ATE for the IPWRA is the same as Eq. (3). On the other hand, suppose that $p(X_i, \hat{\gamma})$ is correctly specified, but the outcome models are misspecified. Wooldridge [51] shows that the IPW estimator under unconfoundedness can recover the solution to unweighted minimization problem in the population. That is, IPWRA can still produce a consistent estimator by weighting the observations by the inverse of the true selection probability even if the outcome models are misspecified. Wooldridge [51] also suggests that bootstrapping the models for IPWRA provides asymptotically correct inference.

Limitations of the study

This study has three major limitations. First, self-reported data might contain a systematic bias in reporting. The bias might be toward over-reporting for socially desirable behaviors and underreporting for socially undesirable behaviors that respondents might feel uneasy talking with strangers [3]. In our study, beneficiaries in treated areas might exaggerate their achievements, particularly if the outcomes were related to projects' goals. Additionally, retrospective questions, such as asking expenditure patterns and marketing in the past 6 months, depended on respondents' memory; thereby, the data might suffer from measurement errors. These aspects might have beneficiaries over-reporting their achievements relative to their comparison groups, resulting in the existence of a project effect.

Second, the consistency of the doubly robust estimator relies on the unconfoundedness assumption. But it was not possible to separately identify the contributions

of unobserved factors in the treatment and study's outcomes, so we could not tell the magnitude of omitted variable bias. There might be a set of characteristics that enhanced the consistency of the estimator but were not controlled in this study. They included, but not limited to, farmers' risk attitude and preference, loan access, history of extension access, agricultural knowledge and technology adoption, and receipt of input subsidies, social assistance, and remittances.

Additionally, including a rich set of observable covariates seems to have a better chance of holding the assumption, but the theory suggests avoiding the use of characteristics that can themselves be affected by treatment [50]. As we discussed in the data section, we used 15 individual and community characteristics, collected several months before the projects ended, and we therefore could not ensure whether control variables used in the DR estimation were not influenced by treatment. However, it was difficult to consider that the projects—implemented to mainly promote vegetable cultivation and poultry rearing for household consumption purposes and provide a marketing outlet for marginal food production—could influence residents' demographic and community attributes during the project life span. On the other hand, economic factors such as asset possession and monthly expenditure—considered as critical determinants of project selection and the outcomes of study's interest—might be affected by treatment. Indeed et al. [23], using intermediate evaluation data, showed that residents in the EJ and NG project sites tended to have higher monthly expenditures relative to farmers with similar livelihood characteristics. Therefore, controlling for economic factors collected during our survey period likely downwardly biases estimates of extension and marketing effects. Therefore, our findings should be carefully interpreted as suggestive associations rather than conclusive causality.

Third, although both projects targeted to serve vulnerable rural farmers, the treatment effect estimated from the two projects might not be comparable due to unobserved heterogeneity—especially different agricultural environments where Dinajpur district (within Rangpur division) was a flash flood and drought-prone area, while Barisal district (within Barisal division) was a saline-flood prone area. In addition, according to the 2011 Bangladesh Demographic and Health Survey (BDHS), literacy rates for women in the Barisal division were about 30% higher than women in the Rangpur division, while women in the Barisal division were reported to experience more severe food security, measured by the frequency of often skipping meals or having less food in a meal due to lack of food at home, than women in Rangpur division [31].

Table 4 A summary of project’s average treatment effects on various self-reported outcomes

	EJ (extension services)		NG (extension services and community marketing)	
	Coef	CG Mean	Coef	CG Mean
<i>Monthly expenditure patterns</i>				
Decrease in food expenditures	-0.278*** (0.031)	0.921	0.127*** (0.044)	0.702
Decrease in healthcare expenditures	-0.109*** (0.040)	0.727	-0.232*** (0.036)	0.933
Decrease in education expenditures	-0.045 (0.035)	0.797	-0.194*** (0.036)	0.850
Decrease in transportation expenditures	-0.107** (0.045)	0.605	-0.515*** (0.034)	0.932
<i>Food security and dietary diversity</i>				
HFIS	-4.209*** (0.335)	6.104	0.116 (0.332)	1.941
HDSD	1.084*** (0.117)	7.088	0.359*** (0.132)	6.872
<i>Homestead food production and marketing</i>				
Poultry rearing	0.113*** (0.043)	0.620	0.034 (0.035)	0.818
Quantity of poultry ^b	1.916 (1.894)	7.748	3.968*** (0.917)	7.131
Sale of poultry ^b	0.141*** (0.037)	0.113	0.181*** (0.048)	0.270
Vegetable Cultivation	0.301*** (0.040)	0.477	0.120** (0.047)	0.462
Vegetable production ^{a, c}	0.341** (0.158)	3.582	0.209 (0.266)	4.350
Sale of vegetable ^c	0.089 (0.050)	0.278	0.196*** (0.069)	0.315
Obs	769		889	

CG mean: predicted comparison group means. Standard errors are bootstrapped using 300 replications of the model and reported in parenthesis. * denotes significance at 10 percent, ** at 5 percent, and *** at 1 percent level

^a Values are expressed in logarithm term

^b Households that were involved in poultry rearing are used in calculating descriptive statistics

^c Households that were involved vegetable cultivation are used in calculating descriptive statistics

However, from the perspective of serving poor rural farmers and examining their differences in outcome variables, our study findings would be informative in answering the question of whether or not an approach, catalyzing women’s marketing barriers that women need to bear, could change household expenditure patterns and food security outcomes in rural Bangladesh.

Results

Table 4 presents a summary of the project’s treatment effects on four sets of outcomes, including *i*) households’ monthly expenditure patterns, *ii*) homestead food production and marketing, and *iii*) food security and dietary diversity. We reported the IPWRA (doubly robust) estimators that combines regression adjustment and

propensity score methods to achieve robustness to misspecification of the parametric models [51]. We used a logistic regression model for binary outcome variables, and standard errors were bootstrapped using 300 replications of the model.⁶ We also performed the balance test, and it accepted the null hypothesis that matching covariates and their power and interaction terms used in the treatment model were balanced for both projects.⁷

⁶ We used STATA’s ‘teffects ipwra’ command to produce doubly robust estimators.

⁷ We used STATA’s ‘tebalance overid’ command, and the test statistics accepted the null hypothesis with a *p*-value of 0.877 and 0.569 for the EJ and NG project, respectively.

The results showed that the EJ treatment group was predicted to consume 1.1 more food groups than the comparison group with a mean of 7.1 food groups. We also found that the treatment group experienced a lower level of household food insecurity by 4.2 points relative to the comparison group that had an HFIAS value of 6.1 out of 27 points. Moreover, the treatment group was predicted to have a lower probability of reducing monthly expenditures on food (by 27.8 percentage points); health-care (by 10.9 percentage points), and transportation (by 10.7 percentage points), compared to those of the comparison group.

In terms of homestead food production and marketing, the EJ treatment group was more likely to raise chickens by 11.3 percentage points than the comparison group, but there was no statistical difference in the total number of chickens in the past 4 weeks (conditioned to households rearing chickens). Similarly, the treatment group was more likely to cultivate homestead vegetables by 30.1 percentage points, and the treatment group that cultivated vegetables tended to have a higher level of vegetable production by 0.3 log point (or 1.35 times greater) than the corresponding comparison groups. Additionally, the treatment group had a higher probability of selling chickens in the past 4 weeks, while there was no significant difference in sale of vegetables between the two groups.

Similarly, the NG treatment group was predicted to consume around 0.4 more food than the comparison group with an HDDS value of 6.9 out of 12 food groups, while there was no statistical difference in HFIAS between the treatment and comparison groups. Unlike EJ effect results, the NG treatment group was more likely to reduce monthly food expenditures by 12.7 percentage points than the comparison group that 70.2% of the group decreased their monthly expenditures on food relative to 6 months ago. On the other hand, the treatment group showed a lower probability of reducing monthly expenditures on healthcare (by 23.2 percentage points), education (by 19.4 percentage points), and transportation (by 51.5 percentage points), compared to those of the comparison group.

For homestead food production and marketing outcomes, the treatment group's probability of raising chickens was not statistically different from the comparison group, while the treatment group was predicted to have four more chickens (during the past 4 weeks) relative to households rearing chickens in the comparison group with a mean of 7.1 chickens. Moreover, the treatment group was more likely to cultivate vegetables by 12 percentage points than the comparison group, but there was no statistical difference in total vegetable production between the two groups. The results also showed that the

treatment group had a higher probability of selling chickens and vegetables by 18.1 and 19.6 percentage points than the comparison groups.

Discussion

Project's effect on food security and monthly expenditure patterns during the lean season

In the previous section, we found that the EJ treatment group improved their dietary diversity and food insecurity outcomes in the household, while the NG treatment group showed only slight improvement in dietary diversity scores, relative to their comparison groups.⁸ In order to understand this phenomenon, it was noteworthy to compare group means of the outcomes between the comparison groups of both projects. For example, NG's comparison group mean of HFIAS was around 2 points, only one-third of the EJ comparison group. That is, residents in EJ areas experienced more extreme food insecurity during the lean season than residents in NG areas [31]. Therefore, to enhance household food security, the EJ treatment group decided to maintain or even increase their monthly expenditures on food during the lean season—although the results in Table 4 showed negative and significant coefficients on some other types of expenditures, the size of the average treatment effect on food is the largest. Additionally, raising chickens and vegetable production would contribute to improving their food security status.

On the other hand, residents in NG areas experienced relatively mild seasonal food deprivation, the treatment group might not perceive the need to maintain or increase their budget shares on food. Instead, the results showed a substantial increase in the treatment group's probability of maintaining or increasing their expenditures on healthcare, education, and transportation. Although the EJ treatment group appeared to show similar expenditure patterns (except food and education), the size of NG's treatment effects was at least twice as much as those in EJ. Plausibly, producing homestead food such as a greater number of chickens and cultivating vegetables attributed to their decisions on levels of household food security and expenditure patterns.

Project's effect on homestead food production and marketing

We found that the EJ treatment group tended to have a higher probability of raising chickens, while there was no statistical difference in their quantities relative to the comparison group. On the other hand, the NG treatment

⁸ As robustness checks, we ran non-bootstrapped regression models with clustered errors at the village level and confirmed that our main findings did not change.

group was predicted to raise more chickens, but the proportion of treatment households rearing chickens was not statistically different from the comparison group. Considering that four-fifths of the comparison group raised chicken in NG areas, relative to three-fifths of the comparison group in EJ areas, we could assume that raising chickens were more prevalent in NG areas. Thus, the remaining one-fifth of residents who did not raise chickens might either lack of chicken-rearing facilities or never-adopters regardless of the provision of extension services. That is, the project had an impact on expanding chicken rearing in the place where a relatively lower proportion of residents raised chickens, while it had an impact on increasing number of chickens in place where the majority of residents already raised chickens. Similarly, we found that both treatment groups had a higher probability of cultivating homestead vegetables than their comparison groups, while only EJ treatment group, conditional on producing vegetables, showed a higher level of its production than the comparison group. This is a dilemma that most extension workers have been confronted with where they should focus their resources and time to maximize project returns.

Our evidence also showed that the NG treatment group had an increased likelihood of marketing chickens and vegetables relative to their comparison groups. Therefore, the following question would be whether community marketing promoted treatment group's sale of chickens. By simply interpreting the sign of the treatment effect coefficient under the unconfoundedness condition, we could presume that community marketing seemed to enhance farmers' marketing activities, but there were several other alternative outlets for sale, including village market, union market, upazila market, neighbors, and so on. We can descriptively answer this question by comparing the distribution of marketing outlets between the treatment and comparison groups in NG areas. Specifically, the data show that 68% of the NG treatment group that sold chickens during the past 4 weeks sold them to community marketing traders, followed by union market (23%) and village market (4%).⁹ On the other hand, 63% of the comparison group sold chickens to local traders (door-to-door visits), followed by union market (30%) and village market (6%). These results indicated that community marketing would make some level of contribution to enhancing sale of chickens.

On the other hand, interestingly, 83% of the NG treatment group who sold vegetables during the previous growing season sold vegetables in the nearest village

market, and 34% sold vegetables in community marketing sites, and 25% sold vegetables in the union market. In contrast, 48.1% of the comparison group that sold vegetables sold them to local traders (door-to-door visit), followed by union market (36.4%) and village market (35.1%). That is, a higher proportion of farmers in the treatment group ever sold their vegetables in the nearest village market than the comparison group farmers, and it might explain that the treatment group tended to maintain or increase their expenditures on transportation. Unfortunately, our data did not provide the quantity sold in markets and to local traders, so we were not able to identify how intensively the treatment group utilized community marketing as an alternative marketing outlet. But, based on our results, we could carefully explain that the farmers might earn small money from selling chicken and vegetables, and some fraction of this money might be used for going to markets to sell homestead foods for days when local traders did not come to the sites. More research is required to understand detailed marketing mechanisms and its relationships with farmers' nutrition and income.

Considering the unique features of community marketing—, which fixed the price at the market price, reduced the opportunity cost of time, and avoided social and cultural barriers and lack of facilities in the market—, the total benefits accrued from community marketing would be greater than just the difference in price.

Challenges of implementing community marketing

The community marketing strategy had a number of challenges and shortcomings. First, to implement community marketing and make it sustainable after the project ended, the NGOs held 6–8 meetings for local traders and farmers in the cluster to understand its potential benefits and what farmers and traders wanted from community marketing. This process built trust between local traders and farmers and increased their ability to sustain community marketing and re-negotiate the marketing rules once the original condition did not fit reality. Finding an agreed point between farmers and traders was difficult, and this discussion and negotiation process often took a long time.

Another concern was the availability of a stable supply of quality food in the marketing sites. Since community marketing did not impose requirements in terms of the quantity and quality (although implicitly agreed between farmers and local traders) of the produce, the supply of foods might be volatile. For example, if there is an unexpected weather shock, the supply of homestead food will decrease substantially and, at this time, farmers will fail to meet the quantity that the traders expect to collect from the marketing sites. If this happens often, the traders will

⁹ The percentages were not mutually exclusive. A farmer could sell chickens and vegetables through multiple marketing outlets.

decrease their interest in participating in community marketing because the traders will still incur their transaction costs to visit the community marketing sites, and they will eventually stop participating in marketing at the point where traders' profits are lower than variable costs of community marketing engagement. When the NGOs designed community marketing to address this concern, they connected one local trader to multiple community marketing sites. However, this might result in giving local market power to selected local traders, and it might increase costs of market entry for other local itinerants and petty traders.

Lastly, we question how long community marketing will be sustainable. During the project's lifetime, the NGOs monitored whether community marketing worked properly—in terms of sharing market price information, using an accurate weight scale, on-the-spot payment, etc.—and mediated conflicts between farmers and local traders. The issue would be whether both marketing parties will have sufficient commitment and a willing attitude to keep the marketing rules and replace the NGOs' work.

These challenges and potential shortcomings led us to consider ways to improve community marketing implementation. First, it is important to foster farmers' ability to communicate effectively with local traders regarding marketing rules as well as their importance to the success of the community marketing innovation. It is also important to build the ability to resolve possible conflicts between marketing parties in negotiation. For quality homestead food production, since the women dominate the production, the project can effectively reach women farmers via the cluster-level approach to share knowledge and practices of recommended farm practices. Furthermore, it would be important to share weather-resistant vegetable seeds and farm practices to prevent significant losses during unexpected weather shocks such as dry periods. This will decrease the risk of lowered food production and thereby keep the local traders from exiting the project.

Contribution of this research to extension policy and practice in Bangladesh

Women generally have less access to agricultural extension services, and this gender inequality has not been improved over the past decades [40, 46]. Agricultural extension research found a multitude of gender-specific constraints in access to extension services. Specifically, extension agents prefer to work with farmers who control economic and productive resources and make decisions within the household [27]. It is most commonly the male in a husband–wife household. Moreover, in Bangladesh, social and cultural norms that restrict women's ability

to attend agricultural training and sale in the market are often cited as the main barriers to their access to extension services [37, 39].

As previously described, in order to avoid cultural conflicts within the household and community, women farmers prefer to sell their commodities in informal markets, accepting buyers' offers rather than negotiating for better prices or selling them in the formal markets [28]. The further the market is away from home, the more women farmers get disadvantaged. The community marketing approach was designed to tackle this social norm—restricting women's mobility beyond the community—by formulating a women farmer group to gather a sufficient quantity of quality agricultural produce and market it to local traders who came to the designated marketing places near communities where women lived. In doing so, women smallholders were able to reduce transaction costs and sell their produce at a higher price than they would have received from individual bargaining in informal markets. This approach was devised to link women smallholders to the markets without conflicting with social and cultural norms for which women were responsive, and our research findings supported the claim that women smallholders benefited from community marketing participation. Therefore, government, NGO, or other extension providers looking for a culturally appropriate approach to address women farmers' limited mobility may consider using or modifying community marketing.

Conclusion

This article explored the relationship between linking small-scale women farmers to market and livelihood outcomes focusing on food security, monthly spending patterns, and food production and marketing. We found that vitalizing marketing in the community could provide small-scale farmers a secured marketing outlet for food production, and it could generate extra money—although it tended to be small—by selling homestead food products, which appeared to be correlated with changes in expenditure patterns. However, if farmers do not spend this extra income on food purchases, it is hard to anticipate improved food security. Additionally, catalyzing women's marketing activities through freeing cultural and structural marketing barriers that women sometimes bear might have a broader effect on women's empowerment beyond marketing decisions.

Abbreviations

CRS: Catholic Relief Service; DR: Doubly robust; EJ: Egiye Jai; FAO: Food and Agriculture Organization of the United Nations; HFIAS: Household Food Insecurity Access Score; HDDS: Household Dietary Diversity Score; IPW: Inverse probability weighting; NG: Nijera Gori; NIPORT: National Institute of Population Research Training; OECD: Organisation for Economic Co-operation and Development; RA: Regression adjustment.

Acknowledgements

This research was supported by the USAID-funded Integrating Gender and Nutrition within Agricultural Extension Services (INGENAES) projects, as well as by internal funds from Catholic Relief Services (CRS), Caritas Bangladesh (CB), and the University of Illinois. These sources of support are gratefully acknowledged. We also deeply appreciate the on the ground assistance of Caritas field staff and private enumerators who assisted with collecting field data. Furthermore, we acknowledge the contribution of CRS monitoring and evaluation staff and other in CRS who contributed to this research. Lastly, we would like to acknowledge the many grassroots farmers who provided survey responses to this study. Hopefully, our research will illuminate policies that have a positive impact on understanding by development practitioners and funders concerning the usefulness of livelihood projects on their target population of small holder farmers.

Author contributions

HBL and PM were involved in most aspects of the paper including data analyses, result interpretation, and paper writing. KB was involved in data collection. All authors read and approved the final manuscript.

Funding

Our research was funded in part by the USAID-funded INGENAES Project led by the University of Illinois (AID-OAA-LA-14-00008), as well as with funds from University of Illinois and CRS.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of University of Illinois at Urbana-Champaign with waiver of informed consent.

Consent for publication

Not applicable.

Competing interests

The authors hereby declare we have no conflicts of interest related to this manuscript and our research on the impact of an agricultural and livelihood development program and its impacts on nutrition in rural Bangladesh.

Author details

¹Urban Education Institute, University of Texas at San Antonio, 501 W. Cesar Chavez Blvd., San Antonio, TX 78207, USA. ²Department of Agricultural and Applied Economics, University of Illinois at Urbana-Champaign, 326 Mumford Hall, MC-710, 1301 West Gregory Drive, Urbana, IL 61801-3605, USA. ³Independent Consultant, DDA SFS Flat No. 515, Sector - 9, Pocket - 2, Dwarka, New Delhi 110075, India.

Received: 9 November 2021 Accepted: 1 April 2022

Published online: 02 May 2022

References

- Allcott H. Site selection bias in program evaluation. *Q J Econ.* 2015;130(3):1117–65.
- Ashraf N, Giné X, Karlan D. Finding missing markets (and a disturbing epilogue): evidence from an export crop adoption and marketing intervention in Kenya. *Am J Agr Econ.* 2009;91(4):973–90.
- Bradburn NM, Sudman S, Blair E, Stocking C. Question threat and response bias. *Public Opin Q.* 1978;42(2):221–34.
- Catholic Relief Services (CRS). Egiye Jai and Nijera Gori food security project. Mid-term review report. 2015.
- Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide: version 3. 2007. https://www.fantaproject.org/sites/default/files/resources/HFIAS_ENG_v3_Aug07.pdf
- Devaux A, Horton D, Velasco C, Thiele G, López G, Bernet T, Reinoso I, Ordinola M. Collective action for market chain innovation in the Andes. *Food Policy.* 2009;34(1):31–8.
- Doss CR. Designing agricultural technology for African women farmers: lessons from 25 years of experience. *World Dev.* 2001;29(12):2075–92.
- Dufló E. Women empowerment and economic development. *J Econ Lit.* 2012;50(4):1051–79.
- Food and Agriculture Organization of the United Nations (FAO). The State of Food and Agriculture 2010–11: Women in Agriculture. Closing the gender gap for development. 2011. Rome, Italy. <http://www.fao.org/docrep/013/i2050e/i2050e.pdf>
- Ferris S, Engoru P, Kaganzi E. Making market information services work better for the poor in Uganda. 2008. Cali, Colombia. <https://doi.org/10.2499/CAPRIWP77>
- Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography.* 2001;38(1):115–32.
- Fischer E, Qaim M. Linking smallholders to markets: determinants and impacts of farmer collective action in Kenya. *World Dev.* 2012;40(6):1255–68.
- Fischer E, Qaim M. Gender, agricultural commercialization, and collective action in Kenya. *Food Secur.* 2012;4(3):441–53.
- Fischer E, Qaim M. Smallholder farmers and collective action: what determines the intensity of participation? *J Agric Econ.* 2014;65(3):683–702.
- Godquin M, Quisumbing AR. Separate but equal? The gendered nature of social capital in rural Philippine communities. *J Int Dev.* 2008;20(1):13–33.
- Grüere G, Nagarajan L, King EO. 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.* 2009;34(1):39–45.
- Gyau A, Franzel S, Chiatoh M, Nimino G, Owusu K. Collective action to improve market access for smallholder producers of agroforestry products: key lessons learned with insights from Cameroon's experience. *Curr Opin Environ Sustain.* 2014;6:68–72.
- Holloway G, Nicholson C, Delgado C, Staal S, Ehui S. Agroindustrialization through institutional innovation transaction costs, cooperatives and milk-market development in the east-African highlands. *Agric Econ.* 2000;23(3):279–88.
- Khandker SR. Seasonality of income and poverty in Bangladesh. *J Dev Econ.* 2012;97(2):244–56.
- Kruijssen F, Keizer M, Giuliani A. Collective action for small-scale producers of agricultural biodiversity products. *Food Policy.* 2009;34(1):46–52.
- Kumar N, Raghunathan K, Arrieta A, Jilani A, Chakrabarti S, Menon P, Quisumbing AR. Social networks, mobility, and political participation: the potential for women's self-help groups to improve access and use of public entitlement schemes in India. *World Dev.* 2019;114:28–41.
- Labonne J, Biller D, Chase R. Inequality and relative wealth: do they matter for trust?. Evidence from poor communities in the Philippines. *World Bank-social development papers.* 2007;103.
- Lee HB, McNamara PE, Bhattacharyya K. Women farmers' access to integrated livestock extension services and the impact on livelihoods in Bangladesh. *J Gend Agric Food Secur.* 2017;2:19–42.
- Markelova H, Meinzen-Dick R, Hellin J, Dohrn S. Collective action for smallholder market access. *Food Policy.* 2009;34(1):1–7.
- Markelova H, Mwangi E. Collective action for smallholder market access: evidence and implications for Africa. *Rev Policy Res.* 2010;27(5):621–40.
- McKenzie DJ. Measuring inequality with asset indicators. *J Popul Econ.* 2005;18(2):229–60.
- Meinzen-Dick R, Quisumbing A, Behrman J, Biermayr-Jenzano P, Wilde V, Noordeloos M, Ragasa C, Beintema N. Engendering agricultural research. International Food Policy Research Institute (IFPRI); 2010.
- Meinzen-Dick R, Quisumbing AR, Behrman JA. A system that delivers: Integrating gender into agricultural research, development, and extension. In: *Gender in agriculture*. Dordrecht: Springer; 2014, 373–391.
- Meinzen-Dick R, Zwartveen M. Gendered participation in water management: issues and illustrations from water users' associations in South Asia. *Agric Hum Values.* 1998;15(4):337–45.
- Mellor JW. Pro-poor growth: The relation between growth in agriculture and poverty reduction. Prepared for USAID/G/EGAD. 1999.
- National Institute of Population Research and Training - NIPORT/Bangladesh, Mitra and Associates/Bangladesh, and ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh: NIPORT,

- Mitra and Associates, and ICF International. 2013. <http://dhsprogram.com/pubs/pdf/FR265/FR265.pdf>
32. Organisation for Economic Cooperation and Development (OECD). Promoting pro-poor growth. Agriculture, DAC guidelines and reference series. A DAC reference document. 2006. <https://www.oecd.org/green/growth/green-development/43514554.pdf>
 33. Okello JJ, Narrod C, Roy D. Food safety requirements in African green bean exports and their impact on small farmers. *Intl Food Policy Res Inst*; 2007.
 34. Pingali P, Khwaja Y, Meijer M. Commercializing small farms: Reducing transaction cost. 2005. <https://www.fao.org/3/af144t/af144t.pdf>.
 35. Pitt MM, Khandker SR. The impact of group-based credit programs on poor households in Bangladesh: does the gender of participants matter? *J Polit Econ*. 1998;106(5):958–96.
 36. Quisumbing AR, Kumar N. Does social capital build women's assets? The long-term impacts of group-based and individual dissemination of agricultural technology in Bangladesh. *J Dev Eff*. 2011;3(2):220–42.
 37. Quisumbing AR, Maluccio JA. Resources at marriage and intrahousehold allocation: evidence from Bangladesh, Ethiopia, Indonesia, and South Africa. *Oxford Bull Econ Stat*. 2003;65(3):283–327.
 38. Quisumbing AR, Pandolfelli L. Promising approaches to address the needs of poor female farmers: resources, constraints, and interventions. *World Dev*. 2010;38(4):581–92.
 39. Quisumbing AR, Roy S, Njuki J, Tanvin K, Waithanji E. Can dairy value-chain projects change gender norms in rural Bangladesh? Impacts on assets, gender norms, and time use. 2013. https://cgspage.cgiar.org/bitstream/handle/10568/35059/ifpriDiscPaper_01311.pdf?sequence=1
 40. Ragasa C. Improving gender responsiveness of agricultural extension. In: *Gender in agriculture*. Springer, Dordrecht; 2014, 411–430.
 41. Reardon T, Berdegue JA. The rapid rise of supermarkets in Latin America: challenges and opportunities for development. *Dev Policy Rev*. 2002;20(4):371–88.
 42. Rondot P, Collion MH. Agricultural producer organizations: their contribution to rural capacity building and poverty reduction. 2001. <https://agritrop.cirad.fr/507568/1/ID507568.pdf>
 43. Shiferaw B, Hellin J, Muricho G. Improving market access and agricultural productivity growth in Africa: what role for producer organizations and collective action institutions? *Food Secur*. 2011;3(4):475–89.
 44. Stringfellow R, Coulter J, Lucey T, McKone C, Hussain A. Improving the access of smallholders to agricultural services in sub-Saharan Africa: farmer cooperation and the role of the donor community. *Nat Res Perspect*. 1997;20:1.
 45. Stockbridge M, Dorward A, Kydd J. Farmer organizations for market access: A briefing paper. London: Imperial College; 2003.
 46. Swanson BE, Farner BJ, Bahal R. The current status of agricultural extension worldwide. In: *Consulta Mundial sobre Extension Agricola*, Rome (Italy), 1989.
 47. Swindale A, Bilinsky P. Development of a universally applicable household food insecurity measurement tool: process, current status, and outstanding issues. *J Nutr*. 2006;136(5):1449S–S1452.
 48. Vorley B, Fearn A, Ray D, editors. *Regoverning markets: a place for small-scale producers in modern agrifood chains?* Boca Raton: CRC Press; 2016.
 49. Wiggins S, Kirsten J, Lambi L. The future of small farms. *World Dev*. 2010;38(10):1341–8.
 50. Wooldridge JM. Violating ignorability of treatment by controlling for too many factors. *Economet Theor*. 2005;21(5):1026–8.
 51. Wooldridge JM. *Econometric analysis of cross section and panel data*. Cambridge: MIT press; 2010.
 52. World Bank. *World development report 2008: Agriculture for development*. The World Bank; 2007.
 53. Zaman H. Patterns of activity and use of time in rural Bangladesh: class, gender, and seasonal variations. *J Dev Areas*. 1995;29:371–88.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

