# 1 Introduction

Bangladesh has witnessed significant reduction in poverty over the last two decades; however, there still remains widespread food insecurity. Out of a total population of 165 million people in Bangladesh, 33 million were classified as lacking food security in 2010 and by 2020 it is estimated that this number will increase to 37 million (USDA 2010). A 2012 survey by the Economist Intelligence Unit of 105 countries ranked Bangladesh 81st in terms of the Global Food Security Index (Economist, 2012). In rural Bangladesh, most of the income of a poor household is derived from the agricultural sector, which exposes households to seasonality in agricultural employment, poverty and consumption. Income from non-agricultural sources could safeguard households against seasonal food insecurity; however, they may lack the resources to diversify into more productive employment opportunities that could assist, particularly during lean seasons. Low income levels, and lack of access to credit, prevents households from accessing food, leaving them susceptible to food deprivation, even when aggregate food supplies are adequate.

Microcredit was developed in order to meet an important need not addressed by formal institutions; namely, providing financial capital to landless and assetless rural households, who would otherwise be either ineligible to access credit or be locked into the informal credit system. From the beginning, one of the major forces motivating the development of microcredit was to improve the food security of the rural poor. This objective, for example, is clearly enunciated in Grameen Bank documents (see eg. Yunus, 1994) and is accepted in the extant literature on microcredit (Imai and Azam, 2012). Microcredit seeks to improve food security of the rural poor through various avenues. One avenue is through generating 'investment-led' benefits, which result in greater levels of income, consumption and wealth. Another is through 'insurance-led' benefits that can protect households against unforeseen risk and seasonality. It is recognised that participation in microcredit institutions (MCI) and access to microcredit provides a safety net that prevents income from falling to such low levels that households are unable to satisfy their basic consumption needs.

A number of related studies find that microcredit program participation results in consumption smoothing and asset building (Kaboski and Townsend, 2005), reduces household vulnerability to health and income shocks (Islam and Maitra, 2012), and improves health and nutrition (Pitt et al., 2003). Higher benefits have also been found to accrue from long-term participation in such programs (Islam, 2011). A few studies have directly examined

the effect of microcredit on poverty. Proxies for poverty used in the literature include female body mass index (BMI) (Imai and Azam, 2012), food consumption (Imai and Azam, 2012; Islam 2015), a composite index based ranking (Imai et al. 2010), household expenditure (Pitt and Khandker, 1998; Banerjee et al. 2015) and household income (Imai and Azam, 2012). The findings from these studies have been mixed. Some studies have found microcredit to have a positive effect on reducing household poverty (see eg. Imai et al., 2010; Imai and Azam, 2012; Khandker, 2005a; Pitt and Khandker, 1998), but others have found that microcredit has no poverty-reducing effect or no effect on consumption (see eg. Banerjee et al. 2015; Cull et al. 2009).

In this study, for the first time, we seek to measure the effect of microcredit along several different dimensions of food security. Our contribution is important because food security is a broader concept than food consumption. In addition to food consumption per se, there is widespread recognition that dietary diversity forms an important component of food security. More generally, the FAO (1996) states that food security exists "when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This definition recognizes availability, access and utilization as the three principal components in the concept of food security. More recently, vulnerability, which captures the extent to which households that are currently food secure may be at risk of future food insecurity, has also been added as a fourth dimension to the measurement of food security. Since, no single indicator can capture all of the above aspects of food security, the use of multiple measures seems appropriate.

We use a large household level panel dataset to examine the effect of microcredit on household food insecurity in rural Bangladesh. Our data includes a rich set of information on item-wise food consumption. The study closest to ours in the literature is that of Imai and Azam (2012) who use the same dataset to examine the effect of microcredit on poverty.[1] Our contribution differs from their study, however, in that those authors use income, female BMI and food consumption to measure poverty, while we use a much broader set of measures of food security. To measure food security we use absolute level of calorie intake and shortfall from standard cut-offs of calorie norms, dietary diversity of the household and anthropometric indicators for children below five years (stunting, wasting and underweight)

[1] Islam (2011); Islam and Maitra (2012) and Islam (2015) also use the same dataset from different rounds to examine the short, medium and long-term effects of microfinance, consumption-smoothing effects in the face of health shocks and effects on consumption expenditure, respectively.

and for women of reproductive age (15-49 years), focusing on BMI and mid-upper arm circumference (MUAC). We also differ from the existing literature in examining the effect of microcredit participation on food security both at the intensive (calorie consumption) and extensive (incidence of food poverty) margins.

We find that households' participation in microcredit programs increases their calorie consumption, both at the intensive and extensive margin, particularly for hard-core food poverty. However, microcredit does not increase the diversity of diet. We find that participation in a program has mixed effects on anthropometric measures for children and females of reproductive age. Microcredit participation reduces child stunting, but only has a weak, or no, effect on child wasting and on being underweight. Similarly, microcredit program participation reduces the incidence of women of reproductive age being underweight and being malnourished, but has no effect on their BMI or MUAC. We also find that, on the basis of the duration of participation in a program, the effect of microcredit participation on food security may be non-linear, in which participation in microcredit initially has no effect on food security or may actually worsen it, before improving it in the long run. The results suggest that a long-term evaluation of the microcredit program could offer different conclusions than short-term evaluation.

The paper is structured as follows. The next section presents a simple conceptual framework that assists to better understand the pathways through which microcredit affects food security. The microcredit program in Bangladesh, the data used and the measurement of food security in this study are discussed in Section 3. Section 4 discusses the alternative estimation methodologies that we use to assess the impact of MCI participation on the food security situation of the household. Section 5 presents the results and the final section concludes.

## 2. The Conceptual Framework

We consider a simple analytical framework to understand the pathways through which microcredit program participation affect household calorie consumption and food insecurity. Demand for calories can be estimated within the framework of consumer demand theory, which incorporates the demand for characteristics (Lancaster, 1966) with household production theory (Becker, 1965). Drawing on Rose et al. (1998), one can consider a utility function that has vectors of taste components, S, and nutrients, N, found in meals, as well as a vector of other goods, $X_0$ and leisure, represented by L:

$$U = U(S, N, X_0, L) \qquad (1)$$

A representative household maximizes its utility, subject to a home production function and constraints on its income and time, given food and other goods' prices. The reduced-form nutrient demand equation for this optimization problem then takes the following form:

$$N = y(P_f, P_0, w, Nw, K, H) \qquad (2)$$

where, $P_f$ is a vector of food prices, $P_0$ is a vector of prices of other goods, $w$ is the wage rate, $Nw$ is non-wage income, $K$ is a vector of capital goods, including human capital, physical assets and land and $H$ is a vector of demographic characteristics, such as household size and composition. Demand functions for other meal characteristics as well as other goods and leisure could be similarly depicted. For the purposes of this exposition, we focus on the case of one nutrient — food energy or calorie availability. Let $C_a$ represent the household's absolute level of calorie availability, an important component of the nutrient vector, which is a function of prices, wages, non-labour income, capital and socio-economic and demographic characteristics of the household. Food insufficiency occurs when the household's calorie (energy) consumption falls below some minimum threshold level, set at some pre-determined level, $C_{min}$, referred to as the minimum energy requirement.

Incidence of food insecurity can be then be represented by an indicator ($A_h$), where

$$\begin{aligned} A_h &= 1 \; if \; C_a < C_{min} \\ &= 0 \; otherwise \end{aligned}$$

Two alternative models of household food insecurity can then be estimated — one based on the absolute level of calorie availability, $C_a$ and the other using the indicator function, $A_h$. Next, we sketch a model of the nutritional status of the most vulnerable in the household (women and children), following Garett and Ruel (1999). Since the study intends to address the issue of food security at the household level only, the nutritional status of children under the age of five and that of women of reproductive age are considered as proxy indicators for the level of food utilization within the household. Nutrition for an individual $i$ is conceived of as the output of a production function in which a specific technology translates inputs into nutritional outcomes, which are represented by some standardized anthropometric measure, such as height-for-age or BMI. Nutrition can be represented by the function:

$$W_i = z(DI_i;\ R_i;\ E_i) \qquad (3)$$

produced by a set of inputs which include dietary intake ($DI_i$), resources available to the household ($R_i$) and household environment ($E_i$). Individual $i$ suffers from acute malnutrition if his/her nutritional status falls below a specified cut-off level, as set by the WHO (2006).

Access to microcredit provided by MCIs increases the available resources and relaxes the budget constraint faced by households. Increases in calorie (energy) availability of the households, however, depend on the shape of their calorie-income curve. Microcredit has no effect on household calorie availability if the calorie-income curve is relatively flat. If there is significant non-linearity, MCI participation may increase calorie availability at the beginning and decrease thereafter. On the other hand, microcredit is likely to affect the nutritional status of women and children in the household directly by increasing the resources available to participating households and indirectly by increasing their dietary intake.

## 3. The Microcredit Program and the Data

Bangladesh has one of the world's oldest microcredit programs. MCIs in Bangladesh adopt the Grameen Bank approach to lending. Specifically, households eligible for microcredit are those with less than 50 decimals (half an acre) of land and, in particular, groups of women who become jointly liable for the repayment of the loan in the absence of any collateral requirement. Initial loans are typically between US$40 and US$150 and are made available for a range of socially acceptable income generating activities, with MCI members permitted to borrow larger sums once they have repaid their first loan.

The dataset used in this paper was collected by the Bangladesh Institute of Development Studies (BIDS) with financial support from the World Bank. The dataset contains information from about 3000 households, which were selected from 91 villages across 23 thanas (sub-districts) within 13 districts. Four rounds of the survey were conducted (in 1997-98, 1998-99, 1999-2000 and 2004-05) over a period of eight years. The participating households were selected from 13 MCIs, one from each of the 13 districts in which the survey was conducted. Among the 91 villages in which the survey was administered, there were 11 control villages in the first round, meaning 11 villages in which there was no MCI activity. The final round of the survey eventually covered only eight control villages as some of the control villages turned into program villages in the subsequent rounds of the survey. The dataset contains detailed information on the food consumption behaviour of the household and anthropometric data for all household members. We use data from the first,

third and fourth round of the survey, given that the second round did not contain the same detailed anthropometric data. The first, third and fourth round of the survey also contains detailed information on personal and household characteristics of participants.

The final dataset is an unbalanced panel from the first, third and fourth round of the survey; there are 2577 households in the first round, 2540 households in the third round and 2358 households in the fourth round. The attrition between the first and fourth rounds was less than 10%, representing about 1.2% per year. This figure is relatively low and does not pose any serious concern for our analysis (see Islam, 2011 for details). As a robustness check on our results, we also analysed separately the consumption behaviour of those who dropped out and those who remained in the survey and we did not find any difference between these two groups. Hence, our results reported below are not corrected for attrition bias.

Differences in the food situation between MCI members and non-members are based on their membership status during a given round. The treatment group consists of households in which at least one individual is a member of one or more MCIs during a given round. We also use the total amount borrowed by participating households in any particular year as an alternative definition of program participation to check the robustness of our results. [2]

### 3.1 Measuring Household Food Security

In the present study, we consider three different quantitative measures of food security, widely used in the literature, to evaluate the impact of microcredit program participation on the food security situation in rural Bangladesh. These can be categorized as: (i) calorie (energy) availability — both as absolute calorie consumption and as a categorical measure, representing shortfall from a standard norm; (ii) dietary diversity indicators; and (iii) anthropometric indicators for children below five years and women of reproductive age. We do not include the self-reported or experiential food security measure, in the absence of relevant data.[3] We now discuss the construction of each of these indicators in more detail.

#### (i) Extracting Calorie Data from the HCES

The Household Consumption Expenditure Survey (HCES) collected (retrospectively) detailed data on the quantity and value of food items consumed by households over the seven days

[2] The loan amount is in ten thousand taka adjusted by the agricultural price index with 1997-98 as the base year.
[3] Information on self-reported food security based on perception of 'lack of enough food' is available for one year only.

preceding the date of inquiry.[4] The quantity estimates of the food items consumed by a household were converted to calorie availability[5] by applying conversion factors using the Gopalan et al. (1981) nutrition chart, which is routinely used in large-scale nutrition surveys, such as India's National Sample Survey Organisation (see NSSO, 2012). [6]

The estimate for total calorie equivalent of all food items consumed by the household during the reference period was derived by aggregating calories over different food groups.[7] Finally, we calculated three different measures of calorie consumption (expressed as kilocalories). These are i) household calorie consumption per day, (ii) per capita calorie consumption per day, calculated by dividing household calorie consumption by household size, and (iii) equivalized calorie consumption per day, calculated by dividing the aggregate calorie figure by the square root of household size, following the OECD (2008). Equivalized calorie consumption takes into account that consumption needs may differ across households. For example, consumption needs will be different for a household consisting of only working age adults and a household with one or more children.

### (ii) Choice of Calorie Norm

Data on food expenditure, gathered through the HCES, can be converted to calories using price per unit or calorie per unit conversion factors. However, it should be noted that inter- and intra-individual variations in nutrient requirement, based on health status, activity level and genetics may complicate the definition of an appropriate intake threshold (Barrett, 2002). Pegging the level of calorie norm has long been subject to debate. Since calorie needs vary with climate and also with age, gender and activity status, a single norm, irrespective of the level at which it is set, cannot capture these differential requirements. Minimum calorie

[4] The exception was cereals, for which the recall period was three days.

[5] We have computed calorie availability, rather than calorie intake. The former may not necessarily represent the 'true' level of intake of a household for two reasons. Firstly, there may be members of the household who might have consumed free meals outside the home and, secondly, persons other than household members might have been entertained as guests (see Strauss and Thomas, 1995). In the presence of information on 'number of meals taken away from home' and 'number of meals served to guests', calorie availability can be adjusted using an appropriate adjustment factor (see Minhas, 1991) to obtain a measure much closer to true intake. However, for the purpose of the paper we use calorie intake and availability interchangeably.

[6] Few countries have appropriate calorie conversion tables, with which to estimate the adequacy of the consumption of all essential nutrients as well as dietary energy. In the absence of a detailed Bangladesh specific food composition table, we used India's food composition table because the dietary pattern of Bangladesh is very similar to that of certain states in India, such as West Bengal, due to historical reasons. The Indian Food Composition Table (Gopalan et al. 1981) has been previously used by researchers working on similar issues in Bangladesh - for example see Chaudhury (1985).

[7] The major food groups in the BIDS survey are: cereals, pulses, edible oil, vegetable, meat, egg, milk, fruits, fish (big and small), spices, other food products including sugar, biscuits and drinks including tea.

requirements are therefore specified for an average household using norms developed by the Bangladesh Bureau of Statistics (BBS) and the FAO. The BBS uses two different thresholds to measure the incidence of food poverty. According to the direct calorie intake (DCI) method, 2,122 kcal per person per day is considered to be the cut-off for defining "absolute poverty" while 1,805 kcal per capita per day is defined as the cut-off for "hard-core poverty" (BBS, 2000). Consistent with the above minimum energy requirements, we use 2,122 kcal and 1,805 kcal per capita per day, respectively, to define "absolute food poverty" and "hard-core food poverty". Our third definition follows the Bangladesh specific cut-off suggested by FAO/WHO/UNU (2004), corresponding to 1,770 kcal per capita per day for 2006-08.

### (iii) Household Dietary Diversity Indicators

We use four different measures to capture the extent of diversity in the diet of households (following eg. Hoddinott, 1999a, 1999b; Migotto et al., 2006). These four measures are (i) the Food Variety Score (FVS), (ii) the Dietary Diversity Score (DDS), (iii) the Gini-Simpson index and (iv) the Shannon index.[8] We use the 12-scale Household Dietary Diversity Score (HDDS), developed by the Food and Nutrition Technical Assistance (FANTA) Project of the United States Agency of International Development (USAID), to aggregate food items in the HCES under the following food groups — cereals, roots and tubers, vegetables, fruits, meats, eggs, fish and other seafood, legumes, nuts and seeds, milk and milk products, oils and fats, sweets, spices, condiments and beverages. The HDDS ranges from zero ("non-diverse") to 12 ("diverse"). The composite measures of diet diversity — the Gini-Simpson and Shannon indices — also establish a continuum between a "diverse" and a "non-diverse" diet, in which zero represents a "non-diverse" diet and the level of diversity increases with the value.

### (iv) Anthropometric and Nutritional Status

The anthropometric indicators that we use to measure the impact of program participation on the nutritional status of children under the age of five are based on weight-for-height z-scores (wasting), weight-for-age z-scores (underweight) and height-for-age z-scores (stunting), while acute malnutrition for women of reproductive age is assessed using BMI and MUAC. Acute malnutrition for children under the age of five is estimated using anthropometric measurements (weight and height), standardizing these results using the WHO (2006)

[8] FVS is a measure of the number of food items while DDS accounts for the number of food groups consumed by the household. The Gini-Simpson index is defined as $1 - \sum s_i^2$, while the Shannon index is $-\sum s_i \log(s_i)$, where $s_i$ is the calorie share of food group $i$, defined using the 12-scale Household Dietary Diversity Score (HDDS), developed by the FANTA Project. These two indices take a value of zero when only one food item is consumed and the value increases with increases in variety in the diet of the household (see FAO, 2011).

reference population and specifying cut-offs (presented as z-scores) in line with WHO recommendations. Children are classified as "total" malnourished – with reference to the median of the reference population – if their z-score is less than -2 standard deviations (SD) and "severely" malnourished if the z-score lies below -3 SD. Thus, a child below five years of age is severely underweight (stunted) if the standardized weight (height)-for-age z-score is less than -3 SD (BBS/UNICEF, 2007).

BMI and MUAC were employed to analyze the extent of acute malnutrition among women of reproductive age (15-49 years). Following the cut-offs specified for BMIs of adults in BBS/UNICEF (2007), a woman is considered to be underweight if their BMI is below 18.5 and chronic underweight if BMI lies below 16. Similarly, she is said to suffer from MUAC-malnutrition if their MUAC is less than, or equal to, 22.1 cm and severe MUAC-malnutrition if MUAC is below 21.4 cm (WHO, 1995).

Table 1 reports the summary statistics of different food security indicators by MCI participation status of the household. Calorie intake, measured in terms of absolute levels as well as incidence of food poverty, varies widely across households. Household calorie consumption is 11,559 kcal per day for MCI household participants compared to 11,531 kcal for non-MCI household participants, whereas per capita calorie consumption per day is 1,949 kcal and 1,944 kcal per day for participant and non-participant households.

Using a calorie cut-off of 2,122 kcal/person/day, we do not find any significant difference in food security between MCI participants and non-participants. Incidence of hard-core food poverty is 44.3% for participating and 46.7% for non-participating households, while 41.8% and 43.9% of households are found to be food poor when the cut-off specified by FAO/WHO/UNU (2004) is used, indicating that microcredit can effectively impact those most vulnerable to food poverty. Comparing dietary diversity indicators and nutritional status of women of reproductive age across participating and non-participating households, we find significant differences between the means of each of these indicators. We do not, however, find any significant difference between the health outcomes of children of program participants and non-participants, measured in terms of wasting, stunting and the likelihood of being underweight. Figure 1 plots the relationship between microcredit loan amount and select indicators of food security. The estimated non-parametric relationship between the loan amount provided by microcredit programs and each of the four different indicators of food security suggests that microcredit could improve the food security situation of households.

[Table 1]

[Figure 1]

## 4. Estimation Methodologies

Individual, household and village-level unobservable characteristics could influence the household's decision to participate in the program and the MCI's decision to select a particular village for its operation. Estimating the causal impact of microcredit program participation on household level food security, therefore, necessitates addressing non-random program placement and the self-selection of households into microcredit programs. Using the three-waves of the unbalanced panel dataset spanning over eight years between 1997 and 2005, we are able to address any potential selection bias and evaluate the effect of microcredit program participation on the food security situation of the household.

### 4.1. Regression Methods

We employ a fixed effects regression model of the form:

$$FS_{jt} = \alpha_j + \beta_1 H_{jt} + \theta P_{jt} + \lambda \tau_t + \varepsilon_{jt} \qquad (1)$$

where $FS_{jt}$ represents the different indicators capturing both the incidence and extent of food insecurity of household $j$ at time $t$ and $H_{jt}$ is a vector of household level characteristics. $\alpha_j$ captures household-level fixed effects while $\lambda \tau_t$ represents the year fixed effects. $\varepsilon_{jt}$ is the household specific error term, which is non-systematic and varies across households. We are particularly interested in the sign and value of the parameter $\theta$ associated with the variable $P_{jt}$, the microcredit program participation status of household $j$ in year $t$. The parameter $\theta$ denotes the effect of program participation on different indicators of household food security.

The following household level variables are controlled for in the regression model: age of household head, number of working-age people in the household, size of the household, highest education achieved by any household member, total arable land (in decimals), number of children aged 6–15, number of women in the household, number of old people in the household, number of married people in the household and gender of the household head. In addition to these covariates, we also control for total household expenditure and total assets including livestock. Total household income is supposed to include both income from wage labour as well as income from non-labour income as discussed in Section 2. We use

total household expenditure, instead of household income, as expenditure data has fewer reporting errors and is a better proxy for permanent income.

We control for unobserved household level characteristics using household level fixed effects. We use year fixed effects to capture macroeconomic shocks and prices that could potentially affect the household's food security. To account for any correlations in errors across villages and year, we compute clustered–robust standard errors at the village-year level. As we use household level fixed effects, we only include a subset of all household level characteristics that vary over time.

### 4.2 Propensity Score Matching

To check the robustness of the results from the panel data approach, we use an alternative strategy that combines the propensity score matching (PSM) method proposed by Rosenbaum and Rubin (1983) with the panel data approach discussed above. The main purpose of using PSM is to examine whether our results hold using a sample based on matched groups of participants and non-participants. In order to do so, we first estimate propensity scores for each household using a standard logit model that regresses participation status of the household in the first round of the survey on their initial set of household- and village-level observable characteristics.[9] Second, we compare participant and non-participant households based on these propensity scores. We re-run Equation (1) for the subset of matched individuals, lying within the common support, estimated using the nearest neighbour estimator with the five nearest neighbours. The results from the balancing test are provided in Appendix Table A1. Both the t-test for equality of means for the treated and non-treated groups as well as the standardized bias test suggests that the covariate distributions across the matched groups are well balanced after matching (Becker and Ichino, 2002).

[9] To estimate the propensity score for each and every household we control for a wide range of household and village level characteristics that influence the decision of the household to participate or not in the program. We control for the following household characteristics: age of the household head, age of household head squared, number of working age people in the household, size of the household, highest education achieved by any household member, total arable land (in decimals), number of children aged 6–15, number of women in the household, number of old people in the household, number of married people in the household and gender of the household head. We control for the following village characteristics: presence of primary school, secondary school or college, health facility, madrasah, the average adult male and female wage, presence of brick-built road, regular market, frequent haat, post office, bus stand, telephone office in village, local government office, youth organisation, distance to nearest Upazila (in kilometres), share of landowners in share cropping (in percentages), number of money lenders in the village, number of large farmers/traders in the village, number of small credit/savings groups in the village and numbers of low lift pumps, shallow tube wells, hand tube wells in irrigation, hand tube wells in drinking water and deep tube wells in the village.

## 5. Results

The regression results for Equation (1) are presented in Tables 2, 3 and 4. Table 2 shows the effect of program participation on absolute calorie consumption and incidence of food poverty. Table 3 presents the regression results for the nutritional status of children under the age of five and women of reproductive age (15-49 years) and Table 4 reports the estimated coefficients for dietary diversity among households in rural Bangladesh. As we are primarily interested in examining whether participation in microcredit programs affects the food security situation of households, in each of the tables we only report the relevant parameter, which is the coefficient $\hat{\theta}$. However, as discussed above, each specification includes a full set of controls and includes both year and household fixed effects.

### 5.1 Impact on Calorie Consumption and Incidence of Food Poverty

The coefficients presented in Panel A of Table 2 show that microcredit program participation significantly increases calorie intake for all specifications. Household's calorie consumption per day increases by 3.11%, equivalized calorie consumption increases by 2.72% and per capita calorie consumption per day by 2.34%. The results for absolute calorie consumption are robust to the use of the different measures of per-day calorie intake, suggesting that households do benefit from microcredit participation in terms of calorie consumption.

[Table 2]

The impact of loan amount is also positive and significant for all specifications of calorie intake. This result implies that calorie intake is highly responsive to increases in available resources resulting from increased access to microcredit. Access to microcredit generates investment-led benefits, which implies that access to microcredit is generating additional income or is helping households stabilise their income. Moreover, many loans obtained by poor households are also used for consumption, mainly for food (Zeller and Sharma, 2000a). Microcredit allows low-income households to augment their otherwise meagre resources and acquire adequate food and other basic necessities. Intuitively, it is expected that calorie intake of the poor (at the lower end of income distribution) will respond positively to increased expenditure, but as expenditure increases further the elasticity will decline, possibly to zero, or even become negative at high enough expenditure levels (Behrman and Deolalikar, 1987; Strauss & Thomas, 1995). The overall results presented in Table 2 point to the possibility that

the calorie-income curve is sufficiently non-linear in rural Bangladesh, thus leading to significant increases in household and individual level calorie consumption.

The results in Panel B of Table 2 suggest that compared to non-participants, participating households are more likely to meet the minimum dietary energy requirements. We find robust evidence that participation in MCI programs significantly lowers the probability of being food-poor, however, it disproportionately benefits those suffering from hard-core poverty. Incidence of hard-core food poverty is reduced by 4.35%, however, we find no effect of participation on absolute food poverty. Interestingly, program participation also significantly reduces the incidence of food poverty, defined by a calorie cut-off of 1,770 kcal/person/day following FAO/WHO/UNU (2004), which lies significantly below the cut-off used to calculate hard-core food poverty by BBS. We also find robust evidence that microcredit (measured as loan amount) reduces the likelihood of food poverty as the coefficient on incidence of food poverty is negative and significant, irrespective of the cut-off used.

One reason why the impact of program participation on absolute food poverty is insignificant could be that participation status improves calorie intake up to a certain point, but once that basic calorie need is satisfied, economic benefits do not get translated into increased calorie consumption. Instead, households diversify into higher-value micronutrient-rich foods. At this calorie threshold, non-food items, such as education and health care, may also receive preference over food items. In general, the results in Table 2 imply that participation in microcredit programs benefit households both at the intensive (calorie consumption) and extensive margins (likelihood of being food poor), particularly for those who are most vulnerable to food insecurity.

### 5.2 Impact on Nutritional Status of Children and Women of Reproductive Age

Next, we report the results for the effect of program participation on the nutritional status of children and women of reproductive age. Panel A in Table 3 presents the results for child nutritional status, while Panel B presents results for the nutritional status of women of reproductive age. The coefficients in Panel A of Table 3 show that program participation is associated with significant decline in the prevalence of stunting among children under the age of five. MCI participation reduces the prevalence of severe stunting by 19.2% as well as total stunting by 32.5%. The significant effects on stunting may be explained by the fact that stunting represents chronic or long term under nutrition, which is a consequence of prolonged

food deprivation. This can be intergenerational, in which poor nutrition of the mother results in low stature of the offspring via the effects of intrauterine growth retardation (Victoria et al., 2008). Stunting can also result from food deprivation in the first two years of life (Steckel, 2008). Since participation in microcredit provides a mechanism to build assets, which provides a cushion against risk (Barrett, 2002), microcredit participation, by allowing consumption smoothing and maintaining long run food consumption levels, can reduce vulnerability to food insecurity (Zeller and Sharma, 2000b) in the early years of life, which ultimately gets reflected in low height-for-age.

[Table 3]

However, participation in microcredit status does not have the same effect on wasting. Microcredit has a weakly significant effect on severe wasting, in which microcredit reduces the incidence of severe wasting by 7.35%. However, the effect of participation status on total wasting is insignificant. A possible explanation for why the impact of program participation on wasting is not as pronounced is that wasting represents short-term acute malnutrition which could be the result of some recent spell of disease or distress, and hence may not be a long-term household economic outcome resulting from participation in MCI. The results for underweight status presented in the last two columns of Panel A of Table 3 reveal that participation in MCI reduces the likelihood of being underweight (total) by 27.2 per cent, but has no impact on the likelihood of being severely underweight. The mixed results for being underweight likely reflect the fact that this indicator is a composite measure of stunting and wasting and, as such, reflects the mixed findings for the other two indicators.

The loan amount does not have any impact on any of the three anthropometric indicators, which is understandable as children's nutritional status may be driven more directly by the level of care, caregiver's educational level, access to health care, access to drinking water, good sanitation and overall environmental condition of the household, rather than through increased income from borrowing (Barrett, 2002; Jones et al., 2013).

We examine the effect of microcredit program participation on nutritional status of women of reproductive age in Panel B of Table 3. The results suggest that women of reproductive age in households which are participating in microcredit programs experience a significant decline in the incidence of being underweight and malnourished, as measured by MUAC (both severe and total malnutrition). Participation in MCI significantly reduces the prevalence of women of reproductive age being underweight by 6.51% and severe and total MUAC-

malnutrition by 3.55% and 3.52% respectively. The estimated coefficients of program participation on BMI and MUAC of reproductive age are insignificant, suggesting that, in general, the extent of malnutrition among women is caused more by gender related discrimination than economic deprivation (Mangyo, 2008). However, access to additional resources in the form of larger loan amounts from MCIs do have a significant positive effect on nutrition status of women of reproductive age, measured in terms of BMI and MUAC.

### 5.3 Impact on Dietary Diversity Indicators

The impact of microcredit program participation on different indicators of household dietary diversity is presented in Table 4. When food security is measured in terms of dietary diversity indicators, program participation is found to have a mixed impact, depending on the type of diversity indicator used. The overall results suggest that participation status does not have any significant impact on the standard measures of diversity in the household diet. It has no statistical effect on the number of food items (FVS) or the number of food groups (DDS) consumed, based on the 12-scale FANTA-HDDS. An explanation for this result is that increased additional income generated from participation in MCI in rural Bangladesh leads to increased calorie consumption, rather than having a positive effect on household dietary diversity. This behaviour can be explained by the previously discussed non-linearity in the calorie expenditure relationship. Below a certain threshold level of expenditure, households concentrate on acquiring additional level of calories (without corresponding increase in diversity); however, once that level is met, further increases in expenditure might cause both calories and dietary diversity to increase (Behrman and Deolalikar, 1987).

[Table 4]

The above argument is further corroborated by the fact that, in the nutrition literature, the number of unique foods or food groups consumed has been found to be more strongly associated with calories from non-staples (Hoddinot and Yohhanes, 2002). Moreover, given that the current sample consists of low income households, it is more likely that in the present case, additional calories resulting from increased income from MCI participation, have resulted from consuming staples, the association of which with unique food or unique food groups have not been found to be consistently strong (Hoddinot and Yohannes, 2002).

The household behaviour discussed so far becomes more prominent when we look at the impact of participation in MCI on the Gini-Simpson and Shannon indices. The estimated

coefficients for both these indices are significant and negative, implying that MCI-participation has reduced dietary diversity at the household level. This result implies that the impact of microcredit participation on food security in this case is not to increase diet quality, but to increase calorie consumption alone, which is consistent with household behaviour at low levels of income and follows directly from the results presented in Table 2. Access to microcredit (measured in terms of the loan amount) also has no impact on any of the dietary diversity indicators. The reasons for this are the same as outlined above.

[Tables 5-7]

As a robustness check for our primary estimation methodology, we estimated Equation (1) for the sub-sample of matched households. The PSM results are very similar to those presented in Tables 2-4. The PSM results corresponding to the regression results in Table 2 are presented in Table 5. Microcredit program participation is found to have a significantly positive impact on household calorie consumption per day (increases by 3.06%), per capita calorie consumption per day (increases by 2.30%) and negative effect on the incidence of hard-core food poverty, which declines by 4.36%. The PSM results corresponding to the regression results in Tables 3 and 4 are reported in Tables 6 and 7. The results are similar to those in Tables 3 and 4. We find evidence that participation in microcredit programs reduces the prevalence of stunting and malnutrition among children aged below five and the incidence of being underweight among women of reproductive age. Finally, we do not find any significant effect of participation status and access to microcredit on household dietary diversity, other than that observed for the Gini-Simpson and Shannon indices.

### 5.4 Duration of Membership and Household Food Security

In this subsection, we examine whether the length of membership of a microcredit program affects food security of the household. The return from microcredit is likely to vary with the length of participation. Microcredit borrowers receive a larger amount of loans as their length of participation increases and they maintain satisfactory progress in loan repayment. Hence, households may not realize the full returns until they receive larger loans to finance their investments. For this reason, results from solely short-term evaluations are likely to bias overall impacts of the program. To address this issue we follow Islam (2011), and categorize households based on their length of participation. Islam (2011) addresses potential selection bias as the participants who became members earlier could differ from those who join later. We follow a similar methodology below. The results reported here are robust to controlling for initial household characteristics including unobservables that are time invariant.

Accordingly, we define the first category as the continuing participants, who were regular microcredit participants in each of the three rounds. The second category is the newcomers1, who were not microcredit participants in the first round, but joined before the third round. The third category is the newcomers2, who were not microcredit participants in the first round, but joined between the third and fourth rounds. The fourth category is the leavers1, who were microcredit participants in the first round, but dropped out before the third round. The fifth category is the leavers2, who were microcredit participants in the first round, but dropped out between the third and fourth rounds. The final category is the drifters, who are occasional clients of MCIs, who do not fit readily into any of the first five categories. In our dataset across the three rounds, 47.2% were continuing participants, 9% were newcomers 1, 5% were newcomers 2, 11.3% were leavers1, 11% were leavers2 and 16.5% were drifters.

We estimate the effect of microcredit participation for each of these categories by comparing them with a benchmark/control group, which we term the non-participants; namely, those households that never participated in any of the microcredit programs, all ineligible households, eligible but non-participant households in the control villages[10] and eligible households in the program villages that chose not to participate.

[Table 8]

Results for each of the categories are presented in Table 8. We find significant differences in household level food security, measured in terms of calorie intake and incidence of food poverty, across categories of program participants. We find a significant effect of participation status on absolute calorie consumption and food poverty for continuing participants, which is robust across all specifications. The results presented in the first column of Table 8 indicate that compared to non-participating households, continuing participants consume 2.36% more calories and are less likely to be food poor – which declines by 4.59% for hard-core food poverty and 4.69% for total food poverty.

For newcomers1 and leavers1, however, we do not find evidence of any positive impact of MCI participation on food security. For newcomers1, this may suggest that households do not realize any gains from MCI participation in the short run in terms of investment-led or asset-led benefits. In fact, the situation may even deteriorate significantly first, before improving over time. As far as total food poverty is concerned, an immediate 'asset-effect' seems to be at work that motivates individuals to act in a more responsible manner (Gamble and

[10] Eligibility is based on the possession of less than 50 decimals of land or equivalent.

Prabhakar, 2005). As far as leavers1 are concerned, it is understandable that there is no impact on food security since they participated in MCI for one year only, which did not allow them sufficient time to realize the gains in terms of improved economic access.

While the results for newcomers2 are somewhat mixed, the impact on food security is larger for leavers 2 and drifters than for continuing participants. The overall results, however, imply that continuing participants consume less calories than drifters. An explanation is that while microcredit program participation improves food security of the household, continuing participants also invest in self-employment that increases household income and mitigates risk, instead of investing further resources in food and calorie consumption.

## 6. Conclusion

Despite the growth in food production and its availability, food insecurity is still a major problem in rural Bangladesh, particularly during the lean seasons when employment opportunities are sparse. Ability to borrow from MCIs assists households to diversify into self-employment based activities, whose returns do not vary much with agricultural production, thus smoothing consumption and improving household food security.

We have examined, for the first time, the impact of microcredit program participation on several indicators of food security. We focus on three different measures; namely, calorie intake – both at the extensive margin (incidence of food poverty) and intensive margin (absolute calorie consumption), anthropometric indicators (both female and child nutritional status) and dietary diversity indicators. Three main conclusions emerge. The first is that program participation and the amount of the loan improves calorie availability and reduces the incidence of food poverty, at least the incidence of hard-core poverty; however, microcredit participation does not increase dietary diversity. Second, if food security is measured in terms of anthropometric indicators, evidence is mixed. Microcredit participation decreases the incidence of stunting among children under the age of five, which reflects chronic malnutrition, suggesting that microcredit participation significantly improves long-term child health. The effect of microcredit participation on child wasting and being underweight is however weak and mixed. Women of reproductive age who participated in MCIs were less likely to be underweight and MUAC-malnourished, but participation has no effect on BMI and MUAC. Moreover, the loan amount has no effect on any of these anthropometric measures. Finally, the findings from the impact of duration of program participation, suggest that the effect of program participation on food security might be non-

linear over time. MCI participation either has no significant effect on food security, measured in terms of calorie consumption or food poverty, or might actually worsen it in the short run, before improving food security in the long run. More generally, these findings point to the importance of using longer-term program participation data to evaluate the effects of microcredit on long-term outcomes such as those we examine.

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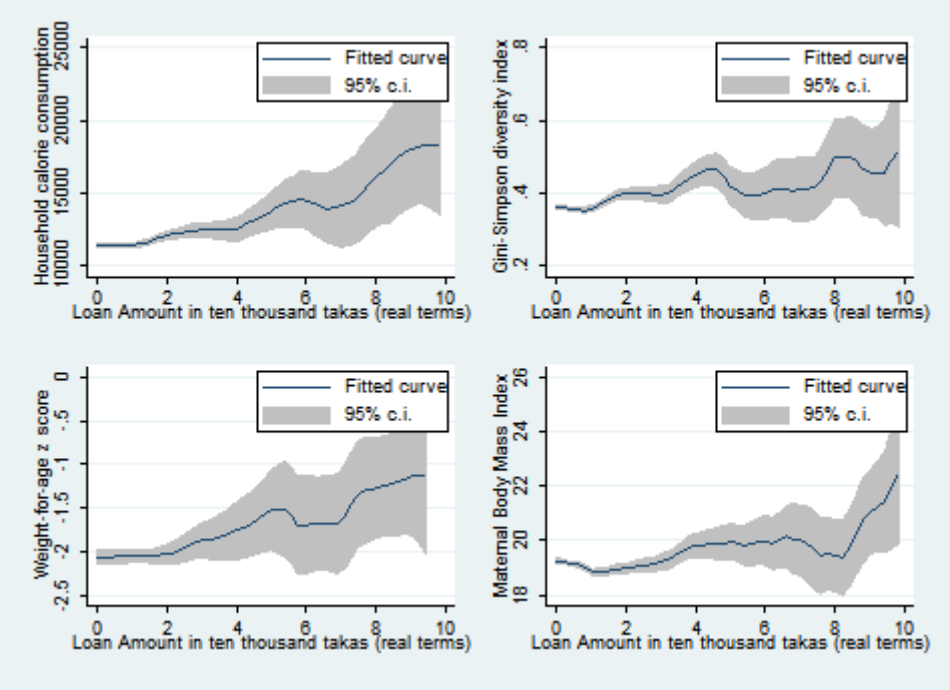
**Figure 1: Non-parametric relationship between Microcredit and Indicators of Household Food Security**




Note: Household calorie consumption is expressed as kilocalories. The Gini-Simpson diversity index is on a scale of 0 ("non-diverse") to 1 ("diverse" diet). A child under the age of five is considered underweight if weight-for-age z-score is less than -2. Loan amount is in ten thousand taka (adjusted by agricultural price index with 1997-98 as base year).

## Table 1: Summary statistics for food security indicators by participation status

| Variables of Interest | Participants | | Non-participants | | Difference |
|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | |
| Group A: Calorie consumption and Incidence of Food Poverty (FP) | | | | | |
| Household calorie consumption per day | 11559.42 | 5504.35 | 11531.80 | 6198.94 | 27.62 |
| Per capita calorie consumption per day | 1949.47 | 732.41 | 1944.23 | 772.02 | 5.25 |
| Equivalized calorie consumption per day | 4659.75 | 1743.83 | 4623.20 | 1872.39 | 36.56 |
| FP using cut-off of 1,805 kcal/person/day | 0.443 | 0.497 | 0.467 | 0.499 | -0.023** |
| FP using cut-off of 2,122 kcal/person/day | 0.633 | 0.482 | 0.637 | 0.481 | -0.003 |
| FP using cut-off of 1,770 kcal/person/day | 0.418 | 0.493 | 0.439 | 0.496 | -0.022* |
| Group B: Indicators of Dietary diversity | | | | | |
| Food Variety Score (FVS) | 16.72 | 8.16 | 17.51 | 8.25 | -0.797*** |
| Dietary Diversity Score (DDS) | 7.90 | 2.85 | 8.08 | 2.77 | -0.179*** |
| Gini-Simpson diversity index | 0.35 | 0.21 | 0.38 | 0.22 | -0.031*** |
| Shannon diversity index | 0.83 | 0.48 | 0.90 | 0.49 | -0.070*** |
| Group C: Indicators of Child's Nutrition status (0-59 month old) | | | | | |
| Severe stunting | 0.304 | 0.460 | 0.319 | 0.467 | -0.015 |
| Total stunting | 0.547 | 0.498 | 0.553 | 0.498 | -0.006 |
| Severe wasting | 0.092 | 0.290 | 0.070 | 0.255 | 0.022 |
| Total wasting | 0.269 | 0.444 | 0.234 | 0.424 | 0.035 |
| Severe underweight | 0.244 | 0.429 | 0.232 | 0.423 | 0.011 |
| Total underweight | 0.512 | 0.500 | 0.493 | 0.500 | 0.019 |
| Group D: Indicators of Nutrition Status of Women of Reproductive Age (15-49 years) | | | | | |
| Body Mass Index (BMI) | 19.05 | 2.91 | 19.37 | 3.12 | -0.326*** |
| Chronic underweight (BMI<16) | 0.107 | 0.309 | 0.105 | 0.307 | 0.002 |
| Underweight (BMI<18.5) | 0.1468 | 0.499 | 0.437 | 0.496 | 0.031** |
| Mid-upper arm circumference (MUAC) | 23.07 | 2.75 | 23.31 | 2.96 | -0.247*** |
| Severe malnutrition | 0.253 | 0.435 | 0.231 | 0.421 | 0.023** |
| Total malnutrition | 0.377 | 0.485 | 0.347 | 0.476 | 0.031** |

Notes: "Std. Dev" is standard deviation. The participants are households in which at least one individual is a member of one or more MCI during a given round. The "Difference" variable is the difference between the outcome variables of the treatment (participants) and control (non-participants) group. The reported p-values are from the two-tailed test with the null hypothesis that the group means are equal. *** p<0.01, ** p<0.05, * p<0.1. Child malnutrition is referred to as "severe" if the z-score is less than -3 and as "total" if it lies below -2 for all specifications (incidence of stunting, wasting and underweight). FVS is a measure of the number of food items while DDS accounts for the number of food groups consumed by the household.

## Table 2: Effects on calorie consumption (in log terms) and incidence of food poverty

| | Log of Household Calorie consumption per day | | Log of Per capita Calorie consumption per day | | Log of Equivalized Calorie consumption per day | |
|---|---|---|---|---|---|---|
| Panel A: Calorie consumption (in log terms) | | | | | | |
| Participation status | 0.0311** | | 0.0234* | | 0.0272** | |
| | (0.0141) | | (0.0137) | | (0.0138) | |
| Log of Loan Amount | | 0.0264*** | | 0.0304*** | | 0.0284*** |
| | | (0.00765) | | (0.00773) | | (0.00764) |
| Observations | 7,475 | 3,669 | 7,475 | 3,669 | 7,475 | 3,669 |
| R-squared | 0.110 | 0.134 | 0.254 | 0.297 | 0.147 | 0.185 |
| Number of Households | 2,692 | 1,842 | 2,692 | 1,842 | 2,692 | 1,842 |
| | Hard-core food poverty | | Absolute food poverty | | Food poverty using the FAO cut-off | |
| Panel B: Incidence of Food Poverty (using cut-offs) | | | | | | |
| Participation status | -0.0435** | | -0.0225 | | -0.0330* | |
| | (0.0179) | | (0.0157) | | (0.0180) | |
| Log of Loan Amount | | -0.0466*** | | -0.0433*** | | -0.0515*** |
| | | (0.00973) | | (0.0102) | | (0.00976) |
| Observations | 7,475 | 3,669 | 7,475 | 3,669 | 7,475 | 3,669 |
| R-squared | 0.189 | 0.245 | 0.190 | 0.227 | 0.182 | 0.234 |
| Number of Households | 2,692 | 1,842 | 2,692 | 1,842 | 2,692 | 1,842 |

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure and total assets (including livestock). All specifications also control for year and household fixed effects. We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Loan Amount is in ten thousand taka in real terms. Equivalized calorie consumption is defined as household calorie consumption divided by the square root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hardcore food poverty respectively). The FAO cut-off is 1,770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5,000 kcal, following Heady and Ecker (2013).

## Table 3: Effects on nutritional status of child and women of reproductive age

| | Severe stunting | | Total stunting | | Severe wasting | | Total wasting | | Severe underweight | | Total underweight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Child Nutrition Status (0-59 month old) | | | | | | | | | | | | |
| Participation status | -0.192*** | | -0.325*** | | -0.0735* | | 0.0545 | | 0.0167 | | -0.272*** | |
| | (0.0729) | | (0.0875) | | (0.0434) | | (0.107) | | (0.0676) | | (0.0690) | |
| Log of Loan Amount | | 0.00230 | | -0.0375 | | -0.0126 | | 0.0636 | | 0.00534 | | 0.0152 |
| | | (0.0286) | | (0.0671) | | (0.0321) | | (0.0898) | | (0.0558) | | (0.0494) |
| Observations | 1,245 | 739 | 1,245 | 739 | 1,198 | 722 | 1,198 | 722 | 1,377 | 809 | 1,377 | 809 |
| R-squared | 0.099 | 0.163 | 0.109 | 0.139 | 0.086 | 0.072 | 0.049 | 0.101 | 0.059 | 0.133 | 0.112 | 0.144 |
| Number of Households | 943 | 571 | 943 | 571 | 918 | 559 | 918 | 559 | 1,025 | 611 | 1,025 | 611 |

| | Body Mass Index (BMI) | | Incidence of chronic Underweight | | Incidence of Underweight | | Mid-upper arm circumference (MUAC) | | Severe malnutrition | | Total malnutrition | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel B: Nutrition Status of Women of Reproductive Age (15-49 years) | | | | | | | | | | | | |
| Participation status | 0.105 | | -0.0146 | | -0.0651*** | | 0.172 | | -0.0355* | | -0.0352* | |
| | (0.109) | | (0.0147) | | (0.0203) | | (0.107) | | (0.0186) | | (0.0193) | |
| Log of Loan Amount | | 0.165** | | -0.0132 | | 0.0205 | | 0.144* | | -0.00108 | | -0.0380** |
| | | (0.0679) | | (0.0109) | | (0.0142) | | (0.0782) | | (0.0123) | | (0.0159) |
| Observations | 3,828 | 2,105 | 3,828 | 2,105 | 3,828 | 2,105 | 3,766 | 2,065 | 3,766 | 2,065 | 3,766 | 2,065 |
| R-squared | 0.234 | 0.223 | 0.031 | 0.062 | 0.145 | 0.157 | 0.081 | 0.075 | 0.049 | 0.060 | 0.040 | 0.055 |
| Number of Households | 2,178 | 1,384 | 2,178 | 1,384 | 2,178 | 1,384 | 2,157 | 1,362 | 2,157 | 1,362 | 2,157 | 1,362 |

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, total assets (including livestock) and per capita calorie consumption per day. All specifications also control for year and household fixed effects. Panel A also includes age and gender of the child, while Panel B also includes age, marital status of the individual, education level (illiterate, can read only, can sign only, can read and write), and family type (extended or not). We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Loan Amount is in ten thousand taka in real terms. Total is defined as either moderate or severe. The exclusion criterion used for child malnutrition in Bangladesh is as follows – for weight-for-height z-scores (wasting) it is -4 and 5, for weight-for-age (underweight) -5.66 and 2.34 and -5.75 and 2.25 for height-for-age (stunting) using BBS/UNICEF (2007, Table 3). Chronic underweight is below a BMI of 16, while underweight is below BMI 18.5, following WHO (1995) and BBS/UNICEF (2007, Table 2). All BMI lies within the recommended limits of 12 and 40 for Bangladesh, following BBS/UNICEF (2007).

## Table 4: Effects on different indicators of dietary diversity

| | Food Variety Score | | Dietary Diversity Score | | Gini-Simpson Diversity Index | | Shannon Diversity Index | |
|---|---|---|---|---|---|---|---|---|
| Participation status | -0.176 | | -0.109 | | -0.0218*** | | -0.0441** | |
| | (0.281) | | (0.109) | | (0.00794) | | (0.0179) | |
| Log of Loan Amount | | -0.00118 | | 0.0590 | | -0.00653 | | -0.0130 |
| | | (0.163) | | (0.0594) | | (0.00450) | | (0.00997) |
| Observations | 8,051 | 3,910 | 8,051 | 3,910 | 8,051 | 3,910 | 8,051 | 3,910 |
| R-squared | 0.434 | 0.564 | 0.368 | 0.472 | 0.216 | 0.267 | 0.233 | 0.295 |
| Number of Households | 2,694 | 1,874 | 2,694 | 1,874 | 2,694 | 1,874 | 2,694 | 1,874 |

Notes: All specifications include the covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, and total assets (including livestock). All specifications control for year and household fixed effects. We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Food Variety Score (FVS) is a measure of the number of food items while Dietary Diversity Score (DDS) accounts for the number of food groups consumed, based on the 12 scale FANTA-HDDS. The Gini-Simpson and Shannon indices establish a continuum between a "diverse" and a "non-diverse" diet, in which zero represents a "non-diverse" diet and the level of diversity increases with the value.

## Table 5: Regression-PSM results: Effects on calorie consumption (in log terms) and incidence of food poverty

| | Log of Household Calorie consumption per day | | Log of Per capita Calorie consumption per day | | Log of Equivalized Calorie consumption per day | |
|---|---|---|---|---|---|---|
| Panel A: Calorie consumption (in log terms) | | | | | | |
| Participation status | 0.0306** | | 0.0230* | | 0.0268* | |
| | (0.0141) | | (0.0137) | | (0.0138) | |
| Log of Loan Amount | | 0.0280*** | | 0.0321*** | | 0.0301*** |
| | | (0.00764) | | (0.00770) | | (0.00762) |
| Observations | 7,445 | 3,640 | 7,445 | 3,640 | 7,445 | 3,640 |
| R-squared | 0.110 | 0.138 | 0.254 | 0.301 | 0.146 | 0.188 |
| Number of Households | 2,692 | 1,837 | 2,692 | 1,837 | 2,692 | 1,837 |
| | Hard-core food poverty | | Absolute food poverty | | Food poverty using the FAO cut-off | |
| Panel B: Incidence of Food Poverty (using cut-offs) | | | | | | |
| Participation status | -0.0436** | | -0.0196 | | -0.0326* | |
| | (0.0180) | | (0.0157) | | (0.0181) | |
| Log of Loan Amount | | -0.0485*** | | -0.0480*** | | -0.0535*** |
| | | (0.00961) | | (0.0102) | | (0.00964) |
| Observations | 7,445 | 3,640 | 7,445 | 3,640 | 7,445 | 3,640 |
| R-squared | 0.188 | 0.248 | 0.189 | 0.230 | 0.181 | 0.237 |
| Number of Households | 2,692 | 1,837 | 2,692 | 1,837 | 2,692 | 1,837 |

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, and total assets (including livestock). All specifications also control for year and household fixed effects. We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Loan Amount is in ten thousand taka in real terms. Equivalized calorie consumption is defined as household calorie consumption divided by the square root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hard core food poverty respectively). The FAO cut-off is 1,770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5,000 kcal, following Heady and Ecker (2013).

## Table 6: Regression-PSM results: Effects on nutritional status of children and women of reproductive age

| | Severe stunting | | Total stunting | | Severe wasting | | Total wasting | | Severe underweight | | Total underweight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Child Nutrition Status (0-59 month old) | | | | | | | | | | | | |
| Participation status | -0.156** | | -0.291*** | | -0.0707 | | 0.0722 | | 0.0365 | | -0.257*** | |
| | (0.0718) | | (0.0919) | | (0.0438) | | (0.110) | | (0.0675) | | (0.0692) | |
| Log of Loan Amount | | 0.0150 | | -0.0249 | | -0.00708 | | 0.0711 | | 0.0136 | | 0.0158 |
| | | (0.0319) | | (0.0626) | | (0.0324) | | (0.0913) | | (0.0580) | | (0.0512) |
| Observations | 1,229 | 724 | 1,229 | 724 | 1,182 | 707 | 1,182 | 707 | 1,359 | 792 | 1,359 | 792 |
| R-squared | 0.106 | 0.176 | 0.112 | 0.131 | 0.086 | 0.074 | 0.050 | 0.103 | 0.062 | 0.143 | 0.116 | 0.144 |
| Number of Households | 933 | 561 | 933 | 561 | 908 | 549 | 908 | 549 | 1,014 | 600 | 1,014 | 600 |

| | BMI | | chronic Underweight | | Underweight | | MUAC | | Severe malnutrition | | Total malnutrition | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel B: Nutrition Status of Women of Reproductive Age (15-49 years) | | | | | | | | | | | | |
| Participation status | 0.0738 | | -0.0139 | | -0.0593*** | | 0.159 | | -0.0328* | | -0.0335* | |
| | (0.109) | | (0.0148) | | (0.0207) | | (0.109) | | (0.0189) | | (0.0197) | |
| Log of Loan Amount | | 0.146** | | -0.00817 | | 0.0249* | | 0.121 | | 0.000926 | | -0.0299* |
| | | (0.0704) | | (0.0110) | | (0.0144) | | (0.0802) | | (0.0129) | | (0.0163) |
| Observations | 3,799 | 2,077 | 3,799 | 2,077 | 3,799 | 2,077 | 3,737 | 2,037 | 3,737 | 2,037 | 3,737 | 2,037 |
| R-squared | 0.236 | 0.229 | 0.031 | 0.062 | 0.145 | 0.161 | 0.080 | 0.074 | 0.049 | 0.058 | 0.038 | 0.049 |
| Number of Households | 2,170 | 1,373 | 2,170 | 1,373 | 2,170 | 1,373 | 2,149 | 1,351 | 2,149 | 1,351 | 2,149 | 1,351 |

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, total assets (including livestock) and per capita calorie consumption per day. All specifications also control for year and household fixed effects. Panel A also includes age and gender of the child, while Panel B also includes age, marital status of the individual, education level (illiterate, can read only, can sign only, can read and write), and family type (extended or not). We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Loan Amount is in ten thousand taka in real terms. Total is defined as either moderate or severe. The exclusion criterion used for child malnutrition in Bangladesh is as follows – for weight-for-height z-scores (wasting) it is -4 and 5, for weight-for-age (underweight) -5.66 and 2.34 and -5.75 and 2.25 for height-for-age (stunting) using BBS/UNICEF (2007, Table 3). Chronic underweight is below a BMI of 16, while underweight is below BMI 18.5, following WHO (1995) and BBS/UNICEF (2007, Table 2). All BMI lies within the recommended limits of 12 and 40 for Bangladesh, following BBS/UNICEF (2007).

## Table 7: Regression-PSM results: Effects on different indicators of dietary diversity

| Variables of Interest | Food Variety Score | | Dietary Diversity Score | | Gini-Simpson Diversity Index | | Shannon Diversity Index | |
|---|---|---|---|---|---|---|---|---|
| Participation status | -0.142 | | -0.103 | | -0.0219*** | | -0.0437** | |
| | (0.283) | | (0.110) | | (0.00803) | | (0.0181) | |
| Log of Loan Amount | | -0.0100 | | 0.0607 | | -0.00665 | | -0.0134 |
| | | (0.165) | | (0.0595) | | (0.00450) | | (0.00996) |
| Observations | 8,020 | 3,880 | 8,020 | 3,880 | 8,020 | 3,880 | 8,020 | 3,880 |
| R-squared | 0.433 | 0.563 | 0.367 | 0.471 | 0.216 | 0.265 | 0.232 | 0.292 |
| Number of Households | 2,694 | 1,869 | 2,694 | 1,869 | 2,694 | 1,869 | 2,694 | 1,869 |

Notes: All specifications include the covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, and total assets (including livestock). All specifications control for year and household fixed effects. We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Food Variety Score (FVS) is a measure of the number of food items while Dietary Diversity Score (DDS) accounts for the number of food groups consumed, based on the 12 scale FANTA-HDDS. The Gini-Simpson and Shannon indices establish a continuum between a "diverse" and a "non-diverse" diet, in which zero represents a "non-diverse" diet and the level of diversity increases with the value.

**Table 8: Impact of the duration of program participation on calorie consumption and incidence of food poverty**

| | Continuing Participants | Drifters | Newcomers1 | Newcomers2 | Leavers1 | Leavers2 |
|---|---|---|---|---|---|---|
| Panel A: Measures of Calorie consumption (in log terms) | | | | | | |
| Log of Household Calorie consumption per day | 0.0236*** | 0.0348* | -0.0110 | -0.0253 | -0.115* | 0.0431 |
| | (0.00881) | (0.0180) | (0.0424) | (0.0238) | (0.0660) | (0.0322) |
| Log of Per capita Calorie consumption per day | 0.0262*** | 0.0462*** | -0.0143 | -0.0402 | -0.115* | 0.0677** |
| | (0.00889) | (0.0170) | (0.0402) | (0.0247) | (0.0628) | (0.0300) |
| Log of Equivalized Calorie consumption per day | 0.0249*** | 0.0405** | -0.0127 | -0.0327 | -0.115* | 0.0554* |
| | (0.00881) | (0.0173) | (0.0412) | (0.0242) | (0.0641) | (0.0308) |
| Panel B: Indicators of Household Food Poverty (using cut-offs) | | | | | | |
| Incidence of food poverty (hard core) | -0.0459*** | -0.0501** | 0.0952 | 0.170*** | -0.00748 | -0.0810** |
| | (0.0111) | (0.0233) | (0.109) | (0.0613) | (0.0564) | (0.0356) |
| Incidence of food poverty (absolute) | -0.0469*** | -0.0274 | 0.130** | -0.0780*** | -0.00165 | -0.130*** |
| | (0.0114) | (0.0237) | (0.0582) | (0.0260) | (0.0424) | (0.0435) |
| Incidence of food poverty (FAO cut-off) | -0.0504*** | -0.0585*** | 0.0927 | 0.241*** | -0.00748 | -0.106*** |
| | (0.0112) | (0.0220) | (0.115) | (0.0510) | (0.0564) | (0.0325) |

Notes:
All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 6-15, number of women in the household, number of old people in the household, gender of household head, number of married people in the household, total expenditure, and total assets (including livestock). All specifications also control for year and household fixed effects. We correct standard errors for village-year clusters. Clustered standard errors are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Loan Amount is in ten thousand taka in real terms. Equivalized calorie consumption is household calorie consumption divided by the root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hardcore food poverty respectively). The FAO cut-off is 1,770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5,000 kcal, following Heady and Ecker (2013).

## Appendix Table A1: Results of the Propensity Score Matching Balance Test

| | Mean | | | t-test | |
|---|---|---|---|---|---|
| Variables of Interest | Treated | Control | %bias | t | p>\|t\| |
| Age of the household head | 43.893 | 43.783 | 0.8 | 0.250 | 0.801 |
| Age of household head squared | 2075.5 | 2067.0 | 0.6 | 0.210 | 0.837 |
| Working age people in the household | 2.786 | 2.791 | -0.4 | -0.110 | 0.916 |
| Household size | 5.656 | 5.711 | -2.4 | -0.670 | 0.504 |
| Maximum education by any household member | 5.268 | 5.216 | 1.2 | 0.350 | 0.723 |
| Total arable land owned (in decimals) | 55.80 | 59.12 | -2.2 | -0.850 | 0.394 |
| Number of children in the household | 2.904 | 2.889 | 0.9 | 0.260 | 0.793 |
| Number of women in the household | 2.686 | 2.729 | -3.1 | -0.840 | 0.402 |
| Number of old people in the household | 0.208 | 0.212 | -0.7 | -0.200 | 0.843 |
| A Woman is the household head | 0.045 | 0.045 | 0.2 | 0.050 | 0.959 |
| Number of married people in the household | 2.378 | 2.413 | -3.2 | -0.870 | 0.385 |
| Health facilities in the village | 0.176 | 0.158 | 4.7 | 1.330 | 0.185 |
| Madrasha in the village | 0.898 | 0.897 | 0.3 | 0.090 | 0.925 |
| Primary school in the village | 0.860 | 0.851 | 2.6 | 0.700 | 0.482 |
| Secondary school in the village | 0.337 | 0.340 | -0.5 | -0.150 | 0.880 |
| Adult male wage | 56.932 | 57.042 | -0.6 | -0.170 | 0.865 |
| Adult female wage | 32.636 | 32.892 | -2.0 | -0.560 | 0.573 |
| Presence of pucca road in the village | 0.348 | 0.341 | 1.6 | 0.430 | 0.667 |
| Presence of grocery market in the village | 0.231 | 0.232 | -0.3 | -0.080 | 0.939 |
| Presence of frequent haat (big market) | 0.323 | 0.343 | -4.3 | -1.190 | 0.232 |
| Presence of bus stand in the village | 0.150 | 0.143 | 2.0 | 0.560 | 0.578 |
| Presence of post office in the village | 0.197 | 0.201 | -0.9 | -0.260 | 0.794 |
| Presence of telephone office in the village | 0.062 | 0.053 | 3.8 | 1.150 | 0.248 |
| Presence of Union Parishad office | 0.138 | 0.142 | -1.2 | -0.330 | 0.741 |
| Youth organization in the village | 0.150 | 0.143 | 2.0 | 0.560 | 0.578 |
| Distance to nearest Upazila (in kms) | 7.189 | 7.114 | 1.2 | 0.360 | 0.722 |
| Share of landowner in share-cropping | 47.561 | 47.555 | 0.1 | 0.020 | 0.981 |
| Number of moneylenders in the village | 8.021 | 8.119 | -0.9 | -0.250 | 0.800 |
| Large farmers/traders in the village | 3.785 | 3.800 | -0.2 | -0.060 | 0.954 |
| Small credit/savings groups in the village | 0.805 | 0.769 | 2.6 | 0.710 | 0.476 |
| Number of Low Lift Pumps | 0.429 | 0.334 | 3.9 | 1.230 | 0.221 |
| Number of Shallow Tube Wells | 12.744 | 13.255 | -2.7 | -0.750 | 0.452 |
| Number of Hand Tube Wells in Irrigation | 2.295 | 2.497 | -2.1 | -0.550 | 0.581 |
| Number of Hand Tube Wells in drinking water | 80.513 | 81.505 | -1.2 | -0.350 | 0.726 |
| Number of Deep Tube Wells | 0.287 | 0.286 | 0.3 | 0.100 | 0.924 |