Microcredit Program Participation and Household Food Security in Rural Bangladesh

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Abstract

We use a relatively new and unique panel dataset collected from rural households in Bangladesh to examine the effect of microcredit program participation on household food security. The main distinguishing feature of our analysis is that no other study, to the best of our knowledge, has made an attempt so far to systematically measure the impact of participation status on different measures of food insecurity — household calorie consumption, dietary diversity indicators and nutritional status of mother and children. The detailed nature of the dataset also allows us to analyze the impact of the duration of participation in such programs on the food security situation of the household. The overall results of the paper suggest that program participation reduces both the incidence and intensity of food insecurity in rural Bangladesh – it increases household and per capita calorie consumption, reduces the incidence of food poverty and the prevalence of malnutrition, but has no significant effect on the dietary diversity indicators of the household.

Keywords: microcredit, food security, calorie availability, malnutrition, dietary diversity.

JEL Classification: G21, I14, I3, Q18

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1 Introduction

Bangladesh has witnessed significant reduction in poverty over the last two decades, however, there remains widespread poverty and hunger both at the national and regional levels. In rural Bangladesh, most of the income of a poor household is derived from the agricultural sector, which exposes households to the seasonality in agricultural employment, poverty and consumption (Dercon and Krishnan, 2000; Dostie et al., 2002; Khandker et al., 2012). Income from non-agricultural sources could safeguard households against such seasonal food insecurity, however, they may lack the necessary resources to diversify into more productive employment opportunities, which could help them cope with difficult times. Low income levels and lack of access to credit prevent households from accessing food, particularly during lean seasons, leaving them susceptible to food deprivation, even when aggregate food supplies are adequate. Microcredit bridges this gap left behind by the formal institutions by 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.

Access to credit may lead to 'investment-led' benefits, which result in greater levels of income, consumption and wealth. There exist now a large number of studies examining the impact of microcredit on self-employment activities (McKernan, 2002; Islam and Pakrashi, 2014), the expansion of existing business enterprises (Banerjee et. al., 2013, Dupas and Robinson, 2013) and business profits (McKernan, 2002; de Mel et. al., 2008; Skoufias, et. al., 2013; Crepon et al., 2013). As a secondary effect, microcredit program participation can also lead to 'insurance-led' benefits that can protect households against unforeseen risk and seasonality. MCI participation and access to microcredit prevents income from falling to such low levels that households are unable to satisfy the basic consumption needs (Sharma, 2000), by smoothing the income and consumption of poor rural households by allowing them to diversify into more profitable self-employment based activities (Gerter, Levine & Moretti, 2009; Islam and Maitra, 2012; Islam and Pakrashi, 2014) that insures them against any seasonality in consumption (Jacoby and Skoufias, 1998; Kochar, 1995; Khandker et al., 2012).

Microcredit also helps to promote social, human and economic development in various ways: it leads to higher income and better livelihoods (Pitt and Khandker, 1998; Karlan and Zinman, 2010; Imai, Thankom, and Annim, 2010; Islam, 2011), results in consumption smoothing, asset building (Pitt and Khandker 1998; Kaboski and Townsend, 2005; Khandker, 2005), reduces

household vulnerability (Amin, et. al. 2003; Islam and Maitra, 2012), improves health and nutrition (Pitt, Khandker, Chowdhury, and Millimet, 2003), children's schooling (Pitt and Khandker, 1998) and women's empowerment (Pitt, Khandker and Cartwright, 2006). The findings also indicate higher benefits accruing from long-term participation in such programs (Berhane and Gardebroek, 2010; Islam, 2011; Khandker and Samad, 2013; Islam and Pakrashi, 2014).

Despite the plethora of empirical work on the impact of microcredit on income, poverty, assets, business profits (see, for example, Pitt and Khandker, 1998; Islam, 2011; Banerjee et al., 2013), no attempt has been made so far to assess its impact on the food security situation in rural Bangladesh. We use a new and unique dataset to systematically analyze the effect of microcredit program participation both on the incidence and the extent of household food insecurity. We examine the issue using different indicators of food security – absolute level of calorie intake and shortfall from standard cut-offs of calorie norms, dietary diversity of the households and anthropometric indicators for children below five years (stunting, wasting and underweight) and women of reproductive age (15-49) years (focussing on BMI and mid-upper arm circumference).

We find robust evidence that households, which have access to institutional credit in rural Bangladesh are more likely to be food secured. The results indicate that as far as participation in MCI is concerned, it improves the food security situation of the household and the impact is fairly robust with respect to the alternative indicators of food security. We find evidence that microcredit program participation reduces both the incidence and intensity of food insecurity — it increases dietary calorie (energy) consumption, and reduces the incidence of food poverty, dietary diversity and the prevalence of malnutrition in the household. The effect is however mixed, when we consider the impact of the loan amount.

The paper is structured as follows. The next section provides background information on the concept and measurement of food security. Section 3 presents a simple conceptual framework to understand the pathways through which microcredit affects food security, followed by a brief discussion of the microcredit program, the important aspects of the data and the different indicators that we use to measure household food insecurity, in Section 4. Section 5 discusses the alternative estimation methodologies that we use to assess the impact of microcredit program participation on the food security situation of the household. Section 6 presents the

estimated results for calorie intake, incidence of food poverty, dietary diversity, nutritional status, and the impact of the duration of program participation on the same. A brief conclusion is finally presented in the last section of the paper.

2 Concept and Measurement of Food Security

The most recent and acceptable definition of food security as advanced by the World Food Summit 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" (FAO, 1996). This definition is comprehensive but operationally complex as it incorporates several dimensions into the concept of food security, which makes measurement a challenging task.

FAO (1996) recognized 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 which are food secure today may be at the risk of future food insecurity, has also been added as a new dimension to the measurement of food security. Since, no single indicator can capture all of the above dimensions, the use of multiple tools and approaches to assess food security therefore seems appropriate but complicates the evaluation of the impact of such programs on food security.

For the purpose of the present study, following Frankenberger (1992), we use outcome indicators of food security which are usually proxies for measuring food consumption. Some of the most common direct outcome indicators are household calorie availability computed from the Household Consumption and Expenditure Surveys (HCES), dietary diversity indicators, and direct experience-based measures which are able to capture the psychological dimensions of food security, for example, uncertainties and worries (Barrett, 2002; Heady and Ecker, 2012; Jones et al., 2013). In addition, indirect outcome indicators which measure the consequences of food insecurity via anthropometric indicators are also widely used in the food security literature.

Calorie deprivation is one of the oldest indicators of food insecurity. It is measured by the Food and Agriculture Organization of the United Nations (FAO) at the country level based on national food balance sheets, and at the household level using consumption and expenditure data available in standard Household Consumption and Expenditure Surveys (HCES) such as

the World Bank's Living Standards Measurement Study (LSMS). Increased availability of HCES and improved computational capabilities have made calorie intake one of the most widely used indicators of food security.

Dietary diversity indicators can also be effective food and nutrition security indicators for two main reasons. First, standard definitions of both food and nutrition security emphasize the importance of both macro- and micronutrients (FAO 1996)[4] and dietary diversity is supposed to capture consumption of both types of nutrients, or a more balanced diet in general (Ruel 2002; 2003). Second, there are evidences in the literature that the household purchases additional taste and non-calorie nutrients as income goes up (Wolfe and Behrman, 1983; Behrman and Deolalikar, 1987; Bouis and Haddad, 1992) and therefore the calorie-income curve is essentially flat, even among the very poor. Additionally, dietary diversity indicators have consistently demonstrated positive association with both nutrient quality of diets (Steyn et. al., 2006), child anthropometry (Rah et al., 2010) and household calorie (energy) availability (Hoddinot and Yohannes, 2002; Hatloy et al., 2000).

The most commonly used dietary diversity indicators are the food variety score (FVS), which provides a count of the number of different food items consumed, the dietary diversity score (DDS) — the number of different food groups consumed (Hoddinott, 1999a and 1999b; Hoddinott and Yohannes, 2002), and the food frequency score (FFS), based on the frequency of consumption of different food groups over a given period of time (Carletto, et.al, 2012).

Compared to the direct outcome indicators, discussed so far, nutritional status captured via anthropometric indicators is the most popular indirect outcome indicator as they are particularly sensitive to changes in the food security situation of a household (Young and Jasper, 2006). Anthropometric indicators, however, measure something more than just food security as nutritional status is the result of not only food intake but also a complex range of factors such as sanitation, health and child care practices. They are less subject to systematic measurement errors (Barrett, 2002), can be disaggregated to provide individual-level information (Frankenberger, 1992) and are well suited for monitoring and evaluating program interventions. The anthropometric indicators are therefore widely used to understand the demographic dynamics of nutritional status within a household — particularly of mothers and

[4] Micronutrient deficiency, sometimes termed "hidden hunger", has always been a serious threat to food security. However, it started to receive the serious attention of the international nutrition community in the mid-1980s. It does not produce hunger as we know it, having no visible warning signs, so that people who suffer from it may not even be aware of it, but it strikes at the core of their health and vitality.

infants as they are among the most vulnerable in the society. A mother's nutritional status is an important indicator of her own health (Victoria et al, 2008) and a crucial determinant of the nutritional status and overall development of their children (Behrman et al., 2004).

3 The Conceptual Framework

We consider a simple analytical framework to understand the pathways through which microcredit program participation affect the household calorie consumption and food insecurity. Demand for calories can be estimated in this theoretical model within the framework of consumer demand theory, which incorporates the demand for characteristics (Lancaster, 1966) with a household production theory (Becker, 1965).[5] Drawing from 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 their income and time, given food and other goods prices. The reduced-form nutrient demand equation for this optimization problem then takes the following form:

$$N = y(P_f, P_0, V, w, K, D) \qquad (2)$$

where, P_f is a vector of food prices, P_0 is a vector of prices of other goods, w is the wage rate, V represents non-wage income, K is a vector of capital goods, including human capital, assets as well as land and D 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 intake. Let C_a represent the household's absolute level of calorie (energy) availability, an important component of the nutrient vector, which is a function of prices, wages, non-labour income, capital, socio-economic and demographic characteristics of the household. Lack of access to food or food insufficiency occurs when the household's calorie intake falls below some minimum threshold level of calorie (energy) consumption, set at some pre-determined level, C_{min}, referred to as the minimum energy requirement.

[5] For examples of models used to examine food insecurity in a developing world context, see Barrett (2002).

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

$$A_h = 1 \; if \; C_a < C_{min}$$

$$= 0 \; otherwise$$

Two alternative models of household food insecurity can then be established and estimated using the theoretical framework discussed so far — 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 mothers and children in the household, following UNICEF (1990) and Garett and Ruel (1999). Since the study intends to address the issue of food security at the household level only, nutritional status of children under the age of five and that of non-pregnant women of reproductive age are considered as proxy indicators for the level of food utilization within the household.

Following Garett and Ruel (1999), 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. Guided by the underlying biological and economic determinants of nutritional status (UNICEF 1990), nutrition can be represented by the following function

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

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

Access to microcredit provided by the MCIs increases the available resources and relaxes the budget constraints faced by the households. Increases in the calorie (energy) intake of the households, however, depends 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 the participating households and indirectly by increasing their dietary intake.

4. The Microcredit Programs and the Data

The microcredit sector in Bangladesh is one of the largest and oldest programs in the world. The growth in the number of microcredit institutions (hereafter MCIs) and total membership has been phenomenal since the 1980s. The data used in this paper covers a wide range of MCIs that vary both in terms of their loan disbursements and coverage. ASA and Proshikha, the third and fourth largest MCIs in Bangladesh provides both credit and savings services on a remarkably large scale. Notable other MCIs include the Society for Social Services (SSS) and Thengamar Mohila Sabuj Sangha (TMSS). As of December 2004, SSS was the tenth largest MCI in Bangladesh in terms of cumulative disbursements and outstanding borrowers, while TMSS is also among the top fifty MCIs in Bangladesh. The other MCIs are relatively small but have similar types of program activities.

All of these MCIs follow the Grameen Bank style lending procedure, providing microcredit to households with less than 50 decimals (half an acre) of land — particularly to groups of women who are jointly liable for the repayment of the loan in the absence of any collateral requirement (Turnell, 2010). Loans in the range of US$40 - $150 are primarily made available to the households for any profitable and socially acceptable income generating activities, but members are allowed to take larger loans once they have repaid their first loan.

The data used in this paper were collected primarily by the Bangladesh Institute of Development Studies (BIDS), with financial assistance from the World Bank, to monitor and assess the impact of the Palli Karma-Sahayak Foundation[6] (hereafter PKSF) MCIs. Covering about 3,000 households selected from 91 program and control villages spread over 23 thanas (sub-districts) from 13 of Bangladesh's 64 districts, this dataset is one of its kind and supposedly the largest microfinance survey ever conducted in Bangladesh or worldwide. The first survey was administered after a census of all households in the 91 villages during October 1997. The participating households were drawn from 13 different MCIs of PKSF, each from a separate district, so as to be representative of all MCIs in Bangladesh. The survey was initially designed to have two control villages and six program villages from each of the areas where the MCI was operating. However, as not enough control villages could be found in all areas, only a total of 11 control villages were included in the first round. The final round of survey

[6] Palli Karma-Sahayak Foundation (PKSF) works as a regulatory organization for the MCIs in Bangladesh, established to monitor the activities of these large numbers of MCI and to lend out donor and other funds to its partner organisations (PO) for microcredit. The first author was also personally involved in the data collection, monitoring and report writing.

eventually covered only 8 control villages as some of the control villages turned into program villages in the subsequent rounds of the survey.

Four rounds of the survey were conducted (in 1997-98, 1998-99, 1999-2000 and 2004-05) over a period of eight years[7] to construct the BIDS-PKSF dataset, which contains detailed information regarding the household's income-expenditure, housing-living, socio-economic conditions, health status and anthropometry. The household survey has separate modules dedicated to the collection of detailed information on the food consumption behaviour of the households and anthropometric data for all household members. Out of the four rounds of the survey that were conducted, for the purpose of our analysis we only use data from the first, third and fourth round, as the second round did not collect comprehensive information on personal and household characteristics.

The final dataset comprises of an unbalanced panel of 2577 households from the first round, 2540 from the third and another 2358 households from the last round. The attrition rate[8] at the household level is reasonably low and does not pose any concern for our analysis (see Islam, 2011 for details). We also conducted the analysis separately for the attritions and stayers in the survey with respect to their consumption behaviour, but did not find any difference between these two groups. Hence, our results are not corrected for attrition bias.

We use the participation status of households during a round to understand the differences in the food security situation between the microcredit participants and non-participants. We define households as participants (the treatment group) if any individual within the household is a member of one or more of the MCIs, during a particular round of the survey, while non-participants households are not members of any MCI. We also use the total amount (loan) borrowed by the participating households in any particular year as an alternative definition of program participation to check the robustness of our results.

4.1 Measuring Household Food Security

In the present study, we consider three different quantitative measures of food security, widely used in the literature and broadly categorized as: (i) calorie (energy) intake — both as absolute calorie consumption and as a categorical measure, representing shortfall from a standard norm, (ii) dietary diversity indicators — food variety score (FVS), dietary diversity score (DDS) and

[7] Each of the surveys was undertaken in the period between December and April.
[8] The attrition between the beginning, 1997 and the end of the survey in 2005 was less than 10% or about 1.2% per year.

(iii) anthropometric indicators for children below five years and women of reproductive age, to evaluate the impact of microcredit program participation on the food security situation in rural Bangladesh. We do not include the self-reported or experiential food security measure, in the absence of relevant data. [9] In the sub-sections that follow, we discuss the construction of each of these indicators in much detail.

4.1.1 Extracting Calorie Data from the HCES

The Household Consumption Expenditure Survey in the BIDS-PKSF dataset collected (retrospectively) detailed data on the quantity and value of food items consumed by the households over the past seven days, the week preceding the date of inquiry.[10] The quantity estimates of the food items consumed by a household were converted to calorie availability[11] by applying conversion factors appropriate to the items of food, using the Nutrition Chart provided in Gopalan (1991) and routinely used in large-scale nutrition surveys similar to those conducted by India's National Sample Survey Organisation[12] (see NSSO, 2012).

The estimate for total calorie equivalent of all food items consumed by the household during the reference period was derived by aggregating calorie intake over different food groups[13]. Finally, we calculated three different measures of calorie intake (expressed as kilocalories) — i) household calorie consumption per day, (ii) per capita calorie consumption per day, calculated by dividing the household calorie consumption by the household size and (iii) equivalized calorie consumption per day, which divides the aggregate calorie figure by the square root of household size, following OECD (2008, 2011). Equivalized calorie consumption takes into account that consumption needs may differ across households – for example needs

[9] Information on self-reported food security based on perception of 'lack of enough food' are available for one year only.

[10] Except cereals, for which the recall period was 3 days.

[11] We have computed calorie availability rather than calorie intake as the average estimate of calorie intake, may not necessarily represent the 'true' level of intake of a household for two reasons (see Bouis, Haddad, and Kennedy 1992; Bouis 1994). Firstly, there may be members of the household who might have consumed free meals outside home and secondly, persons other than the household members might have been entertained as guests. 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 appropriate adjustment factor (see Minhas, 1991) to obtain a measure much closer to true intake.

[12] 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, for example, West Bengal, due to historical reasons. The Indian Food Composition Table (Gopalan, 1981) has been previously used by researchers in Bangladeshi (see Chaudhury, 1985, for example).

[13] The major food groups in the BIDS-PKSF 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.

will be different for a household consisting of only working age adults and a household with one or more kids (Zaidi and Burchartd, 2005).

4.1.2 Choice of Calorie Norm

Data on food expenditure, gathered through 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 (Srinivasan, 1981, Higgins and Alderman, 1997 cited in 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 whatever may be the level at which it is set, cannot capture these differential requirements. Minimum calorie requirements are therefore specified for an average household using norms developed by the Bangladesh Bureau of Statistics (BBS) and the FAO.

The Bangladesh Bureau of Statistics (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 2122 kcal and 1805 kcal per capita per day, respectively, to define 'absolute food poverty' and 'hard-core food poverty' in our paper. The third specification follows the Bangladesh specific cut-off suggested by FAO/WHO/UNU (2004) which corresponds to 1770 kcal per capita per day, for 2006-08.

4.1.3 Household Dietary Diversity Indicators

We use four different measures to capture the extent of diversity in the diet of the households (following Hoddinott, 1999a, 1999b; Hoddinott and Yohannes, 2002 and Migotto et.al., 2006). They include: (i) food variety score (FVS), (ii) dietary diversity score (DDS), (iii) Gini-Simpson index and (iv) the Shannon index (see Appendix for a brief discussion of the dietary diversity indicators). We have used 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 the food items in the HCES

under the following food groups[14] — 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 (Swindale and Bilinsky 2006a, 2006b). The HDDS ranges from 0 ("non-diverse") to a maximum of 12 ("diverse"). The composite measures — Gini-Simpson and Shannon index also establishes a continuum between a "diverse" and a "non-diverse" diet, where a zero represents a "non-diverse" diet and diversity increases with the index value.

4.1.4 Anthropometry 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 5 are weight-for-height z-scores (wasting), weight-for-age (underweight) and height-for-age (stunting), while acute maternal malnutrition is assessed using body mass index (BMI) and mid-upper arm circumference (MUAC). Acute malnutrition for children under the age of 5 is estimated using the anthropometric measurements (weight and height), standardizing these results using the WHO (2006) reference population and specifying cut-offs (presented as z-scores) in line with global recommendations[15]. Thus, children will be classified as "total" malnourished – with reference to median of the reference population – if their z-score is less than -2 SD and "severely" malnourished if the z-score lies below -3 SD. For example, a child below 5 years of age will be classified as severely 'underweight' ('stunted') if the standardized weight (height)-for-age z-score is less than -3 SD (BBS/UNICEF, 2007).

BMI and MUAC was however considered to analyze the extent of acute malnutrition among prospective non-pregnant women of reproductive age (15-49 years). Following the cut-offs defined for BMIs of adults in BBS/UNICEF (2007), an individual mother is referred to as "underweight" if BMI<18.5 and as "chronic underweight" if BMI<16. While cut-offs have been defined for BMI in adults, there is no international consensus on the cut-off points for classifying severe malnutrition in adults, using MUAC. The cut-offs presented over here are

[14] The vegetable food group includes vitamin A rich vegetables, dark green leafy vegetables and other vegetables. The fruit group on the other hand comprises of vitamin A rich fruits and other fruits while the meat group is a combination of organ meat and flesh meat (FAO, 2011).

[15] In 2006, the World Health Organisation (WHO) introduced a new growth standard (WHO GS) for children 0-60 months of age, which was endorsed in 2009 by WHO and UNICEF (2009) for use in the identification of severe acute malnutrition.

commonly used during emergencies. Thus, "malnutrition" is described as a condition when MUAC<=22.1cm and "severe malnutrition" when MUAC<21.4 cm (WHO, 1995).

Table 1 reports the summary statistics of different food security indicators by participation status of the households. Calorie intake measured in terms of both absolute levels as well as the incidence of food poverty vary widely across households – household calorie consumption is about 11,559 kcal per day for participants compared to 11,531 kcal for non-participant households, whereas per calorie consumption per day is 1,949 kcal and 1,944 kcal per day. Using a calorie cut-off of 2122kcal/person/day, we do not find any significant difference between the participants and non-participants. Incidence of (hard-core) food poverty on the other hand is about 44.3% for participating and 46.7% for non-participating households, while 41.8% and 43.9% of the 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 the dietary diversity indicators and mother's nutritional status across the 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 the program participants and non-participants, measured in terms of wasting, stunting and the likelihood of being underweight. The estimated non-parametric relationship between the loan amount provided by the microcredit programs and each of the four different indicators of food security (see Figure 1) also suggests that microcredit could improve the food security situation of the households.

[Table 1]

[Figure 1]

5. Estimation Methodologies

There exists possibility of a selection bias when program placement is endogenous and individuals from eligible households have the option to self-select into the credit programs. 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 the non-random program

placement and the self-selection of households into the microcredit programs. Using the three-wave 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.

5.1 Regression Methods

The primary empirical methodology that we have adopted in this section to estimate the impact of microcredit program participation on different indicators of food security can be expressed as 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} is the outcome of interest — different indicators capturing both the incidence and extent of food insecurity of household j at time t; H_{jt} is a vector of household level characteristics which includes household size, total arable land owned, gender and age composition of the household (see appendix for a list of the variables). α_j captures household-level fixed effects while $\lambda \tau_t$ represents the year fixed effects. ε_{jt} is the household specific error term which is non-systematic and vary across households. We are particularly interested in the sign and value of the parameter θ associated with the variable P_{jt}, the microcredit program participation status of household j in year t. The parameter θ therefore picks up the estimated effect of program participation on different indicators of household food security.

We control for unobserved household level characteristics using household level fixed effects and time variant unobservables like market conditions and weather shocks, with year fixed effects. To account for any correlations in errors across villages and year, we compute clustered–robust standard errors at the village-year level. As we run a fixed effects regression model, we only include a subset of all household level characteristics that affect our outcome variable but do not get eliminated due to the choice of the estimation strategy.

5.2 Alternative Estimation Strategies

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 so far. At first we estimate propensity

scores for each household using a standard logit model that regresses the participation status of the household as of the first round of survey on their initial set of household- and village-level observable characteristics[16], and then compare the 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 (NN) estimator with the five nearest neighbour. The results from the balancing test are provided in the appendix. 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 (Becker and Ichino, 2002), after matching.

6. Results Section

The results of our basic estimation equation are presented in Tables 2, 3 and 4, where Table 2 shows the effects of program participation on absolute calorie consumption and incidence of food poverty. Table 3 presents the regression results for maternal and child nutritional status and Table 4 reports the estimated coefficients for dietary diversity among households in rural Bangladesh. The regressions use the full set of controls (see the appendix), and include year and household fixed effects. We are particularly interested in examining whether participation in microcredit programs[17] affects the food security situation of the households and so we focus on the sign and value of the estimated parameter $\hat{\theta}$. Each column in the table is associated with a different indicator of food security and only the coefficient $\hat{\theta}$ is reported.

6.1 Impact on Calorie Availability and Food Poverty

The coefficients presented in Panel A of Table 2 show that microcredit program participation significantly increases calorie intake for all specifications of calorie consumption — household's calorie consumption per day increases significantly 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 in terms of calorie consumption.

[16] 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. (see appendix for a brief discussion of the variables used to estimate the propensity score).

[17] The results are robust to the definition of program participation. We have also used total loan borrowed by the participating households as a robustness check but the results are very similar to that obtained by using treatment effects.

[Table 2]

The impact of loan amount is also positive and significant for all specifications of calorie intake and this may typically imply that calorie intake is highly responsive to increases in available resources brought about by increased access to microcredit. We may refer to investment-led benefits here, which would imply 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 of food (Zeller and Sharma, 2005). The outcome is to allow 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 poor (at the lower end of income distribution) will respond positively[18] 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 and Thomas, 1995; Subramanian and Deaton, 1996; Gibson and Rozelle, 2002; Abdulai and Aubert, 2004). The overall results presented in Table 2 imply 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 significantly reduced by 4.35%, however, we find no such significant effect of participation on absolute food poverty, which declined by only 2.25%. Interestingly, program participation also significantly reduces the incidence of food poverty defined with a calorie cut-off of 1770 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 of food poverty is negative and significant, irrespective of the cut-off used.

[18] Moreover, many loans obtained by poor households are used for consumption, mainly of food. An IFPRI study on eight developing countries in Asia and Africa (Zeller and Sharma, 2005) report about 50–90 percent of loans obtained were spent on consumption related purchases. This finding is consistent with our finding of increased amount of loans leading to increased calorie availability.

One reason why the impact of program participation on absolute food poverty is insignificant could be that participation status improves calorie intake upto a certain point and once that basic caloric needs is satisfied, economic benefits do not get translated into increased calorie consumption and households diversify into higher-value micronutrient-rich foods (Jensen and Miller, 2010). At this calorie threshold, non-food items like education and health care may also get more preference over food items (Hoddinot and Yohhane, 2002). In general, the result implies, that program participation benefits households both at the intensive (calorie consumption) and extensive margins (likelihood of being food poor), particularly those most vulnerable to food insecurity.

6.2 Impact on Maternal and Child Nutritional Status

Next, we report the results for the effect of program participation on maternal and child nutritional status. Panel A in Table 3 (in the top panel) presents the results for child nutritional status, while Panel B (in bottom panel of Table 3) refers to maternal nutritional status. 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 participants are found to have a significantly large negative effect on both total and severe stunting (presented in the first two columns of Panel A in Table 3) — it reduces the prevalence of severe stunting by 19.2% and overall stunting (total) by 32.5%, effectively reducing the incidence of stunting.

[Table 3]

The significant effects on stunting may be explained by the fact that stunting represents chronic or long term undernutrition — a consequence of prolonged food deprivation which is sometimes intergenerational — poor nutrition of mother passed on to low stature for the offspring (Victoria et al, 2008). Since apart from generating additional income, access to MCI also implies building up assets which provide cushion against risk (Barrett, 2002), participation in such program can reduce vulnerability to food insecurity in the long run which ultimately gets reflected in a child's height-for-age.

However, participation status does not have much of an impact on wasting – barring a weakly significant effect on severe wasting, where microcredit reduces the incidence of severe wasting by 7.35%. It is possible that the impact of program participation on wasting is not pronounced as wasting represents short term acute malnutrition which could be the result of some recent

spell of diseases or distress, and hence may not be an outcome of a household's long term economic stability brought about by participation in MCI.

As for underweight status, the results presented in the last two columns of Table 3 reveal that participation in MCI significantly reduces the likelihood of being underweight (total), with no impact on the likelihood of being severely underweight. This indicator is a composite measure of stunting and wasting, which does not distinguish between the two and the results are somewhat mixed.

Loan Amount, however, 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 (Frankenberger, 1992; Barrett, 2002; Jones et al., 2013) which would come through borrowing.

We further investigate the effect of microcredit program participation on maternal nutritional status. The bottom panel in Table 3 demonstrates that households which are participating in microcredit programs experience a significant decline in the incidence of underweight and malnutrition, measured by MUAC. Participation in MCI significantly reduces the prevalence of maternal underweight by 6.51% and severe and total malnutrition by 3.55% and 3.52% respectively. The estimated coefficients of program participation on maternal body mass index and mid-upper arm circumference are insignificant, suggesting that in general maternal undernutrition is caused more by gender related discriminations rather than by economic deprivation - intrahousehold resource allocation issues being more relevant in influencing maternal nutritional status (Mangyo, 2008). However, access to additional resources in the form of larger loan amounts provided by the MCIs may have a significant positive effect on maternal nutrition status, measured in terms of BMI and MUAC measurements.

6.3 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 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 household diet. It decreases the

number of food items (FVS) by 0.176 units and the number of food groups consumed (DDS) based on the 12 scale FANTA-HDDS by 0.109 units, though none of these effects are statistically significant.

[Table 4]

One plausible explanation of the result is that increased additional income generated from participation in MCI in rural Bangladesh leads to increased calorie consumption/acquisition 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 (Strauss and Thomas, 1995; Subramanian and Deaton, 1996; Abdulai and Aubert, 2004) — 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 increase in income might cause both calories and dietary diversity to increase[19] (Behrman and Deolalikar, 1987).

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

The household behaviour discussed so far becomes more prominent when we look at the impact of participation in MCI on Simpson and Shannon indices, The estimated coefficients for both these indices are significantly negative (-0.0218 for Gini-Simpson and -0.0441 for Shannon index), implying that MCI-participation has in fact reduced dietary diversity at the household level. This result would imply that the food security impact of participation in this case is not to increase diet quality but may be to increase calorie consumption alone, which is consistent with household behaviour at low levels of income and follows directly from the results

[19] Calorie demand is more responsive to income at lower levels of income, the rationale for which stems from the observation that with increase in income people purchase a wide variety of foods rather than calories where desire for variety is driven more by other attributes of food like colour, flavour, texture, taste and ease of preparation. Therefore, for households at the lower end of income distribution, an increase in income will be reflected in increased calories rather than in increased diversity of diet.

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 for the reasons stated above.

[Table 5]

Finally, we present the results from the alternative estimation methodology in Table 5 and also in the appendix. As a robustness check for our primary estimation methodology, we run Equation (1) on the sub-sample of matched households. The PSM results are very similar to those presented in Tables 2-4. 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 (also increases by 2.30%) and negative effect on the incidence of hard-core food poverty, which declines by 4.36%. The estimated results in Table 1 and 2 of Appendix B are very similar to those in Tables 3 and 4. We find evidence that participation in microcredit programs reduces the prevalence of stunting and undernutrition among children aged below five and the incidence of underweight among prospective mothers. 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 Simpson and Shannon index.

6.4 Duration of Membership and Household Food Security

In this subsection, we examine the heterogeneous impact of program participation on food security by focussing on the length of time that each household has participated in the microcredit program. We sort the participating households into six broad sub-categories based on their date of joining and/or leaving the program, using the definitions used by Islam (2011) to separate out the short term effects from the medium and long term effects of microcredit program participation (Islam, 2011; Khandker and Samad, 2013). The six different groups that we consider in our analysis are as follows:

i) *Continuing participants*: these are the households who have been regular clients of the MCI during all of the four rounds of surveys conducted between 1997 and 2005.

The households which have not been regular (continuing) participants of the microcredit program can be identified as occasional clients and are further classified into newcomers — who were not members during the first round but joined later and into dropouts — who were clients as of 1997 but dropped out later.

ii) *Newcomers1*: households that were not clients of the MCIs as of 1997 but joined it between 1999 and 2001.

iii) *Newcomers2*: these are the more recent participants of the MCIs, having joined them later, between 2001 and 2004.

iv) *Leavers1*: households who were clients as of 1997 but dropped out after 1998, and never participated in any other MCI again.

v) *Leavers2*: these are the most recent dropouts who participated until 2001 and then decided to drop out of the program.

vi) the rest of the occasional clients of the MCIs, who were not classified as newcomers or leavers will be referred to as drifters henceforth.

47.2% of the 1592 households that were clients of the MCIs at one point or the other were regular clients, while 9% of them were newcomers1 and 5% newcomers2. Out of the remaining 38.8% — 11.3% and 11% were leavers1 and leavers2 respectively. The rest of the 16.5% are drifters, the MCI program participants who did not fit into any other category of participants.

Based on the following classifications we are able to observe the differences in outcomes between different groups of program participants. We estimate the effect of participation for each of these groups by comparing them with the benchmark group — the non-participants, those households that never participated in any of the microcredit program, all ineligible households, eligible[20] but non-participant households in the control villages and eligible households in the program village that chose not to participate.

[Table 6]

Results from the sub-group analysis are presented in Table 6. We find significant differences in household level food security, measured in terms of calorie intake and incidence of food poverty, across the different groups of program participants. We find significant effect of participation status on absolute calorie consumption and food poverty for regular participants, which is robust across all the specifications considered in our analysis (Table 6). The results presented in the first column of Table 6 indicates that compared to non-participating households, regular participants are found to consume 2.36% more calories and are less likely

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

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 Newcomers 1, 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. Infact 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 which urges individuals to act in a more responsible manner (Gamble and 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 to realize the gains in terms of improved economic access.

While the results for Newcomers2 are somewhat mixed, the impact on food security is significantly large for Leavers 2 and drifters, even larger than the positive impact on food security experienced by regular participants. The overall results however imply that regular participants continue to be more careful and consume less calories than occasional participants – microcredit program participation improves the food security of the household but regular participants continue to invest in productive self-employment based activities which increases household income and mitigates risk and therefore do not invest resources sufficiently in food and calorie consumption.

7. Conclusion

Despite the growth in food production and its availability, food insecurity is still a major problem in rural Bangladesh, mainly because of the lack of purchasing power and limited access to food, particularly during the lean seasons when employment opportunities are rare and households suffer from poverty, unemployment and food deprivation. The ability to borrow from the MCIs help households diversify into self-employment based activities, whose returns do not vary much with agricultural production, thereby smoothing consumption and improving household food security.

In this paper, we examine, for the first time, the impact of microcredit program participation on household food security. We focus on three different categories of food security measures

– calorie intake – both at the extensive (incidence of food poverty) and intensive (absolute calorie consumption) margins, anthropometric (both maternal and child nutritional status) and dietary diversity indicators. Overall, MCI participation improves the food security situation of the household but the results are not robust across individuals and indicators. We find robust evidence that program participation improves calorie availability and reduces the likelihood of being food poor. However, it only decreases the incidence of stunting among children under the age of five – which reflects chronic undernutrition, suggesting that participants significantly improve the long term indicators of child health. The effect on wasting and underweight is somewhat mixed and therefore inconclusive. Membership in microcredit programs is also found to reduce the prevalence of maternal underweight and MUAC-malnutrition. The overall results suggest that program participants are relatively more food secured with improved calorie consumption, child and maternal nutrition status and reduced food poverty, however, participation status does not impact food quality positively, which gets reflected in the dietary diversity indictors of the household.

The impact of the duration of program participation also provide interesting results in this paper – MCI participation either has no significant effect on food security measured in terms of calorie consumption or food poverty in the short run or worsens it, before ultimately improving it in the long run. The limited effect of participation status for regular participants, compared to occasional participants cast doubt on our expectations that participation in microcredit programs can significantly improve the food security situation of poor households. It does not look like microcredit program participation will necessarily improve the food security situation of the households on its own. Interventions to improve calorie consumption and reduce food poverty and malnutrition needs to be targeted more towards the most vulnerable sections in the society and microcredit does not seem to be the answer to the food security problem in rural Bangladesh.

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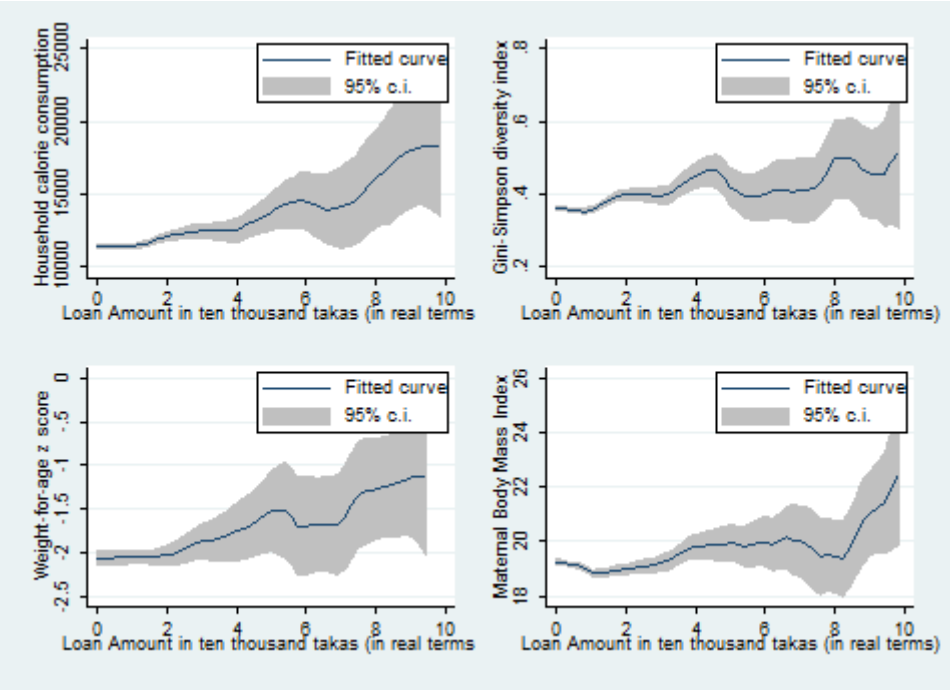
Figure 1: Microcredit and Indicators of Household Food Security



Source: BIDS-PKSF dataset from rural households in Bangladesh

Table 1: Summary Statistics of different food security indicators by program participation status

Variables of Interest	Participants Mean	Participants Std. Dev.	Non-participants Mean	Non-participants Std. Dev.	Difference
Group A: Calorie consumption and Incidence of Food Poverty					
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
using cut-off of 1805 kcal/person/day	0.443	0.497	0.467	0.499	-0.023**
using cut-off of 2122 kcal/person/day	0.633	0.482	0.637	0.481	-0.003
using cut-off of 1770 kcal/person/day	0.418	0.493	0.439	0.496	-0.022*
Group B: Indicators of Dietary diversity					
Food Item count (FVS)	16.72	8.16	17.51	8.25	-0.797***
Food Group count (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					
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 Mother's nutrition status					
Body Mass Index	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 (in cm)	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**

The reported p-values are from the two-tailed test with the null hypothesis that the group means are equal. The difference variable is the difference between the outcome variable of the treatment (participants) and control (non-participants) group. *** p<0.01, ** p<0.05, * p<0.1. Child and maternal malnutrition is "severe" if the z-score is less than -3 and "total" if below -2 for all specifications (the incidence of stunting, wasting and underweight).

Table 2: Regression Results for Calorie consumption (in log terms) and Incidence of food poverty

Regression Adjusted Estimates of	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
	Incidence of food poverty (hard core)		Incidence of food poverty (absolute)		Incidence of food poverty (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

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 root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2122/1805 kcal/person/day (for absolute and hardcore food poverty respectively). The FAO cut-off is 1770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5000 kcal, following Heady and Ecker (2013).

Table 3: Regression Results for Child and Mother nutritional status

Regression Adjusted Estimates of	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		Arm circumference (MUAC in cm)		Severe malnutrition		Total malnutrition	
Panel B: Maternal Nutrition Status (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

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. 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 either moderate or severe. 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). 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). Chronic underweight is below a BMI of 16, while underweight is BMI below 18.5, following WHO (1995) and BBS/UNICEF (2007, Table 2). All maternal BMI lies within the recommended limits of 12 and 40 for Bangladesh, following BBS/UNICEF (2007).

Table 4: Regression Results for different Indicators of Dietary Diversity

Regression Adjusted Estimates of	Food Item Count		Food Group Count		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

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

Table 5: Propensity Score Matched Regression Results for Calorie consumption (in log terms) and Incidence of food poverty (for Robustness check)

Regression Adjusted Estimates of	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
	Incidence of food poverty (hard core)		Incidence of food poverty (absolute)		Incidence of food poverty (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

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 root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2122/1805 kcal/person/day (for absolute and hardcore food poverty respectively). The FAO cut-off is 1770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5000 kcal, following Heady and Ecker (2013).

Table 6: Regression Estimates for the Impact of the Duration of Program Participation on Calorie consumption and Incidence of food poverty

Regression Adjusted Estimates of	Regular 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)

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 root of household size. Incidence of food poverty is calculated using BBS cut-offs of 2122/1805 kcal/person/day (for absolute and hardcore food poverty respectively). The FAO cut-off is 1770 kcal/person/day. The exclusion criteria for per capita per day calorie consumption is 500 kcal and 5000 kcal, following Heady and Ecker (2013).

7. Appendix to the Paper

The variables that have been used in the primary empirical methodology are as follows:

7.1 Individual- and household-level variables

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, 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 labor as well as income from non-labor income as discussed in Section 3. Household income, however, has been substituted by total household expenditure in this present study, as expenditure data might be generally more reliable than income data with fewer reporting errors. Moreover, household expenditure is typically a better proxy for permanent income — income might be subject to transitory fluctuations but households typically use a variety of mechanisms to smooth consumption over time. A study by Haddad et al. (1994), for instance, found that household total expenditures and food expenditures were both more closely correlated to indicators of calorie adequacy than household income. Several other studies have also used expenditure as a proxy for income in estimating calorie demand functions (Subramanian and Deaton, 1996; Garrett and Ruel, 1999).

The level of total assets on the other hand is expected to insure households against any abrupt changes in prices, income, or any unforeseen events that may raise need for additional expenditures. Hence, total assets owned by the household is considered to be an important factor that could affect the household's food security situation. Most of these variables come from the list of socio-economic indicators of food and nutrition security provided in Frankenberger (1992) and Haddad et. al. (1994).

7.2 Variables used in the Propensity Score Matching (PSM)

We use the following variables in the alternative estimation methodology that combines the Propensity Score Matching technique with fixed effects regression, discussed in the primary estimation methodology in Section 5.

7.2.1 Household-level variables

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, gender of the household head.

7.2.2 Village-level variables

Presence of primary school, secondary school or college, health facility, madrasah, 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, large farmers/traders, 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.

7.3 Brief discussion on Gini-Simpson and Shannon Diversity Index

The composite measures that we have used in this paper in addition to food variety score (FVS) and dietary diversity score (DDS) are relatively new and not as commonly used in the literature as the simplest measures of dietary diversity discussed in Section 2. We use the Gini-Simpson and Shannon index, following FAO (2011). 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 Food and Nutrition Technical Assistance (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.

Appendix A Table 1: Results of the Propensity Score Matching Balance Test

Variables of Interest	Mean			t-test	
	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

Appendix B Table 1: Propensity Score Matched Regression Results for Child and Mother nutritional status

Regression Adjusted Estimates of	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
	Body Mass Index		Incidence of chronic Underweight		Incidence of Underweight		Arm circumference (in cm)		Severe malnutrition (MUAC)		Total malnutrition (MUAC)	
Panel B: Maternal Nutrition Status (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

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. 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 either moderate or severe. 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). 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). Chronic underweight is below BMI 16, while underweight is BMI 18.5, following WHO (1995) and BBS/UNICEF (2007, Table 2). All maternal BMI lies within the recommended limits of 12 and 40 for Bangladesh, following BBS/UNICEF (2007).

Appendix B Table 2: Propensity Score Matched Regression Results for different Indicators of Dietary Diversity

Variables of Interest	Food Item Count		Food Group Count		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

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