Does Access to Microcredit Lead to Agricultural Productivity Gains? Evidence from Bangladesh

by

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Abstract

I analyze data from a 1991—92 field survey of rural Bangladeshi households to determine the effect of access to microcredit on agricultural productivity in rural areas. I argue that rural farmers with access to microcredit should only realize productivity gains if they are credit-constrained. I find that, relative to people who had no opportunity to join a microcredit program, access to a microcredit program does not lead to direct productivity gains for farmers of either transplanted Aman rice or a high-yield variety of Aman rice. Only access to a Grameen Bank microcredit program is associated with a lower cost of sharecropping—defined as the share kept by the landlord multiplied by the sharecropped proportion of the total land cultivated by the farmer—and a subsequent significant productivity gain when considered jointly with a reduction in sharecropping costs, while access to the Bangladesh Rural Advancement Committee and Bangladeshi Rural Development Board programs are not. There are no significant *ceteris paribus* productivity gains associated with any microcredit program. The results suggest that access to microcredit does not lead to direct improvements in agricultural productivity.

Keywords: Access to microcredit; Agricultural productivity; Bangladesh; Economic development; Grameen Bank; BRAC

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List of Acronyms

BRAC	Bangladesh Rural Advancement Board (outdated)
BRDB	Bangladesh Rural Development Board
HH	Household
HYV	High Yield Variety (Aman rice)
MFI	Microfinance Institution
RD	Rural Development Program
TR	Transplanted (Aman rice)
USD	United States Dollars
NGO	Non-governmental Organization

Glossary

Maund	A unit of mass, in this case referring to the Bengal Maund, equal to eighty-two pounds and two ounces
Microcredit	Small loans made to low-income borrowers who often lack access to formal credit markets
Microfinance	A range of financial services for low-income people
Sharecropping	An agricultural tenancy arrangement wherein the agreed-upon rent is some fixed proportion of the output realized by the farmer, rather than some fixed- sum or amount of output
Taka	The currency of Bangladesh
Thana	A sub-district in the administrative divisions of Bangladesh

1. Introductory Remarks

The welfare of the world's poor is of fundamental concern in development economics. 1.22 billion people in less developed countries live on less than $1.25 per day, 850 million of whom are undernourished, and 70% of whom live in rural areas (Food and Agriculture Organization of the United Nations [FAO] 2012; World Bank 2013). Insofar as the welfare of the poor is linked to real incomes and consumption, the over-arching question facing development economists has been: how can sustained, long-run improvements in these indicators can be realized?

Microcredit, the provision of small loans to borrowers who often lack access to formal credit markets, has often been advanced as the antidote to poverty—the means by which impoverished peoples will be empowered to pull themselves out of penury and take control of their own financial well-being, often by starting their own businesses. Yet economic opportunities in rural areas are often heavily dominated by agriculture (Haggblade, Hazell and Reardon 2009; FAO 2012; World Bank 2013). While some rural areas have managed to diversify their output, many others have few opportunities beyond agriculture, often due to poor infrastructure and a lack of industrialization (Ahmed and Hossain 1990; Khatun 2003; Asian Development Bank 2010; GIZ 2013). Even where rural nonfarm economic opportunities do exist, they are much less likely to be associated with poverty reduction when agricultural productivity is low (Ravillion and Datt 2002). If there is a link between access to microfinance and sustained higher household consumption and poverty reduction, then it will be found in increased productivity among borrowing entrepreneurs; in the many rural areas where even basic infrastructure is underdeveloped, this will almost certainly mean increased agricultural productivity (defined as 'yield per acre').

To investigate whether this link exists, I use the same data as Pitt and Khandker (1998), Khandker (1998) and Morduch (1998) to measure the effects of access to microcredit from three large Bangladeshi microfinance institutions (MFIs) on agricultural productivity for farmers of transplanted (TR) Aman and high-yield variety (HYV) Aman rice in rural Bangladesh. The three MFIs are the Grameen Bank, BRAC (previously known as the Bangladesh Rural Advancement Board), and the Bangladesh Rural Development Board (BRDB). As far as I can tell, this use of the data is unique: while previous analyses have looked at the effects of access to microcredit on variables such as consumption and school enrollment rates, none have explored the impact on agricultural productivity.

I find that access to a Grameen program (on the extensive margin) is associated with a ~9% lower sharecropping-cost—defined here as the proportion of sharecropped output farmers paid to landlords multiplied by the sharecropped proportion of the total land those farmers cultivated—when growing either type of rice relative to households which had no opportunity to join an MFI. The effects on sharecropping-cost of joining a BRAC program are not robust across rice varieties, while there are no significant effects on sharecropping-cost from joining a BRDB program. This disparity is possibly due to Grameen programs training their members to demand better contractual terms while targeting villages in which the poor initially have less political power, but this is speculative and not verifiable with this dataset.

I find that there are no significant, direct productivity gains associated with access to any of the three microcredit programs, though access to a Grameen program does yield indirect productivity gains for both TR and HYV Aman farmers through a reduction in sharecropping-costs. That is, access to a Grameen program is associated with lower sharecropping-costs, and lower sharecropping-costs are associated with greater productivity (gains of 25-30% per one percent decrease in sharecropping-costs). This result is identified through a linear-restriction F-test. Access to BRAC and BRDB programs have no significant effects on productivity, even jointly with reduced sharecropping-costs.

Additionally, I find that productivity increases are positively and significantly affected directly by lower sharecropping-costs for TR farmers in the baseline regression and all the robustness checks. This result strongly suggests that greater shares motivate greater effort from tenant-farmers, as economic theory predicts they should, but apparently only for those growing TR Aman. The well-documented inverse relationship between productivity and farm size is also confirmed. The estimated effect of increasing input expenditures is small and generally insignificant, though it achieves significance for TR farmers in two of the robustness checks. Section 2 of this paper discusses the relevant background literature. Section 3 describes the data. Section 4 presents and discusses results. Section 5 discusses the results of a series of robustness checks. Section 6 concludes.

2. Background Literature

2.1. Microcredit

In 1976 a Bengali economics professor named Muhammad Yunus began lending to Bangladesh's rural poor in the hope it would unleash their latent talents and open the door for economic development. Appalled by the abject poverty in his home country and by vicious circles in which the poorest seemed trapped for want of sometimes mere pennies of credit, he and some colleagues began making small, interest-free, collateral-free loans to the poor out of their own pockets (Yunus 2003). His idea was straightforward: by providing low-interest microloans to poor entrepreneurs, he could break the poverty cycle in which these people had no option but to take out high-interest loans to purchase their productive inputs and pay out the entirety of their resultant profits as interest on those loans. By utilizing a lending process instead of charity he intended to empower the poor to work their own ways out of poverty.

The importance of financial institutions in the economic growth and development of communities and nations has long been contentious, with highly regarded economists taking starkly contrasting positions on the matter. Hicks (1969), for example, asserts the financial system was essential for England's Industrial Revolution, while Lucas (1988) states "the importance of financial matters is very badly over-stressed" by many economists. In recent decades, however, a large and growing body of evidence has led to a broad consensus that financial institutions play a critical role in economic outcomes, with access to credit for producers and consumers alike being viewed as essential (Levine 1997). Where financial institutions have been weak, economies have tended to founder (McKinnon 1973). In economies where banking systems have been underdeveloped, firms have often been capital starved, while individuals requiring credit have had to turn to informal financial markets, often borrowing from family members or local money lenders (Rahman 1992).

Yet even when competent banking systems have been present in less developed countries (LDCs), the poor have often found themselves shut-out of formal credit markets because of information and enforcement issues suffered by formal lenders,[1] and because the amounts the poor often wish to borrow are widely perceived as too small to make it profitable to extend them loans (Hoff and Stiglitz 1990; Yunus 2003). When the rural poor face unexpected expenses, or when the entrepreneurs among them wish to purchase productive inputs and materials for their businesses, they have often had little choice but to turn to informal credit providers, often at punishingly high rates of interest (Morduch 1998; Rahman 1992; Hoff and Stiglitz 1990; Yunus 2003).

Grameen Bank, the MFI Yunus founded in 1983 with a grant from the Ford Foundation and the assistance of the Bangladeshi government, has since made over 11.35 billion USD in low-interest loans to over 8 million rural poor, with a reported loan-recovery rate of more than 96% (Grameen Bank 2011). Grameen has made a point of encouraging saving as well as borrowing, and has undertaken to educate and train its members, many of whom it claims have been lifted out of poverty by its programs. The resultant enthusiasm for micro-lending has since reached dizzying heights; it is difficult to pinpoint exact numbers, but as of 2009 the world contained nearly 1100 MFIs operating with 38 billion USD in outstanding loans extended to 74 million borrowers (Microfinance Information Exchange 2009). The Microcredit Summit Campaign (2012) estimated the number of poor families with a microloan exceeded 137.5 million in 2010. Kiva, an online portal which enables ordinary people to make micro-loans, has nearly 1 million member donors who have extended over 420 million USD in outstanding loans despite the fact that interest payments go to the field agencies which administer the loans rather to the lenders (Kiva 2013). Hillary Rodham Clinton claimed, “Microcredit is a macro idea. This is a big idea, an idea with vast potential. Whether we are talking about a rural area in South

[1] For example, formal lenders in LDCs often have little information regarding the default-risks of the rural poor, and insufficient means of compelling them to repay their loans—problems which are often mitigated by the structure of informal credit markets.

Asia or an inner-city in the US, micro credit is an invaluable tool in alleviating poverty." Support across the political spectrum has been palpable.

Yet is this enthusiasm warranted? Many MFIs operate at losses and depend on large subsidies from donors to keep them operational (Morduch 1999a, 1999b). Loan repayment rates have fallen somewhat as microfinance has become more ubiquitous: increased competition has led many MFIs to adopt weaker lending practices and has weakened the incentives for borrowers to repay. Many for-profit MFIs have been accused of being worse than the money lenders whom microfinance was originally intended to replace (Banerjee, Duflo, Glennerster, and Kinnan 2013). Perhaps more importantly, the evidence on the success of microfinance as a means of alleviating poverty is at best mixed. Khandker (1998) concluded "Microcredit programmes are an effective policy instrument for reducing poverty among poor people with the skills to become self-employed", Pitt and Khandker (1998) found lending to women unequivocally increased household consumption, and Khandker (2005) found that microfinance in rural Bangladesh unequivocally helped borrowers and had positive spillover effects on non-borrowers. Yet Morduch (1998) used the same data and found "access to the three microfinance programs does not yield meaningful increases in per capita consumption, the education of sons, nor the education of daughters." Banerjee et al. (2013) measured the effect of access to microcredit in poor neighbourhoods in Hyderabad, India, finding 68% of households in the treatment neighbourhoods had at least one loan before gaining access to microcredit. Three-and-a-half years later, only 38% of eligible households had obtained a loan from an MFI, suggesting that less than half of them felt microcredit was a way to help them out of poverty. Given that those who did borrow saw no gains in consumption or the profitability of their businesses except at the very upper end of the tail, it's not hard to see why this would be.

The promise of microcredit seems large only if the underlying assumption is true: in the absence of microcredit the poor have the option of high-interest loans money-lenders or nothing at all. Yet given the prevalence of lending between family and friends in underdeveloped countries, to say nothing of the lending conducted by state agricultural banks, this assumption seems suspect. Add to this the fact that many microcredit programs are heavily subsided, and the question arises: could the NGOs, governments, and individuals who subsidize these programs use this money more effectively in other poverty reduction programs? The answer is unclear, as it is difficult to measure the impact of microcredit on poverty from standard indicators like household consumption per capita. For example, it may be the case that access to credit allows borrowers to smooth consumption but not to permanently increase it (since even low-interest MFI loans charge over 20%). It is also possible that those entrepreneurs who borrow may re-invest their profits rather than increasing consumption. Regardless of the short term effects of access to microfinance, any link to sustained higher household consumption must result from productivity gains; as argued above, in many rural areas this will mean agricultural productivity improvements. If microcredit does not lead to productivity gains the value of which are greater than the cost of borrowing, then it cannot lead those borrowers to sustained higher levels of consumption. An absence of sufficient productivity gains would not preclude the possibility of microcredit benefiting the poor through mechanisms such as income smoothing or consumption smoothing (Morduch 1998), but such effects only reduce the hardships of poverty, not the rates.[2]

[2] Access to credit markets can allow households to partially insure themselves against negative shocks to consumption levels by providing loans in hard times which are paid back in better times. This process reduces the volatility of consumption, effectively ‘smoothing’ it over time. Similarly, loans are sometimes used to establish businesses which yield low but reliable returns, allowing borrowers to smooth their incomes but not grow them. Access to credit can therefore benefit the poor by reducing the incidence of starvation when disaster hits, but since borrowers must repay loans with interest, if the loans are not productive beyond the cost of borrowing, using credit in this way will only make the poor poorer: the worst hardships are mitigated, but at the cost of continuing and possibly deeper poverty.

2.2. The Link to Agricultural Productivity

Given the over-arching question addressed by this study, it is informative to explore the mechanisms by which agricultural productivity gains might be realized through improved access to credit. There are many. In particular, literature abounds which explores the relationships of sharecropping and farm size with agricultural productivity.

2.2.1. Sharecropping

Sharecropping is a land tenure system which has been widely practiced for centuries in countries around the world (Reid 1976). Sharecropped land is owned by one person but farmed by a tenant who pays the landowner a fixed proportion of the resultant crop. The difference from fixed rent (or cash rent) contracts arises from the fact that with cropshare contracts the rent paid to the landowner is a fixed proportion of the final output, rather than a fixed amount. This form of contract means that sharecropping farmers never receive the full marginal products of their efforts. If output is an increasing function of a farmer's effort, if exerting effort is utility decreasing for the farmer, and if effort is non-contractible and not easily monitored by the landlord, then the contractual form induces an apparent inefficiency into the production process: utility maximizing sharecropping farmers will give less-than-optimal levels of effort, and output will be lower than optimal. Landowners and farmers alike receive less output than would be possible with a different contractual form.

The question of why a seemingly inefficient contractual structure like sharecropping would have become so prevalent dates back at least to Adam Smith (1998 [1776]), who observed the apparent inefficiency: if farmers cannot afford to purchase land from the landlords, then fixed-rent contracts seem the efficient choice. There are, roughly speaking, two broad streams of thought on this. The first views sharecropping as a second-best efficient contractual form resulting from general risk aversion and imperfect or missing insurance markets, while the other views it as a second-best efficient contractual form resulting from the presence of non-zero transaction costs and trade-offs along multiple margins.

The risk aversion approach views sharecropping as a means of risk-sharing between landlords and tenants in the absence of a superior insurance alternative. The models tend to abstract from the possibility of farmers over-working the land they rent, and often (though not always) assumes transaction costs are zero. The emphasis is the reduced output resulting from the sub-optimal farmer effort levels which cropshare contracts induce. In the standard model, tenant-farmers are risk averse, thus output volatility imposed by nature makes it unappealing for them to commit to paying a fixed amount to rent land. Landowners in the standard model are risk neutral, so they do not mind bearing the risk in exchange for some premium. Of course, fixed-wage contracts completely disincentivize farmer effort, so sharecropping is a convenient if non-optimal middle ground which partially mitigates both problems, but results in sub-optimal output levels as a consequence of farmers' sub-optimal effort levels. The implication of the risk-aversion view of sharecropping is that emphasis should be placed on the mitigation of those influences, such as imperfect credit and insurance markets, which induce the adoption of cropshare contracts as a rational response to farmer risk aversion.

The transaction cost approach focuses more on the incentives present on a plurality of margins, and on the costs of monitoring and enforcing tenancy contracts (Allen and Lueck 2002). The models tend to emphasize more complex sharecropping models which allow farmers to choose the utilization-intensity of non-labour inputs like land, fertilizers, and seeds, where non-land, non-labour input costs are sometimes shared by landlords and tenants, and where sharecropping reduces the incentives for tenants to over-farm the land relative to fixed-rent contracts. This second result—reduced incentives to over-farm rented land—follows from the fact that the long-term fertility of soil depends heavily on the nutrients and moisture it contains, and that nutrient- and moisture-levels can be significantly affected by prior farming practices imposed on the soil.

In particular, it is possible for farmers to coerce greater short-term yields from plots of land by farming in ways which deplete nutrient- and moisture-levels and diminish the long-term fertility of the soil. Such land-use intensity may be super-optimal, as it diminishes the agricultural viability of the land. If landowners are unable to perfectly monitor and price soil exhaustion into contracts, and if tenant-farmers do not maintain longer-term tenancies on plots of land (and so do not have an incentive to maintain the soil quality over time), then they do not bear the full costs of soil exhaustion and thus will over-work the land to realize great immediate yields. Here the incentive to reduce effort, relative to a fixed-rent contract and induced by sharecropping, will also serve to reduce over-use of the land, though it may still be used more intensively than would be optimal. Thus sharecropping, in this view, helps to balance (at the margin) the mal-incentives present in fixed-wage and fixed-rent contracts. As long as the other costs incurred as a result of sharecropping (eg. the costs of measuring and dividing the crop) are low enough, sharecropping, in this view, is a rational response to the many incentives faced by tenant-farmers and results in a second-best efficient outcome.

The risk aversion models imply sharecropping results in sub-optimal output levels, and that addressing those issue which lead landlords and tenants to rationally establish sharecropping contracts in response should be an effective means of improving agricultural productivity, and should be Pareto improving. The transaction cost models are more ambiguous about the effects of sharecropping on productivity, as sharecropping discourages productivity along some margins, but encourages it along others. Regardless of the effect on productivity, the transaction cost framework, taken alone, implies tenant-farmers and landlords can do no better given the constraints they face, though it suggests anything which lowers transaction costs will likely lead to output levels closer to the first-best. While the greater complexity of the transaction cost model is appealing, and while

Allen and Lueck (2002) find evidence for it using North American data, the authors suggest output should be higher on fixed-rented land than on owned land (since fixed-rent contracts incentivize over-working the soil, while owners are more concerned with the long-term agricultural viability of the land). Yet this is inconsistent with Shaban (1987), who found no significant differences between owned and fixed-rented plots of land, or between the input intensities used on the two types by farmers who cultivated both their own and rented land. Furthermore, the incentive to over-work the land should only be present if farmers do not believe they will be farming the rented land for extended periods of time, yet Cheung (1969b) concluded many contracts are either longer-term or are renewed regularly. It is therefore unclear which of the two models is correct. Indeed, Cheung (1969b) argued both postulates are necessary. This paper takes the view that risk-aversion plays at least some role in the determination of tenancy contracts, and that it is thus possible (though not certain) that poor tenant-farmers can be made better off through a reduction in sharecropping-costs.

2.2.2. Farm Size and Productivity

There is also significant literature suggesting the existence of an inverse relationship between farm size and productivity, first discussed by Sen (1962) who dismissed it as simply the result of greater per-acre inputs on small farms, and particularly of greater amounts of family labour per acre on family-operated farms. Larger farms, conversely, depend on less efficient wage labour (and less of it, per acre cultivated), which contributes to the productivity gap. This view has been supported by Carter (1984), who finds that small farms employ 36% more labour than is optimal given the areas cultivated (though he notes that this analysis is based on market prices of factors of production, which may well overstate the true opportunity costs faced by farmed families. If this is true, then the input intensity on small farms is still efficient). Cornea (1985) concurs, but notes that the intensity of the inverse relationship varies with land scarcity: where land is scarce and conspicuous surplus labour is present, the relation is stronger.[3] The general consensus is that this inverse relationship is not the result of decreasing returns to scale, as might be assumed at first glance, since labour input quality is not constant.

If this is the case, the returns should be high for labour-augmenting capital inputs like fertilizer, draft animals, farm equipment, and reliable irrigation, and HYV seeds. Through the development and adoption of HYV cereal grains, and through modern agricultural technologies and management techniques, the so-called 'Green Revolution' which began in the 1960s resulted in dramatic productivity improvements (Hazell and Ramasamy 1991). Yet much of the success came from only parts of Asia and South America, and has proved difficult to replicate elsewhere because of the need to develop environment-appropriate varieties for each region and the complementary input intensity required by most HYVs. Indeed, most of the gains came from areas with reliable irrigation or rain-fed lowlands where the water levels can be easily controlled (Evenson and Gollin 2003). Farmers in regions not endowed with reliable and controllable water supplies, and those who could not afford—or, due to land tenure situations, were unwilling to invest in—the necessary fertilizers and pesticides, or who were ignorant to the optimal balance of inputs, saw fewer productivity gains (Griffin 1974; Hazell and Ramasamy 1991; International Food Policy Research Institute 2003; Sattar 1999). Even in regions where the use of HYVs may not have been feasible, the returns to inputs like fertilizer and farm equipment should be high, particularly for labour-intensive family operations. Yet the necessity of purchasing these inputs up-front has often discouraged or prevented farmers from using them. Those who were unable to afford the initial purchase price were unable to realize the productivity gains and were often unable to afford the purchase price the next time around, keeping them in low-productivity traps

[3] Cheung (1969a) insists there is no "surplus" labour on these farms, but that rather, because arable land is scarce and farming skills are not highly valued in other industries, labour is rationally used in intensities that may seem greater than optimal only to the untrained eye, observing "Crowded farming is the result of wealth maximization, not of 'irrationality'".

(FAO 2009). Where this has obtained, improved access to credit should make up-front purchases possible, leading to greater productivity.

An alternative explanation of the inverse relationship between farm size and productivity is proposed by Assuncao and Ghatak (2003). They develop a model in which heterogeneous farmer skill is independent of exogenous wealth distribution, and the absence of a credit market means farm size is directly proportional to initial wealth, with the result that the marginal skilled-farmer is poorer than the marginal unskilled one, and the marginal small farm is more productive than the marginal large one. Which explanation better accounts for the inverse relationship between farm size and productivity—surplus high-quality labour on small family farms or poor but highly skilled farmers unable to afford larger farms—is unclear. If the first, the returns on labour-augmenting capital inputs should be high. If the second, improved access to credit for poor farmers should result in a more efficient market for land. In either case, better credit markets should lead to productivity gains.

2.3. Implications

The productivity impacts of sharecropping and of the inverse relationship between farm size and productivity (along with a vastly unequal distribution of land holdings between rich and poor) have often served to justify calls for land reform in less developed countries. Yet effective implementation of land reforms are tricky; when they are poorly designed or enforced, rent-seeking landowners tend to act in ways which result in lower overall productivity and which are generally welfare-decreasing for their tenants—the very people the reforms are intended to help. Landowners may evict tenants if they suspect legislation is likely to pass which gives tenants security, and they are likely to transfer to family members their land-holdings which are in excess of proposed land-ceilings. For example, Ghatak and Roy (2007) review the effects of land-reform legislation in post-Independence India, finding a negative and significant effect on productivity. When they decompose the effects of the various reforms, they find that land-ceiling legislation had a significant and negative effect on productivity, though the effect of tenancy reform was statistically insignificant. Conversely, tenancy reforms in the Indian state of West Bengal, which were enacted and strictly enforced by a more left-leaning government, appear to have induced productivity gains (Banerjee, Gertler and Ghatak 2002).

Because of the difficulties associated with the implementation of land reforms, particularly the risk of inducing extra hardship on poor farmers, market-based solutions to the issues of tenancy and land-holding would be theoretically preferable to land-redistribution if financial institutions were strong. To the extent that credit markets are imperfect in underdeveloped countries, agricultural inefficiencies will persist and productivity will remain too low to lift farmers out of poverty. Regardless which explanation of the inverse relationship between farm size and productivity is correct, improved credit markets should in theory increase productivity. If heterogeneous farmer skill is the explanation, then better credit markets would allow the marginal skilled-farmers to borrow and rent land from the marginal unskilled ones and lend their skill to greater plots of land, realizing productivity gains. If the explanation is instead that small farms are simply flush with reliable family labour but are unable to afford to purchase more land or productive inputs, then better credit markets would allow them to make those purchases and would again lead to productivity gains (assuming land titles have been granted and a market for land exists). Poor farmers who sharecrop because they cannot afford to purchase land or rent it up-front would also benefit from improved credit markets. Finally, if poor, rural farmers are risk averse and lack access to formal insurance markets, greater access to credit may be an imperfect but preferable form of insurance relative to sharecropping; hence greater access to credit would result in less sharecropping and thus higher effort levels. In nearly all these cases, if poor, rural farmers are truly credit-constrained, improved access to credit through MFI programs should help drive productivity gains.

3. The Data

The data come from a survey conducted by The World Bank in cooperation with the Bangladesh Institute for Development Studies in 1991-92. It covers 1798 households randomly selected from 87 rural villages in 29 different thanas (districts) in Bangladesh. Of those thanas, 24 contained villages which were being served by one of Bangladesh's three large MFIs (8 each for BRAC, Grameen Bank, and BRDB RD-12).[4] The remaining five did not contain villages being served by an MFI. Of those 1798 households, 1538 had access to an MFI program and were deemed eligible to participate, with 905 households choosing to do so. 1769 household were surveyed three times during the year—once for each of the three major rice growing seasons. Unfortunately, the data are not complete for all households across all three seasons. Certain variables necessary for this analysis—in particular, those recording agricultural productivity—were only observed for a very small subset of households over all three seasons. Furthermore, since the varieties grown in the three seasons require different conditions and vary in average productivity, they would not be directly comparable even if productivity was recorded for each household in each season. It is thus impractical and inappropriate to use the data for anything other than cross-sectional analysis. The focus is on the season with the most usable observations—the Aman rice season, which lasts from November-February, during which more than half of all rice grown in Bangladesh is cultivated[5] (International Rice Research Institute 2012).

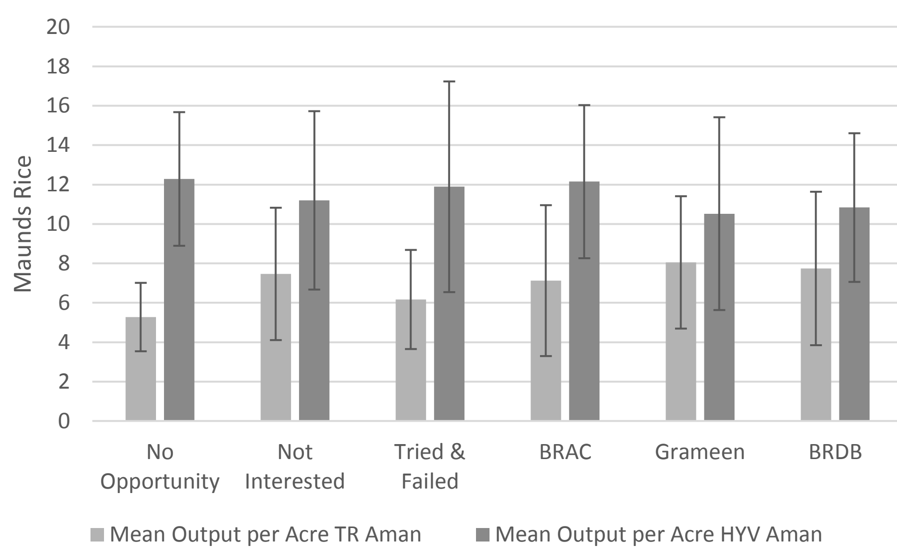
The effect of access to microcredit on productivity is measured separately for each type of rice. HYV crops tend to be much more productive than traditional varieties when grown under the right conditions and with the right balance and intensity of inputs, and

[4] The reduced sample contains one apparent violation of this separation of MFI programs: one household in a BRAC village received a BRDB loan but not a BRAC loan, though it's possible this was a recording error.

[5] The researchers who conducted the survey list the Aman season as running from November-February. IRRI (2012) lists it as running from July-December.

so the productivities of farmers growing different types are not directly comparable (Figure 1). Since inputs such as monthly household labour hours are not identified by the type of rice which they were used to cultivate, their effects on the production of each type are not identified. Assuming the proportional allocation of inputs by the area cultivated with each type would be unreasonable (for example, if an input was used exclusively with one type of rice, its true effect on production of the other would be zero). Thus the best option is to discard those households which planted both types.

Figure 1: Mean Output per Acre (Maunds Rice)



NOTES: Error bars indicate one standard deviation to either side of each group mean, though this is likely skewed by the zero lower-bound on productivity.

After aggregating the variables within each household and dropping households with inconsistent observations (e.g. reporting sharecropped acreage greater than total area cultivated) and those which planted seed but reported zero output, the sample consists of observations from 527 households of which 313 cultivated land with transplanted Aman rice (TR) and 214 cultivated land with a high yield variety (HYV) of Aman. Of these 527 households, 242 had at least one member in a microcredit program, 71 reported no opportunity to join a program, 23 tried to join a program but failed, and 191 neither tried to join a program nor reported the absence of an opportunity to do so.

The surveys were completed with the assistance of study workers, so the possibility of selection bias due to such factors as literacy is not an issue. Of much greater concern is that the remaining sample contains no households from non-treated villages. Were it not for the apparently blatant disregard by MFI workers for their own program eligibility conditions in treated villages, unbiased estimation of the effects of program access on productivity would be impossible. Helpfully, the eligibility criterion were not widely followed. Only those households which owned less than half an acre of land were supposed to be eligible, yet the mean acreage per household in the sample was 104, 76, and 59 acres for BRAC, Grameen, and BRDB participants, respectively (Table 1).[6] These numbers are almost certainly inflated due to land purchases made by MFI members after they received their loans, but these households still often owned too much land to be technically eligible for microloans. Analyzing the same data, Morduch (1998) noted "The data demonstrate frequent violations of the rules… Among households labeled in the survey as "eligible to borrow" and with access to programs, the fraction of borrowers is nearly twice as high for those holding over half an acre versus those below (63% vs 34% for the three programs combined…)."

[6] Modal landholdings were zero for every group.

Table 1: Land Owned (Acres)

					---------------- Quantile------------------			
Program Joined	**Obs.**	**Mean**	**S.D.**	**Min**	**0.25**	**Mdn**	**0.75**	**Max**
No Opportunity	71	18.96	15.87	0	0	18	30	50
Not Interested	191	217.86	390.65	0	44	120	264	4575
Tried/Failed	23	28.74	24.16	0	0	27	45	100
BRAC	63	103.73	145.09	0	12.5	57	134	750
Grameen	96	76.4	113.91	0	13	44	93	840
BRDB	83	58.77	75.1	0	0	26	75	333

The violation of the eligibility criterion allows for the exploitation of this group as a non-treated control for access to microcredit if the violation was random. Yet it is not immediately clear if violation *was* random. For example, program workers may have bent the rules for individuals who appeared promising, for low-consumption households, for larger households, or for women from Muslim households (conservative Muslim households often practice 'purdah'—the seclusion of women—which disadvantages women from those households. Microcredit programs often target such women). Since assets are likely fungible within households, it is possible (even likely) that individual decisions to borrow were the result of collective decision-making within a household, and that some or all of the borrowed funds were applied to household activities such as farming. Thus it is possible that 'treatment' (being granted membership in an MFI program) was the result of such non-explicit factors. An analysis of the no-opportunity group and the in-program groups reveals no significant differences in averages of sex of the household head, Muslim or not, household size, or per-person consumption (Table 2).[7] The assumption of random violation may thus be reasonable, allowing unbiased estimates to be realized.

Table 2: Descriptive Statistics

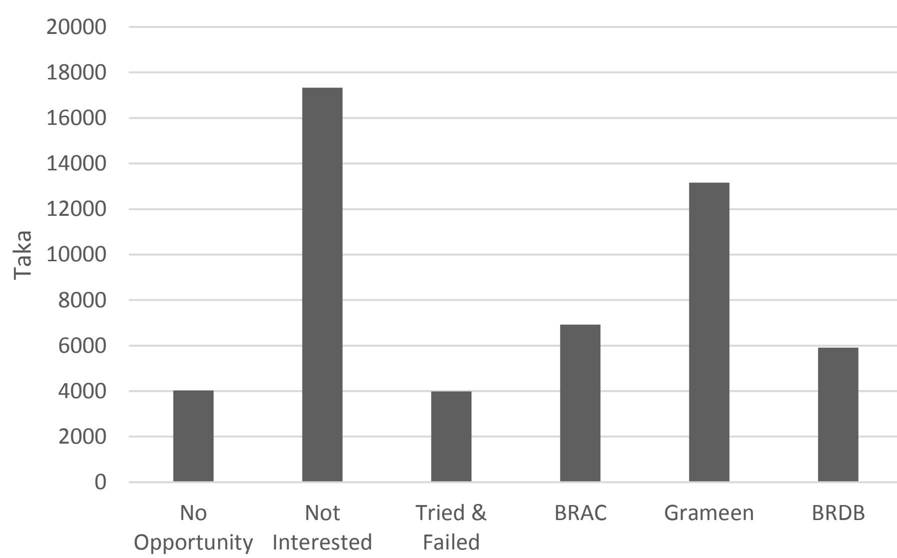
Program Joined	Obs.	% HH Head Male		HH Size		Consumption/ Person, Taka		% Muslim	
		Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
No Opportunity	71	100	0	5.96	2.67	8.6	3.07	92	28.0
BRAC	63	98	12.	5.84	2.49	8.05	2.15	100	0
Grameen	96	96	20.	5.44	1.92	8.64	2.65	75	43.5
BRDB	83	100	0	5.3	2.18	8.17	2.55	93	26.1
In Program	242	98	14.	5.49	2.17	8.33	2.50	88	33.0
All TR	313	99	9.7	5.88	2.51	8.56	2.68	90	30.3
All HYV	214	99	12	5.76	2.57	8.78	3.16	90	29.8

The average value of the principal amounts borrowed by each group further suggests no unobserved advantage held by members of the group which had no opportunity to join a program—indeed, they appear disadvantaged regarding credit: they borrow smaller sums than MFI members at more than double the interest rate (see Figures 2 & 3). The amounts borrowed by both the ‘No Opportunity’ group and the ‘Tried and Failed’ groups are identical and substantially less than the amounts borrowed by the ‘Not Interested’ group, plausibly due either to lower demand for or restricted access to loans for these groups. The smaller loan sizes of the ‘No Opportunity’ and ‘Tried and Failed’ groups relative to members of the three MFIs suggest microcredit improves access to credit if the households under the assumption these households are otherwise similar. Also of note is the significantly greater sums borrowed by Grameen Bank members

[7] Consumption may have been influenced by access to a program, but will likely be highly correlated with before-treatment status.

relative to members of the other two MFIs. The higher average interest rates paid by the 'No Opporunity' group relative to MFI members is due to the dramatically lower rates charged by the MFIs (see Figure 3). The greater loan-weighted interest rates for BRAC and, particularly, BRDB members are entirely due to outstanding loans from non-MFI sources—interest rates from the MFIs range from 16—19%. The average loan sizes seem to suggest Grameen members were on average granted higher credit limits, possibly allowing them to pay-out most other outstanding loans, and yielding lower loan-weighted interest rates for their members. Interestingly, the 'Not Interested' group paid a very high average interest rate despite their much greater landholdings, suggesting access to greater collateral does not lead to lower interest rates. Furthermore, every group experienced at least some increase in the increase in the average interest rate paid when weighted by loan size, suggesting high rates are not the result of fixed administrative costs.

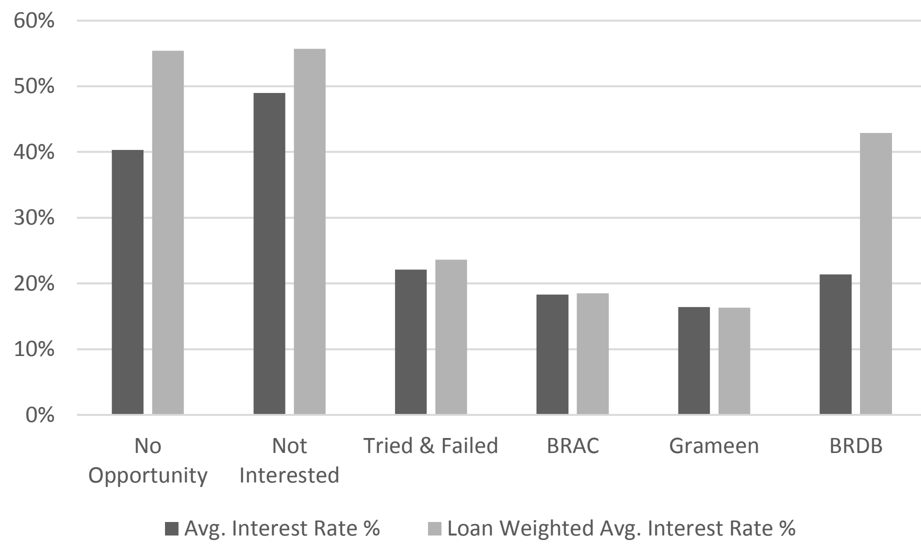
Figure 2: Mean Amount Borrowed (Taka)



NOTES: Restricted to households with total loans > 0 Taka.

Figure 3: Interest Rates Paid

(Average and Loan-weighted Average)



NOTES: (1) Restricted to households with total loans > 0 Taka. (2) Avg. Interest Rate % is calculated as follows: principal multiplied by the fractional interest rate paid=i is calculated for each borrower, then summed within households (hh_i). The proportion of each borrower's i within a household is then calculated (i/hh_i)=z. Avg. Interest Rate % for each group is the mean of group household Avg. Interest Rates paid %, calculated as the sum of household members' z multiplied by the fractional interest rate paid. (3) Loan Weighted Avg. Interest Rate % is calculated as follows: q=Avg. Interest Rate % for each household multiplied by the total amount borrowed by that household. d_k*=the sum of q within groups, where k is the group indicator.* w_k*=q/*d_k *is the loan weighting for each group. The Loan Weighted Avg. Interest Rate % for each group is then calculated as the sum of the Avg. Interest Rate % for each household multiplied by* w_k*.*

It is worth noting that credit markets are clearly not absent from these villages: members of each of the out-of-program groups were able to borrow funds—albeit at higher interest rates than those in the program, and at much lower participation rates. For many of the poorer out-of-program borrowers, these loans came from the state agricultural bank (Krishi Bank), or from family members, friends, neighbours, and local money-lenders, though many MFI members also had outstanding loans from such sources, perhaps from prior to joining an MFI program (See Table 3 and Appendix, Tables A.1 & A.2). Many of the wealthier ('Not Interested') out-of-program borrowers were able to secure loans from commercial banks or the government-owned agriculture-focused

Krishi Bank, but the average interest rate these borrowers paid was higher than for members of any other group. This suggests the possibility that high interest rates—and not credit rationing—were responsible for the relatively low rates of borrowing outside the microcredit programs, particularly in the 'No Opportunity' and 'Failed to Join' groups (many of those in the 'Not Interested' category may well have been uninterested in borrowing at all).

The proportions of cultivated land owned, sharecropped, and rented vary substantially among groups and within groups across TR and HYV farmers, though the average area cultivated by farmers in each group is broadly similar across farmer type (see Appendix, Figures A.1 & A.2). The proportion of owned land cultivated is not statistically different between the two types, suggesting (along with the absence of statistically different levels of per-person consumption across the two types of farmers, Table 2) that TR and HYV farmers have similar levels of wealth. Despite wildly different means across groups for cultivated land sharecropped and the proportion of sharecropped output paid, the variance is so high as to make the groups statistically indistinguishable (see Table 4).

Table 3: Average Loans by Source and Village MFI

Village MFI	# of Borrowers	Gov't	Krishi Bank	Bank or Coop	Micro Lender	Other NGO	Family/ Friend/ Money Lender	Total
BRAC								
No Opportunity	0	0	0	0	0	0	0	0
Not Interested	5	0	400	800	0	0	2980	4180
Tried & Failed	2	0	3250	0	0	0	600	3850
BRAC	53	0	19	75	6766	0	55	6915
Grameen	0	0	0	0	0	0	0	0
BRDB	1	0	0	0	12000	0	0	1200
Grameen								
No Opportunity	0	0	0	0	0	0	0	0
Not Interested	17	0	529	1191	0	0	2765	1520
Tried & Failed	2	0	0	2500	0	0	1500	4000
BRAC	0	0	0	0	0	0	0	0
Grameen	95	0	0	0	13039	0	116	1315
BRDB	0	0	0	0	0	0	0	0
BRDB								
No Opportunity	2	0	2500	0	0	0	2000	4500
Not Interested	18	278	25556	1789	0	0	2883	3050
Tried & Failed	2	0	2500	0	0	0	1600	4100
BRAC	0	0	0	0	0	0	0	0
Grameen	0	0	0	0	0	0	0	0
BRDB	72	0	153	69	4900	33	663	5818

*NOTES: By source, restricted to households with total loans > 0 Taka. 'Total' is thus not the sum of the mean loan size from each source, but rather the mean total loan size for each group regardless of source. **This BRDB borrower in a BRAC village may be the result of a recording error.*

Table 4: Sharecropping Summary Statistics by Program

Program	Amt. of Cultivated land Sharecropped, %		Avg. Share Paid from Sharecropped Output, %		Avg. Sharecropping-Cost*, %	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
TR Aman						
No Opportunity	39.8	45.9	19.8	23.8	17.9	22.6
BRAC	19.7	37.8	13.1	26.4	11.7	25.6
Grameen	26.8	37.9	13.3	20.8	10.5	18.0
BRDB	22.7	38.5	11.4	20.3	9.7	18.8
HYV Aman						
No Opportunity	20.3	37.3	9.1	17.5	7.9	16.3
BRAC	5.3	15.3	3.6	10.5	1.4	4.8
Grameen	11.6	28.3	7.3	18.1	5.4	15.3
BRDB	25.9	40.2	13.4	22.0	11.9	20.6

*NOTES: *Proportion of sharecropped output paid to landlord times the sharecropped proportion of total land cultivated. The results are likely skewed due to the zero lower bound.*

Finally, it is instructive to note the differences in input use for the two types of farmers. Direct comparisons of input utilization would be preferable, but unfortunately, for many of the households in the sample, utilization rates for numerous potentially important inputs are not observed; however, outlays (in taka) on those inputs *are* recorded. I assume that constant market prices for inputs (seeds, fertilizer, pesticide, water, and wage labour) obtain within villages, and use the aggregated cost as a proxy for non-land, non-household labour input intensity. Summary statistics for the log of this proxy are presented in Table 5. While the means are statistically indistinct across the two types, the higher HYV mean combined with the lower variance suggests HYV farmers are more consistently spending greater amounts on these inputs. Since HYV crops require greater input-intensity, this would make sense.

Table 5: Mean Logged Input Costs (Taka)

Rice Variety	Mean Logged Input Costs	Std. Dev.
TR Aman	5.64	1.67
HYV Aman	6.31	1.41

4. Results and Discussion

4.1. Estimation of Sharecropping-Cost

If sharecropping is simply the result of poor farmers being unable to purchase or rent land at fixed rates due to insufficient access to affordable credit (through high interest rates, credit rationing, etc.), then access to microcredit should alleviate that constraint by either reducing the amount of land which tenant farmers sharecrop, or by allowing for hybrid agreement between landlord and tenant in which the tenant pays the landlord some fixed rent in exchange for the right to keep a greater share of the output. If sharecropping results from risk-sharing between tenant farmers and landlords, then the flexible repayment plans offered by many MFIs may increase certainty, resulting in lower levels of sharecropping or lower shares paid by tenant farmers. To see if this is true, I create a composite measure of the proportion of total output paid for sharecropping by multiplying the proportion of sharecropped output farmers paid to landlords by the sharecropped proportions of total land cultivated.[8] This measure is then regressed on dummies for membership in each of the groups ('No Opportunity' is left out), age of the household head, household size, the log of total land cultivated, and dummies for each village to control for village-level unobservables. The results are presented in Table 6.

[8] This is necessary because most of the sharecropping households in the sample also cultivate either fixed-rented or owned land, but output is not reliably recorded according to the tenancy conditions for the land on which it was grown. The measure simply accounts for this, and represents the share of a household's total output which was paid to a landlord.

Table 6: Estimation of Sharecropping-Cost

(Proportion of Total Output Paid to Landlord for Sharecropping)

Regressors	TR Aman	HYV Aman	Both Types
Not Interested	**-0.115*** **	**-0.086*** **	**-0.195*** **
	(-3.18)	*(-2.92)*	*(-4.58)*
Tried/Failed	**-0.113** **	**-0.028**	**-0.140***
	(-2.28)	*(-0.49)*	*(-1.87)*
BRAC	**-0.012**	**-0.099*** **	**-0.108***
	(-0.22)	*(-2.77)*	*(-1.75)*
Grameen	**-0.090** **	**-0.084** **	**-0.172*** **
	(-2.15)	*(-2.06)*	*(-3.22)*
BRDB	**-0.068**	**-0.008**	**-0.075**
	(-1.60)	*(-0.20)*	*(-1.31)*
Age HH Head	**-0.001**	**0.008*** **	**0.006**
	(-0.00)	*(2.83)*	*(1.39)*
Age-sq. HH Head	**0.000**	**-0.000**	**0.000**
	(0.00)	*(-2.64)*	*(-1.52)*
HH Size	**0.000**	**-0.005***	**-0.004**
	(0.00)	*(-1.85)*	*(-0.81)*
Log Area	**0.029*** **	**0.033*** **	**0.024***
	(4.72)	*(4.15)*	*(1.77)*

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Membership in a Grameen Bank program is associated with an 8-9% lower cost of sharecropping for either crop relative to households which had no opportunity to join a microcredit program.[9] Membership in a BRDB program is insignificant for both types of farmers. Membership in a BRAC program is associated with a 10% decrease in the cost of sharecropping for HYV farmers, but has no significant effect on TR farmers. This inconsistency of the 'effect' across rice types for BRAC members suggests the result may not be robust, particularly when the aggregated effect ('Both Types') is only significant at

[9] Households with 'membership' in a program are those in which at least one household member reported being a member of an MFI program. Not all member households have outstanding loans. 'Membership' thus refers to households with access to credit rather than to those with outstanding MFI loans.

the 10% level. The Grameen results are robust and, surprisingly, quite similar to those of the ‘Not Interested’ group, membership in which is associated with significantly lower sharecropping-costs—possibly due to greater wealth levels, as suggested by their greater landholdings, or by the significantly greater sums of money they borrow, which could be used as an alternative and preferable form of insurance, relative to sharecropping. Logged area cultivated has a positive and significant but negligible (3%) effect on sharecropping-cost (see Section 5.1 for further analysis including individual regressions with each component of sharecropping cost as the dependent variable).

4.2. Estimation of Input Expenditure

If greater sharecropping shares can lead to agricultural productivity gains, it is plausible that it would be through farmers’ greater willingness to utilize costly agricultural inputs. As discussed, direct input intensities were not recorded, but input expenditure is a more than adequate proxy. If access to microcredit leads to agricultural productivity gains, through reduced sharecropping-costs, then it is possible that this effect comes through improved incentives to invest in costly inputs. To determine the direct effect of access to microcredit on input expenditure, I regress logged input expenditure on dummies for group membership (‘No Opportunity’ is the left out dummy), the proportion of output kept (equal to one minus the cost of sharecropping), logged area cultivated with type, fertilizer utilization, and a set of controls including monthly household hours dedicated to labouring on household farmland, household size and age of the head (entering as a quadratic), dummies for plough and draft cattle ownership, and dummies for each village to control for village-level unobservables, such as soil quality and weather, which could affect the choice of input utilization. The results are presented in Table 7.

Table 7: Estimation of Logged Input Expenditure (Taka)

Regressors	TR Aman	HYV Aman
Not Interested	**0.031**	**0.081**
	(0.29)	*(0.32)*
Tried/Failed	**-0.066**	**0.122**
	(-0.39)	*(0.40)*
BRAC	**0.115**	**-0.104**
	(0.87)	*(-0.32)*
Grameen	**-0.170**	**-0.239**
	(-0.80)	*(-0.85)*
BRDB	**0.343****	**0.156**
	(2.14)	*(0.50)*
Age HH Head	**0.001**	**-0.000**
	(0.04)	*(-0.01)*
Age-sq. HH Head	**0.000**	**0.000**
	(-0.05)	*(-0.03)*
Proportion of Output Kept	**0.335****	**(0.069)**
	(2.19)	*(0.29)*
Log Area Cultivated	**0.384*****	**0.682*****
	(3.42)	*(4.98)*
Ploughs	**-0.048**	**-0.051**
	(-0.44)	*(-0.39)*
Draft Cattle	**-0.037**	**0.503****
	(-0.29)	*(2.50)*
Ploughs+Draft Cattle	**0.101**	**-0.303**
	(0.65)	*(-1.28)*
Log Fertilizer (kg)	**0.644*****	**0.318****
	(6.45)	(2.41)

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Access to a BRDB program is associated with a 34% increase in input expenditure for TR Aman farmers only, but access to the other programs has no significant effect. Access to microcredit seems to have very little direct effect on greater input utilization/expenditure. Increasing the proportion of output kept by 1% is associated with a 34% increase in input expenditure for TR farmers only, suggesting that when these farmers are guaranteed a greater share of their output they are more willing to invest in their farms. That the size of the coefficient is so large is likely the result of very low input utilization when the proportion of output kept is low. That the effect is not present for HYV farmers may be due to the fact that growing HYV Aman is more input-intensive than growing TR Aman—most HYV farmers are likely already investing in more and costlier inputs, while TR farmers facing high sharecropping-costs may have had less incentive to invest. This is consistent with the discussion surrounding Table 5. Unsurprisingly, cultivating greater plots of land and using more fertilizer is associated with greater expenditure on inputs.

4.3. Estimation of Productivity

Having explored the effects of access to microcredit on sharecropping-costs and input expenditures, logged productivity (total output per acre cultivated) is now regressed, for each type of rice (measured in Bengal maunds—approximately 82 lbs.), on dummies for group membership ('No Opportunity' is the left out dummy), the proportion of output kept, logged area cultivated with type, fertilizer utilization, logged input expenditure, and a set of controls including monthly household hours dedicated to labouring on household farmland, household size and age of the head (entering as a quadratic), dummies for plough and draft cattle ownership, and dummies for each village to control for village-level unobservables, such as soil quality and weather (see Table 8). Additional regressions without the group membership dummies are included to check the other results.

The coefficients on logged area cultivated indicates the presence of the expected inverse relationship between farm size and productivity, with output per acre decreasing 17.5% per 1% increase in area cultivated with TR Aman, and decreasing 13.8% per 1% increase in area cultivated with HYV Aman. The result is remarkably robust even with the exclusion of the main variables of interest. The insignificance of both the household labour and the input expenditure variables are not consistent with the suggestion that the inverse relationship is simply due to greater input intensity on small farms. Yet the Assuncao and Ghatak (2003) model is even more unsatisfactory as an explanation of the inverse relationship between farm size and productivity—it assumes poor, skilled farmers are unable to purchase land, but (Morduch 1998 points out that) the data show evidence of a robust land market involving many of the sample households in the years before this study. See Section 5.2 for further analysis and discussion of this result. Productivity is increasing in the proportion of output kept, but only for TR Aman farmers. This is possibly due to the effect of increases in output kept (decreases in sharecropping-cost) on input expenditures. The joint significance of these two variables is tested using the linear restriction H_0: $\beta^{Proportion\_kept}$ + $\beta^{\text{Log Input Expenditures}} = 0$.[10] The result is highly significant ($F(1, 240) = 6.28, p = 0.0129$) for TR Aman farmers only, as suggested by the results in Table 7. Logged input costs—the proxy for non-land input intensity—is tiny and insignificant. See Section 5.3 for a series of robustness checks.

While MFI program membership is not individually significant for any group growing either type of rice, an F-test of the formβ^{MFI} + $\beta^{Proportion\_kept} = 0$, which tests whether access to an MFI program is jointly significant with the proportion of output kept (one minus the sharecropping-cost), is run for both types, finding joint significance for Grameen only ($F(1{,}240) = 5.49, p = 0.02$ and $F(1, 150) = 4.37, p = 0.0382$ with one restriction each for TR and HYV, respectively).[11] This is particularly telling for HYV farmers, where neither Grameen membership nor the proportion of output kept are individually significant. Proportion of output kept is not jointly significant with BRAC or BRDB membership for either type. Testing this linear restriction is reasonable given the size and significance of the Grameen coefficients on sharecropping-cost.

[10] The basic restriction (H_0: $\beta^{Proportion\_kept} = \beta^{\text{Log Input Expenditures}} = 0$) is not tested, since it only tests whether *at least* one of the coefficients $\neq 0$, and since it is already clear that $\beta^{Proportion\_kept} > 0$.
[11] See footnote 11.

Table 8: Estimation of Productivity

(Output per Acre, Maunds Rice)

Regressors	TR Aman		HYV Aman	
Not Interested		**-0.003**		**0.128**
		(-0.03)		(1.08)
Tried/Failed		**-0.125**		**-0.025**
		(-0.89)		(-0.10)
BRAC		**-0.187**		**-0.226**
		(-1.53)		(-0.99)
Grameen		**0.138**		**0.238**
		(0.92)		(1.28)
BRDB		**-0.161**		**0.029**
		(-1.18)		(0.22)
Proportion of Output Kept	**0.280*** **	**0.252** **	**0.176**	**0.127**
	(2.64)	(2.34)	(1.17)	(0.69)
Log Area Cultivated	**-0.161*** **	**-0.175*** **	**-0.107** **	**-0.138** **
	(-3.82)	(-4.14)	(-1.78)	(-2.32)
HH Farm Hours	**0.000**	**0.000**	**0.000**	**-0.000**
	(0.89)	(1.02)	(-1.60)	(-1.18)
Log Input Expenditures	**0.037**	**0.04**	**0.030**	**0.04**
	(1.42)	(1.60)	(0.62)	(0.85)
***F-Test* (1,240)**: $\beta^{Grameen}$		5.49		
p-value		**0.0200**		
***F-Test* (1,150)**: $\beta^{Grameen}$				4.37
p-value				**0.0382**

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

The joint significance of output proportion kept with Grameen membership alone follows from the significant and negative effect of Grameen membership alone on the sharecropping-cost. That is, the medium through which Grameen membership appears to be associated with increased productivity is through a reduction in the cost of sharecropping (that is, an increase in the proportion of sharecropped output kept by the farmers). Yet this inverse relationship is only evident when controlling for the other regressors in the sharecropping-cost regression—in particular, the village-level effects (without controlling for village fixed effects, on average BRAC members actually face the lowest sharecropping-costs and BRDB members the highest (Table 4)). While the data do not reveal why this might be, it is possible this pattern results from Grameen targeting villages where the poor tended to work higher proportions of sharecropped land or pay higher shares of the output to landlords—villages where the bargaining power of the poor was lower, even if they had comparable living standards to the poor in other villages.[12] Indeed, Grameen was nearly as concerned with the personal development and political engagement of its members as it was with making loans to the poor (Yunus 2003). Educating and equipping those with the least bargaining power to demand better contractual terms may be a winning strategy; access to microcredit may somewhat strengthen the bargaining positions of such households.

On the face of it, the size of loans borrowed and used specifically for agricultural purposes may seem highly relevant to the question being asked, though this is questionable given the fungibility of assets within households: loans borrowed and used for other purposes nonetheless free up assets for agricultural investment. To test whether agriculture-specific microloans positively impact agricultural productivity, the previous regression is re-run with the group membership dummies replaced by the logged agricultural loan amounts multiplied by the group membership dummies (see Table 9). None of the group-borrowing amounts are individually significant. For TR farmers only, the coefficients on all three group-borrowing amounts are jointly significant with the proportion of output kept, but this is almost certainly due to the negligible size of the BRAC and BRDB coefficients rather than to any interesting relationship, particularly since the BRDB coefficient has the wrong sign. The Grameen coefficient is more than six times the size of the BRAC coefficient, and may plausibly be jointly significant with the proportion of output kept. There are no significant effects for HYV farmers. A check controlling for the timing of loans is discussed in section 5.3.

[12] If this is the case, then the effect is not causal, but rather merely the result of selection.

Table 9: Estimation of Productivity

(Ouput per Acre, Maunds Rice)

Microcredit Agricultural Loan Size

Regressors	TR Aman	HYV Aman
Not Interested	**0.063**	**-0.002**
	(0.94)	*(-0.03)*
Tried/Failed	**-0.031**	**-0.201**
	(-0.30)	*(-0.84)*
Log BRAC Loan Size	**0.004**	**-0.037**
	(0.29)	*(-1.15)*
Log Grameen Loan Size	**0.026**	**-0.024**
	(1.42)	*(-0.94)*
Log BRDB Loan Size	**-0.001**	**-0.014**
	(-0.07)	*(-1.08)*
Proportion of Output Kept	**0.266****	**0.14**
	(2.46)	*(0.91)*
Log Area Cultivated	**-0.171*****	**-0.120****
	(-3.96)	*(-2.02)*
HH Farm Hours	**0.000**	**0.00**
	(0.99)	(-1.39)
Log Input Expenditures	**0.038**	**0.03**
	(1.43)	*(0.64)*
***F-Test* (1,240)**: β^{BRAC} +	6.15	
p-value	***0.0138*****	
***F-Test* (1,240)**: $\beta^{Grameen}$ +	6.84	
p-value	***0.0095******	
***F-Test* (1,240)**: β^{BRDB} +	5.93	
p-value	***0.0156*****	

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. The Not Interested and Tried/Failed regressors are simply dummies indicating group membership. The microcredit program variables are total microcredit agricultural loans multiplied by the dummies for group membership.*

This analysis has not accounted for possible positive spillover effects on non-members. For example, if Grameen members are taught how to negotiate better contractual terms with their landlords, it is entirely likely that they will share such knowledge with their non-member friends. Or, if MFIs teach their members better farming practices, non-members in the village will likely be exposed to it. If such effects are present, the estimated effects of access to microcredit would be biased downward. The results may also be biased if the violation of the selection criterion was based on some unobservable that did significantly differentiate members from those with no opportunity to join a program. The relatively small sizes of the different groups may have reduced the precision of the estimates somewhat, though this likely would have no bearing on the signs on the coefficients for BRAC and BRDB members (mostly negative). It is also true that the estimated results may not be externally valid: the rural poor in villages targeted by MFIs may differ significantly from those elsewhere, including other parts of Bangladesh. Finally, difficulties with the way the data were recorded prevent the use of difference-in-difference estimation to control for household fixed effects. Thus the productivity effects of household characteristics are absent from the analysis.

5. Robustness Checks

5.1. Sharecropping-costs

It is slightly surprising that the effect of group membership on sharecropping-cost is dependent on the program joined. Because of the apparent importance of sharecropping-costs to Grameen members, it matters if this result is driven by the significantly greater sums of money Grameen members borrowed (if, for example, greater access to credit improves their bargaining power). Sharecropping-cost is thus re-estimated by including the loan size as a regressor (Appendix, Table A.3). Loan size has a negligible effect on the size and significance of the coefficients on the other regressors (though it does carry the TR Aman BRDB coefficient to significance at the 10% level), and itself has an effect approaching 0. The robustness of the (joint) effect of Grameen membership suggests that the greater sums borrowed by Grameen members are not the reason for their ceteris paribus lower sharecropping-costs relative to members of other programs.

To decompose the effects on sharecropping-costs, individual regressions are run using each of the components of the sharecropping cost measure as dependent variables: the output share paid and the sharecropped proportion of cultivated land are each regressed on the baseline list of regressors (Appendix, Tables A.4 & A.5). The results are broadly consistent with those from the baseline estimation (Table 6).

5.2. Farm Size and Productivity

As further checks on the robustness of the inverse relationship result, two alternate specifications are estimated—one using the square of area cultivated, and another for which I change the dependent variable to log output per acre, per household hour worked on the family farm (see Appendix, Tables A.6 & A.7, respectively). With the first, the coefficient on area cultivated is negative while that on squared area cultivated is positive (both significant, for both types of rice), suggesting productivity is decreasing in area cultivated at a decreasing rate.[13] With the second, the coefficients on logged area cultivated are even larger than in the baseline specification, hinting that greater household labour inputs may indeed be driving the inverse relationship between productivity and area cultivated. If true, this would also explain why the effect seems weaker for HYV farmers—HYV Aman is hardier and tends to require less meticulous care to maximize its yield than does TR Aman.

5.3. Additional Checks

In the regressions discussed above (Tables A.6 & A.7), the joint significance of Grameen membership with output kept holds. As an additional robustness check, productivity is re-estimated using standard errors clustered by Thana (district), which results in the loss of Grameen membership joint significance for TR farmers but individual significance of Grameen membership for HYV farmers (Appendix, Table A.8). Input expenditure has a small, positive, significant effect on productivity for TR farmers. These regressions are not preferred over the baseline due to the unlikeliness of Thana-wide error-term correlation that stops at the borders of each district.

Quantile regressions for each type are also included (Appendix, Tables A.9 & A.10). While the significant effects of output proportion kept and area cultivated hold for TR Aman farmers across the productivity distribution, they do not hold for HYV farmers. Furthermore, the joint significance of Grameen membership and the proportion of output kept is no longer present for either type of farmer at the quantiles chosen, indicating the jointly-significant effect of Grameen membership on productivity is by no means present

[13] Since the variable is in acres, the size of the coefficient is predictably small. It is the sign, and not the size, which is informative with this specification.

for all Grameen members. Input expenditure has a small, positive, significant effect on productivity at the 0.25 and 1 quantiles for TR farmers.

Section 5.1 discusses the insignificance of loan size to sharecropping-costs (the variable through which Grameen membership has a positive effect). Despite this result, it may be the case that the timing of the loans mattered for their effects on productivity. To test this, group members are separated according to the timing of their borrowing: 'Recent' borrowers are those who borrowed within the 1991-92 Aman growing season (to ensure the loans were not used for growing other crops). While none of the group membership coefficients are individually significant, the joint significance between Grameen membership and output kept remains (particularly for TR farmers who borrowed recently. Appendix, Table A.11).

5.4. Summary of Results

In short, the robustness checks suggest that the size of loans doesn't seem to change the effects (present or absent) of MFI membership on sharecropping-cost, and that neither the timing- nor the use of loans significantly affects productivity. The inverse relationship between farm size and productivity is robust and plausibly the result of more intensive utilization of household labour.

6. Concluding Remarks

Many of the world's poor, rural farmers have traditionally lacked access to formal credit markets, while much economic theory suggests that credit market inefficiencies may contribute to depressed agricultural productivity. Microcredit has often been lauded as a means of alleviating credit constraints faced by the poor. This motivates the question: does access to microcredit lead to agricultural productivity gains among poor, rural farmers?

This paper addresses that question by analyzing data from a 1991—92 field survey of rural Bangladeshi households. Membership in a Grameen Bank program was alone associated with a reduction in its members' direct costs of sharecropping. Membership in a Grameen Bank program was alone significantly associated with higher productivity, but then only when considered jointly with the share of their own output which was kept by sharecropping farmers (the share not paid to landlords). While this one mildly positive result was robust to a number of specifications, quantile regression analysis demonstrated that there were many Grameen members for which it did not obtain. The positive effects also seemed more robust for (lower-productivity) TR Aman farmers than for HYV farmers, hinting that any productivity gains associated with greater access to microcredit may be realized through switching to high-yield crop varieties. The sample displays little evidence to support the idea that microcredit is an effective means of increasing agricultural productivity. Members of two of the three MFIs saw no significant increases in output despite borrowing an average of 5000-6000 taka (~US$135) at average interest rates around 20%. Even Grameen borrowers may not have seen significant enough productivity gains to offset the cost of borrowing. Yet given that these households still chose to borrow, it is a fair presumption that doing so was in some way welfare-improving—perhaps through income- or consumption-smoothing. Microcredit may well thus have a positive impact on the lives of the rural poor, but given the costs associated with subsidizing microcredit, and given the debt burdens which unproductive loans may place upon borrowers, it is reasonable to ask, as many economists already have, if these funds might be more effectively used to reduce poverty through a different medium.

References

Ahmed, Raisuddin, and Mahabub Hossain. 1990. *Developmental Impact of Rural Infrastructure in Bangladesh.* Washington: International Food Policy Research Institute. Accessed August 2013. http://www.ifpri.org/sites/default/files/publications/rr83.pdf.

Allen, Douglas W, and Dean Lueck. 2002. *The Nature of the Farm.* Cambridge, Massachusetts: MIT Press.

Asian Development Bank. 2010. "Gender Equality Results Case Studies: Bangladesh." *Asian Development Bank.* November. Accessed August 18, 2013. http://www.adb.org/sites/default/files/pub/2010/gender-case-study-ban.pdf.

Assuncao, Juliano J., and Maitreesh Ghatak. 2003. "Can unobserved heterogeneity in farmer ability explain the inverse relationship between farm size and productivity." *Economics Letters* 189-194.

Banerjee, Abhijit V., Paul J. Gertler, and Maitreesh Ghatak. 2002. "Empowerment and Efficiency: Tenancy Reform in West Bengal." *Journal of Political Economy* 239-280.

Banerjee, Abhijit, Esther Duflo, Rachel Glennerster, and Cynthia Kinnan. 2013. "The miracle of microfinance? Evidence from a randomized evaluation." *Working Paper.*

Carter, Michael R. 1984. "Identification of the inverse relationship betwen farm size and productivity: and empirical analysis of peasant agricultural production." *Oxford Economic Papers* 131-145.

Cheung, Steven. 1969a. *The Theory of Share Tenancy.* Chicago: The University of Chicago Press.

Cheung, Steven. 1969b. "Transaction costs, risk aversion, and the choice of contractual arrangements." *Journal of Law and Economics* 23.

Cornia, Giovanni Andrea. 1985. "Farm Size, Land Yields and the Agricultural Production Function: An Analysis for Fifiteen Developing countries." *World Development* 513-534.

Evenson, R. E., and D. Gollin. 2003. "Assessing the Impact of the Green Revolution, 1960 to 2000." *Science* 758-762.

Food and Agriculture Organization of the United Nations. 2009. "The State of Agricultural Commodity Markets: High food prices and the food crisis--experiences and lessons learned." Accessed April 13, 2013. ftp://ftp.fao.org/docrep/fao/012/i0854e/i0854e.pdf.

Food and Agriculture Organization of the United Nations. 2012. *The State of Food Insecurity in the World.* Annual Report, Rome: Food and Agriculture Organization of the United Nations.

Ghatak, Maitreesh, and Sanchari Roy. 2007. "Land reform and agricultural productivity in India: a review of the evidence." *Oxford Review of Economic Policy* 251-269.

GIZ. 2013. *Rural Infrastructure Improvement Projects I & II.* Accessed August 2013. www.giz.de/Themen/en/14664.htm.

Grameen Bank. 2011. *Grameen Bank At A Glance.* October. Accessed April 14, 2013. http://www.grameen-info.org/index.php?option=com_content&task=view&id=26&Itemid=175.

Griffin, Keith B. 1974. *The political economy of agrarian change, an essay on the green revolution.* Cambridge, Massachusetts: Harvard University Press.

Haggblade, Steven, Peter B.R. Hazell, and Thomas Reardon. 2009. *Transforming the Rural Nonfarm Economy.* Issue Brief, Washington: International Food Policy Research Institute.

Hazell, P. B.R., and C. Ramasamy. 1991. *The Green Revolution reconsidered: the impact of high-yielding rice varieties in South India.* Baltimore: The Johns Hopkins University Press.

Hicks, John. 1969. *A Theory of Economic History.* Oxford: Clarendon Press.

Hoff, Karla, and Joseph E. Stiglitz. 1990. "Imperfect Information and Rural Credit Markets: Puzzles and Policy Perspectives." *The World Bank Economic Review* 235-250.

International Food Policy Research Institute. 2003. "Green Revolution: Curse or Blessing?" *IFPRI.* Accessed July 14, 2013. http://www.ifpri.org/sites/default/files/pubs/pubs/ib/ib11.pdf.

International Rice Research Institute. 2012. "Rice Cropping Patterns in Bangladesh." *IRRI.* January 09. Accessed August 18, 2013. irri.org/index.php?option=com_k2&view=item&id11680:rice-cropping-patterns-in-bangladesh&Itemid=100242&lang=en.

Khandker, S. R. 1998. *Fighting Poverty with Microcredit: Experience in Bangladesh.* World Bank Publications.

Khandker, Shahidur R. 2005. "Microfinance and Poverty: Evidence Using Panel Data from Bangladesh." *The World Bank Economic Review* 263-286.

Khatun, Hafiza. 2003. *Integrating Gender Into World Bank Financed Transport Programs.* Case Study, World Bank. Accessed August 2013. http://www4.worldbank.org/afr/ssatp/Resources/HTML/Gender-RG/Source%20%20documents/case%20studies/ICNET%20Case%20Studies%20for%20WB/CSICN4%20Bangladesh%20Dhaka%20Urban%20project.pdf.

Kiva. 2013. *Kiva - About Us.* Accessed April 14, 2013. http://www.kiva.org/about.

Levine, Ross. 1997. "Financial Development and Economic Growth: Views and Agenda." *Journal of Economic Literature* 688-726.

Lucas, Robert E. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics* 3-42.

McKinnon, Ronald I. 1973. *Money & Capital in Economic Development.* Brookings Institution Press.

Microcredit Summit Campaign. 2012. "State of the Microcredit Summit Campaign Report 2012." *Microcredit Summit Campaign.* Accessed April 14, 2013. http://www.microcreditsummit.org/resource/46/state-of-the-microcredit-summit.html.

Microfinance Information Exchange. 2009. "MFI Benchmark Analysis | Microbanking Bulletin, December 2009 (Issue No. 19)." *Microfinance Information Exchange.* December. Accessed April 14, 2013. http://www.themix.org/publications/microbanking-bulletin/2009/12/mfi-benchmark-analysis-microbanking-bulletin-december-200.

Morduch, Jonathan. 1998. *Does Microfinance Really Help the Poor? New Evidence from Flagship Programs in Bangladesh.* Research Program in Development Studies, Woodrow Wilson School of Public and International Affairs.

Morduch, Jonathan. 1999a. "The Microfinance Promise." *Journal of Economic Literature* 1569-1614.

Morduch, Jonathan. 1999b. "The role of subsidies in microfinance: evidence from the Grameen Bank." *Journal of Development Economics* 229-248.

Pitt, Mark M., and Shahidur R. Khandker. 1998. "The Impact of Group-Based Credit Programs on Poor Households in Bangladesh: Does the Gender of Participants Matter?" *Journal of Political Economy* 958-996.

Rahman, Atiq. 1992. "The Informal Financial Sector in Bangladesh: And Appraisal of its Role in Development." *Development and Change* 147-168.

Ravillion, Martin, and Guarav Datt. 2002. "Why has economc growth been more pro-poor in some states of India than others?" *Journal of Development Economics* 381-400.

Reid, Joseph D. 1976. "Sharecropping and Agricultural Uncertainty." *Economic Development and Cultural Change* 549-576.

Sattar, Sheikh A. 1999. *Bridging the Rice Yield Gap in Bangladesh.* Bridging the Rice Yield Gap in Asia and the Pacific, Food and Agriculture Organization of the United Nations.

Sen, Amartya K. 1962. "An Aspect of Indian Agriculture." *The Economic Weekly* 243-246.

Shaban, Radwan Ali. 1987. "Testing between Competing Models of Sharecropping." *Journal of Political Economy* 893-920.

Smith, Adam. 1998 [1976]. *An Inquiry Into the Nature and Causes of the Wealth of Nations.* Oxford: Oxford University Press.

World Bank. 2013. *Agriculture and Rural Development.* Accessed July 21, 2031. data.worldbank.org/topic/agriculture-and-rural-development.

Yunus, Muhammad. 2003. *Banker to the Poor.* New York: Public Affairs.

Appendix

Figure A.1: Mean Area Cultivated

(Acres TR Aman), By Contract

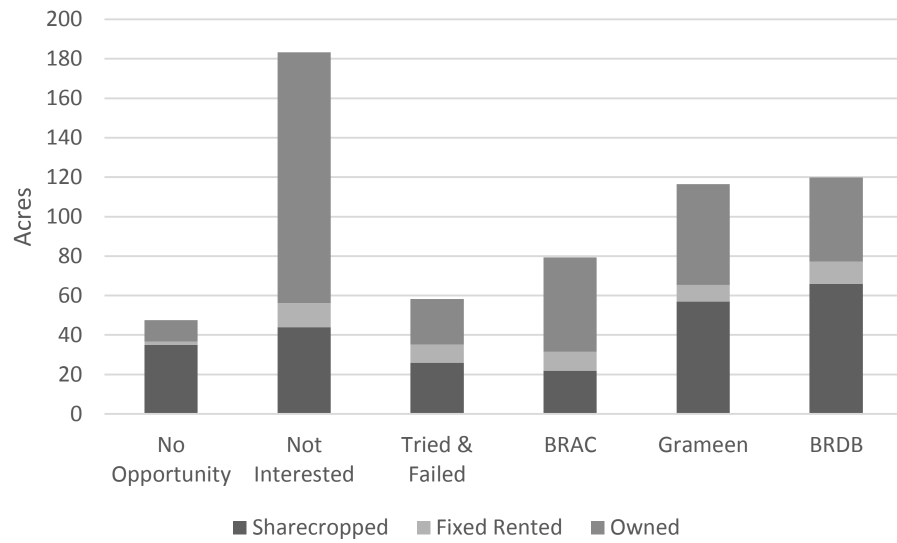


Figure A.2: Mean Area Cultivated

(Acres HYV Aman), By Contract

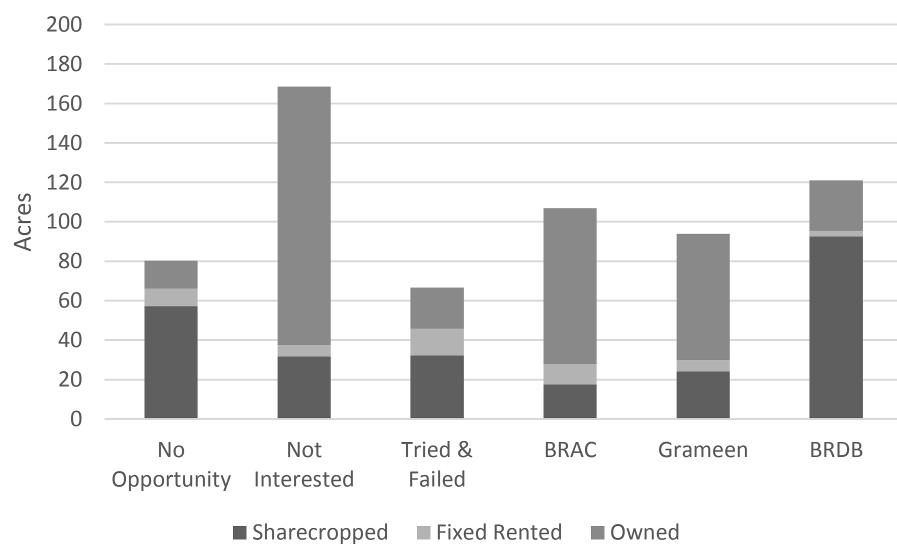


Table A.1: Average Loans by Source*

Program Joined	Gov't	Krishi Bank	Bank or Coop	Micro Lender	Other NGO	Family/Friend/ Money Lender	Total
TR Aman							
No Opportunity	0	64	255	0	0	1362	1681
Not Interested	0	4315	872	0	0	572	5759
Tried & Failed	0	433	0	0	0	80	513
BRAC	0	24	95	4479	0	69	4667
Grameen	0	0	0	10189	0	204	10393
BRDB	0	85	53	3443	51	213	3845
HYV Aman							
No Opportunity	0	208	229	0	63	1238	1738
Not Interested	60	128	2187	0	0	1198	3573
Tried & Failed	0	625	625	0	0	775	2025
BRAC	0	0	0	8120	0	0	8120
Grameen	0	0	0	16393	0	0	16393
BRDB	0	194	69	5639	0	1047	6949

*NOTES: *Includes households with no loans.*

Table A.2: Average Loans by Source*

Program Joined	Gov't	Krishi Bank	Bank or Coop	Micro Lender	Other NGO	Family/Friend/ Money Lender	Total
TR Aman							
No Opportunity	0	3000	6000	0	0	4000	4389
Not Interested	0	93200	7246	0	0	3863	20733
Tried & Failed	0	3250	0	0	0	1200	3850
BRAC	0	1000	4000	6068	0	1450	5939
Grameen	0	0	0	10381	0	3667	10589
BRDB	0	4000	2500	4045	2400	5000	4407
HYV Aman							
No Opportunity	0	5000	5500	0	1500	3300	3475
Not Interested	5000	3533	60500	0	0	5847	12891
Tried & Failed	0	5000	5000	0	0	3100	4050
BRAC	0	0	0	8526	0	0	8526
Grameen	0	0	0	16393	0	0	16393
BRDB	0	7000	2500	6548	0	4713	7819

*NOTES: *By source, restricted to households with total loans > 0 Taka. 'Total' is thus not the sum of the mean loan size from each source, but rather the mean total loan size for each group regardless of source.*

Table A.3: Estimation of Sharecropping-Cost

(Proportion of Total Output Paid to Landlord for Sharecropping, Maunds Rice)

Control for Loan Size

Regressors	TR Aman	HYV Aman	Both Types
Not Interested	**-0.115*** **	**-0.086*** **	**-0.195*** **
	(-3.16)	*(-2.95)*	*(-4.57)*
Tried/Failed	**-0.112** **	**-0.028**	**-0.140* **
	(-2.26)	*(-0.49)*	*(-1.86)*
BRAC	**-0.009**	**-0.099*** **	**-0.107* **
	(-0.18)	*(-2.77)*	*(-1.71)*
Grameen	**-0.085** **	**-0.084** **	**-0.167*** **
	(-2.03)	*(-2.07)*	*(-3.14)*
BRDB	**-0.071* **	**-0.008**	**-0.077**
	(-1.66)	*(-0.19)*	*(-1.35)*
Age HH Head	**-0.001**	**0.008*** **	**0.006**
	(-0.31)	*(2.83)*	*(1.40)*
Age-sq. HH Head	**0.000**	**-0.000**	**0.000**
	(0.00)	*(-2.64)*	*(-1.53)*
HH Size	**0.001**	**-0.005* **	**-0.003**
	(0.31)	*(-1.82)*	*(-0.63)*
Log Area Cultivated	**0.029*** **	**0.033*** **	**0.025* **
	(4.75)	*(4.15)*	*(1.80)*
Loan Size	**0.000** **	**0.000**	**0.000** **
	(2.13)	(0.16)	(-2.26)

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Table A.4 Estimation of Sharecropping Share Paid

(Proportion of Sharecropped Output Paid to Landlord for Sharecropping, Maunds Rice)

Regressors	TR Aman	HYV Aman
Not Interested	**-0.108*** **	**-0.086*** **
	(-2.74)	*(-2.78)*
Tried/Failed	**-0.100***	**-0.013**
	(-1.75)	*(-0.23)*
BRAC	**-0.000**	**-0.075***
	(-0.00)	*(-1.92)*
Grameen	**-0.092****	**-0.072***
	(-2.00)	*(-1.71)*
BRDB	**-0.078***	**0.002**
	(-1.67)	*(0.05)*
Age HH Head	**-0.000**	**0.009*** **
	(-0.16)	*(3.01)*
Age-sq. HH Head	**-0.000**	**-0.000****
	(-0.10)	*(-2.86)*
HH Size	**0.001**	**-0.003**
	(-0.17)	*(-1.19)*
Log Area Cultivated	**0.038*** **	**0.039*** **
	(5.76)	*(4.83)*

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Table A.5: Estimation of Sharecropped Proportion of Total Land Cultivated

Regressors	TR Aman	HYV Aman
Not Interested	**-0.226*** **	**-0.204*** **
	(-3.50)	*(-3.17)*
Tried/Failed	**-0.211*** **	**-0.140**
	(-2.35)	*(-1.61)*
BRAC	**-0.067**	**-0.236*** **
	(-0.77)	*(-3.07)*
Grameen	**-0.143* **	**-0.182** **
	(-1.88)	*(-2.31)*
BRDB	**-0.113**	**-0.050**
	(-1.49)	*(-0.62)*
Age HH Head	**0.002**	**0.020*** **
	(0.31)	*(3.53)*
Sq. Age HH Head	**-0.000**	**-0.000*** **
	(-0.56)	*(-3.39)*
HH Size	**0.001**	**-0.012** **
	(0.19)	*(-2.31)*
Log Area Cultivated	**0.070*** **	**0.070*** **
	(6.45)	*(5.81)*

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Table A.6: Estimation of Productivity

(Output per Acre, Maunds Rice)

Quadratic Area Cultivated

Regressors	TR Aman	HYV Aman
Not Interested	**-0.003**	**0.128**
	(-0.30)	*(1.17)*
Tried/Failed	**-0.147**	**-0.076**
	(-1.06)	*(-0.32)*
BRAC	**-0.210***	**-0.219**
	(-1.72)	*(-0.97)*
Grameen	**0.101**	**0.229**
	(0.68)	*(1.27)*
BRDB	**-0.196**	**0.015**
	(-1.47)	*(0.12)*
Proportion of Output Kept	**0.270*****	**0.133**
	(2.58)	*(0.71)*
Area Cultivated	**-0.003*****	**-0.003*****
	(-3.52)	*(-3.56)*
Squared Area Cultivated	**0.000*****	**0.000*****
	(3.44)	*(3.60)*
HH Farm Hours	**0.000**	**-0.000**
	(0.27)	(-1.27)
Log Input Expenditures	**0.037**	**0.036**
	(1.41)	*(0.85)*
***F-Test* (1,239)**: $\beta^{Grameen}$ + $\beta^{\text{Proportion Kept}}$ = 0	5.06	
p-value	***0.0254****	
***F-Test* (1,149)**: $\beta^{Grameen}$ + $\beta^{\text{Proportion Kept}}$ = 0		4.40
p-value		***0.0377****

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Table A.7: Estimation of Productivity

(Output per Acre per HH Hour Farm Labour, Maunds Rice)

Regressors	TR Aman	HYV Aman
Not Interested	**0.185**	**0.104**
	(-0.88)	*(0.38)*
Tried/Failed	**-0.073**	**-0.462**
	(-0.26)	*(-1.17)*
BRAC	**-0.278**	**-0.16**
	(-1.12)	*(-0.35)*
Grameen	**0.332**	**-0.041**
	(1.24)	*(-0.12)*
BRDB	**-0.011**	**-0.181**
	(-0.04)	*(-0.62)*
Proportion of Output Kept	**0.365***	**-0.364**
	(1.75)	*(-1.14)*
Log Area Cultivated	**-0.388*****	**-0.441*****
	(-3.71)	*(-5.23)*
HH Farm Hours	**-0.003*****	**-0.005*****
	(-8.24)	(-9.08)
Log Input Expenditures (HH Farm Hours Excluded)	**0.068**	**0.040**
	(1.46)	*(0.73)*
***F-Test* (1,235)**: $\beta^{Grameen} + \beta^{\text{Proportion Kept}} = 0$	4.79	
p-value	***0.0297****	
***F-Test* (1,150)**: $\beta^{Grameen} + \beta^{\text{Proportion Kept}} = 0$		1.39
p-value		***0.3361***

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level. Households which had no opportunity to join a microcredit program are the left out group.*

Table A.8: Estimation of Productivity

(Output per Acre, Maunds Rice)

Standard Errors Clustered by Thana

Regressors	TR Aman	HYV Aman
Not Interested	**-0.003**	**0.128***
	(-0.02)	*(1.91)*
Tried/Failed	**-0.125**	**-0.025**
	(-0.95)	*(-0.19)*
BRAC	**-0.187**	**-0.226**
	(-1.58)	*(-0.89)*
Grameen	**0.138**	**0.238****
	(0.61)	*(2.01)*
BRDB	**-0.161**	**0.029**
	(-0.98)	*(0.33)*
Proportion of Output Kept	**0.252***	**0.127**
	(1.72)	*(0.64)*
Log Area Cultivated	**-0.175*****	**-0.138***
	(-2.94)	*(-1.90)*
HH Farm Hours	**0.000**	**-0.000***
	(0.77)	(-1.80)
Log Input Expenditures	**0.041****	**0.04**
	(2.32)	*(0.66)*
***F-Test* (1,25)**: $\beta^{Grameen} + \beta^{\text{Proportion Kept}} = 0$	3.01	
p-value	***0.0952***	
***F-Test* (1,18)**: $\beta^{Grameen} + \beta^{\text{Proportion Kept}} = 0$		11.91
p-value		***0.0028*****

*NOTES: t-statistics in parentheses, calculated using clustered standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level.*

Table A.9: Estimation of TR Aman Productivity by Quantile

(Output per Acre, Maunds Rice)

	------------------------Quantile-----------------------			
Regressors	**0.25**	**0.5**	**0.75**	**1**
Not Interested	**-0.063**	**-0.027**	**-0.035**	**-0.091**
	(-0.95)	*(-0.27)*	*(-0.36)*	*(-0.64)*
Tried/Failed	**-0.037**	**-0.190**	**-.0275**	**-0.003**
	(-0.16)	*(-0.87)*	*(-1.40)*	*(-0.01)*
BRAC	**-0.097**	**-0.190**	**-0.148**	**-0.252**
	(-0.50)	*(-1.17)*	*(-0.98)*	*(1.07)*
Grameen	**-0.061**	**0.026**	**0.011**	**-0.176**
	(-0.45)	*(0.16)*	*(0.10)*	*(-1.11)*
BRDB	**-0.296****	**-0.177**	**-0.089**	**-0.332**
	(-2.54)	*(-1.13)*	*(-0.58)*	*(-1.26)*
Proportion of Output Kept	**0.145****	**0.196****	**0.172**	**0.231****
	(1.99)	*(2.04)*	*(1.23)*	*(2.07)*
Log Area Cultivated	**-0.113****	**-0.137*****	**-0.096****	**-0.134**
	(-1.96)	*(-2.87)*	*(-2.29)*	*(-1.58)*
HH Farm Hours	**0.000**	**0.000**	**0.000**	**0.000**
	(0.12)	*(1.01)*	*(0.11)*	*(-0.67)*
Log Input Expenditures (HH Farm Hours Excluded)	**0.058****	**0.029**	**0.038**	**0.060***
	(2.07)	*(1.04)*	*(1.35)*	*(1.86)*

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level.*

Table A.10: Estimation of HYV Aman Productivity by Quantile

(Output per Acre, Maunds Rice)

	-------------------------Quantile------------------------			
Regressors	**0.25**	**0.5**	**0.75**	**1**
Not Interested	**0.157**	**0.122**	**-0.022**	**0.269**
	(0.80)	*(0.67)*	*(-0.15)*	*(1.22)*
Tried/Failed	**0.13**	**0.04**	**-0.030**	**0.277**
	(0.45)	*(0.14)*	*(-0.09)*	*(1.00)*
BRAC	**-0.033**	**-0.094**	**0.060**	**0.067**
	(-0.14)	*(-0.33)*	*(0.24)*	*(0.25)*
Grameen	**0.288**	**0.160**	**0.024**	**0.016**
	(0.94)	*(0.70)*	*(0.15)*	*(0.05)*
BRDB	**-0.081**	**0.167**	**0.014**	**0.111**
	(-0.33)	*(0.97)*	*(0.10)*	*(0.46)*
Proportion of Output Kept	**0.275**	**0.15**	**0.126**	**0.29**
	(0.94)	*(0.84)*	*(0.57)*	*(0.93)*
Log Area Cultivated	**-0.110**	**-0.117**	**-0.126**	**-0.03**
	(-0.86)	*(-1.18)*	*(-1.19)*	*(-0.19)*
HH Farm Hours	**0.000**	**0.000**	**0.000**	**0.000**
	(-0.55)	*(-0.48)*	*(-0.66)*	*(-1.03)*
Log Input Expenditures (HH Farm Hours Excluded)	**0.061**	**0.046**	**0.04**	**-0.020**
	(0.77)	*(0.80)*	*(0.62)*	*(0.20)*

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level.*

Table A.11: Estimation of Productivity

(Output per Acre, Maunds Rice)

Regressors	TR Aman	HYV Aman
Not Interested	**-0.009**	**0.139**
	(-0.09)	*(1.18)*
Tried/Failed	**-0.141**	**-0.013**
	(-1.00)	*(0.06)*
Recent BRAC Loan	**-0.221**	**-0.453**
	(-1.62)	*(-1.38)*
Recent Grameen Loan	**0.177**	**0.208**
	(1.07)	*(1.19)*
Recent BRDB Loan	**-0.249**	**-0.008**
	(-1.53)	*(-0.06)*
Older BRAC Loan	**-0.176**	**-0.079**
	(-1.31)	*(-0.37)*
Older Grameen Loan	**-0.059**	**-0.482**
	-0.35	*(1.31)*
Older BRDB Loan	**-0.108**	**0.181**
	(-0.71)	*(1.21)*
Proportion of Output Kept	**0.261****	**0.082**
	(2.51)	*(0.43)*
Log Area Cultivated	**-0.175*****	**-0.125****
	(-4.17)	*(-2.13)*
HH Farm Hours	**-0.000**	**-0.000**
	(1.14)	(-0.91)
Log Input Expenditures	**0.046***	**0.038**
(HH Farm Hours Excluded)	*(1.67)*	*(0.90)*
***F-Test* (1,237)**:	5.91	
p-value	***0.0158*****	
***F-Test* (1,237)**: $\beta^{Older\ Grameen}$	2.95	
p-value	***0.0873****	
***F-Test* (1,147)**:		2.44
p-value		***0.1207***
***F-Test* (1,147)**: $\beta^{Older\ Grameen}$		3.17
p-value		***0.0769****

*NOTES: t-statistics in parentheses, calculated using robust standard errors. *Significant at 10% Level; **Significant at 5% Level; ***Significant at 1% Level.*