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Does Social Capital Build Women's Assets?

The Long-Term Impacts of Group–Based and Individual Dissemination of Agricultural Technology in Bangladesh

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ABSTRACT

This paper investigates the long–term impact of agricultural technologies, disseminated using different implementation modalities, on men's and women's asset accumulation in rural Bangladesh. Data were collected in 1996–97 to examine the effects of the adoption of new vegetable varieties and polyculture fishpond management technologies on household resource allocation, incomes, and nutrition, and a followup survey was conducted ten years later. We make three types of comparisons using nearest neighbor matching, comparing (1) early and late adopters of the technology; (2) NGO members with access to the technology and those without access to the technology; and (3) NGO members vs. non–NGO members. Our results suggest that implementation modalities are important in determining the impact of new technologies on men's and women's asset accumulation. Women's assets increase more relative to men's when technologies are disseminated through women's groups. These findings are robust to controls for unobserved household–level characteristics. These results suggest that social capital, as embodied through women's groups, not only serves as a substitute for physical assets in the short run, but helps to build up women's asset portfolios in the long run.

Keywords: **Gender, assets, social capital, impact evaluation, Bangladesh**

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Neha Kumar[1] and Agnes Quisumbing

1. INTRODUCTION

Poverty reduction remains the central policy challenge in Bangladesh, despite impressive reductions in poverty from the mid–1990s up to the onset of the food price crisis in 2007. The percentage of the population living in poverty fell from 51 percent in 1995 to 40 percent in 2005; while there have been substantial improvements in nonmonetary indicators of the poorest (BBS 2006, Sen and Hulme 2006). Nevertheless, widespread poverty remains a key challenge; it's most serious consequence is that a quarter (25.5 percent) of the country's population—36 million people—cannot afford an adequate diet, according to the 2005 estimates of food poverty or extreme poverty (BBS 2006).

There is also a well recognized gender dimension to poverty in Bangladesh. Of the 43 studies reviewed by Haddad et al. (1996) pro–male bias in nutrient allocations and nonfood health inputs appears to be most prevalent in South Asia. Furthermore, this is the only region of the world where girls have higher child mortality rates than boys.[2] A study by Smith et al. (2003), based on nationally representative data sets from 39 developing countries, also found that the low status of women relative to men is an important factor explaining higher child malnutrition rates in South Asia relative to Sub–Saharan Africa. In Bangladesh, rural households headed by women are more likely to be among the poorest; women also lag behind in terms of education – with more than one in three women having no schooling, compared to one in four men. A recent analysis also showed that lack of education in adult women in Bangladesh is a strong correlate of being "ultra–poor": 80 percent of adult women with no education live below half a dollar a day (Ahmed et al. 2007). Given the strong links between gender and poverty, government and NGOs in Bangladesh have undertaken many important interventions designed to help individuals and households escape poverty, many of these targeted to women.

This paper examines the long–term impact of agricultural technologies, disseminated using different implementation modalities, on men's and women's asset accumulation in rural Bangladesh. Using matching methods applied to panel data, this paper aims to investigate the following questions:

- What are the long–term impacts of each of the interventions on men's and women's asset accumulation at the household level?

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[2] Boys are biologically more vulnerable to infections and mortality during their first few years of life.

- What are the long–term impacts of the interventions on the gender asset gap within households?
- What factors underlie the differential impact of the interventions on the abovementioned household and individual–level outcomes?

Our results suggest that implementation modalities are important in determining the impact of new technologies on men's and women's asset accumulation. Women's assets increase more relative to men's when technologies are disseminated through women's groups. These findings are robust to controls for unobserved household–level characteristics. These findings are consistent with our results in a related study (Kumar and Quisumbing 2010), in which we examined impacts on household consumption, incomes, and assets, as well as individual nutritional status. In the other study, we found that, while the income gains from the group vegetables site, which involves women's groups, are minimal, significant improvements in nutritional status have been achieved. It is possible that the targeting modality—working through women's groups that emphasize women's empowerment, and disseminating vitamin–A and iron–rich vegetables that are consumed by women—may have had a positive net impact on nutritional status, despite the insignificant impacts on household–level outcomes. Taken together, these results suggest that social capital, as embodied through women's groups, not only help women build physical capital, but also enable them to invest in their own nutritional status and that of their children. Thus, social capital accumulated by women not only serves as a substitute for physical assets in the short run, but helps to build up women's asset portfolios in the long run.

The remainder of the paper is organized as follows. Section 2 reviews the literature on gender and collective action in Bangladesh, focusing on interventions that have been implemented through women's groups. Section 3 presents an overview of the agricultural technologies, the original sampling design of the 1996–97 evaluation, a description of the 2006–2007 follow–up, and descriptive statistics for treatment and control groups. Section 4 discusses the methods used in this paper. Section 5 presents results from nearest neighbor matching using difference–in–difference methods at the household and intra–household levels. Section 6 concludes and relates this study's findings to those of the larger study.

2. WHAT DO WE KNOW ABOUT THE GENDERED IMPACT OF COLLECTIVE ACTION IN BANGLADESH?

Working with groups is a major mechanism through which development programs can enable women to increase their control of assets, improve their productivity, and enhance their status and well–being. In fact, the social capital that groups generate has been recognized as an important asset in itself. But building social capital is not costless. Women in poor households face particularly serious time constraints because of their various livelihood activities and childcare responsibilities. Membership fees may create a further barrier to participation by poor women who have limited control over cash (Meinzen–Dick and Zwarteveen 1998), unless ways are found for women to contribute small amounts (for example, during each meeting) rather than pay lump–sum fees. Social inequality and ethnic differences may also create barriers to social capital accumulation (Alesina and La

Ferrara 2000); with some barriers differentially affecting women (see Pandolfelli, Meinzen–Dick, and Dohrn 2008).

While the specific institutional mechanisms that enable women to join groups and remain active members will depend on the local context, these typically include allowing non–household heads and non–landowners to be group members; timing meetings to accommodate women's workloads; ensuring that poorer women have opportunities to voice their concerns in group meetings; and soliciting women's feedback in project monitoring and evaluation (Pandolfelli, Meinzen–Dick, and Dohrn 2008). Programs targeted to women's groups in Bangladesh, particularly microfinance programs targeted to poor women, have developed innovative means to address context–specific constraints, such as the low levels of asset ownership by women. In these microfinance programs, group liability acts as a substitute for personally owned assets that can be used as collateral (see, for example, Sharma 2001; Morduch 1999; and Quisumbing and Pandolfelli 2010).

Various evaluations have examined several aspects of microfinance programs in Bangladesh. Hashemi, Schuler, and Riley (1996), for example, have found that Grameen Bank and Bangladesh Rural Advancement Committee (BRAC) programs have had significant effects on a variety of measures of women's empowerment, including mobility, economic security, control over income and assets, political and legal awareness, and participation in public protests and political campaigning. Kabeer (1998), using participatory evaluation techniques, found that despite increased workloads due to receipts of credit, women feel empowered by it, clearly feeling more self–fulfilled and valued by other household members and the community. Pitt and Khandker (1998), using data collected during 1991–92 from 87 villages in Bangladesh, found that welfare impacts on the household were significantly better when borrowers were women—increases in household consumption, improved nutritional status for both sons and daughters, and increased investment in nonland assets. A resurvey conducted in 1998–99 of the same households interviewed in 1991–92 (Pitt, Khandker, and Cartwright 2003) found that credit program participation leads to women taking a greater role in household decision making, having greater access to financial and economic resources, having greater social networks, having greater bargaining power in relation to their husbands, and having greater freedom of mobility. In contrast, male credit had a negative effect on several areas of women's empowerment, including physical mobility, access to savings and economic resources, and power to manage some household transactions. Despite the demonstrated gains of targeting credit to women and working through women's groups, achieving development goals through collective action activities may not always work. For example, Amin, Rai, and Topa's (2003) study of two villages in Bangladesh found that while the Grameen Bank has been successful in reaching the poor, it was less successful in reaching the vulnerable, and unsuccessful in reaching those most prone to destitution, the vulnerable poor.

Beyond participation in formal groups, particularly microfinance, relatively less is known about the gendered impact of collective action, in general, and its long–term impact, in particular. The broader literature on collective action is richer in terms of studies that have examined gender differences in motivations to engage in collective action than it is in areas of its effectiveness and impact. For example, a review of the literature on gender and collective action highlights differences in the

reasons why men and women join different types of groups in Nigeria, Central Kenya, Eastern Kenya, the Philippines, and Ethiopia (Meinzen–Dick et al. 2005). The same review points out that there is limited evidence on how gender affects the effectiveness of collective action programs, meaning the ability of groups to meet their immediate purposes. While there is some evidence on the impact of collective action in terms of changing gender relations and achieving broader objectives such as poverty reduction, many of these studies do not satisfactorily account for the endogeneity of participation in collective action activities when evaluating impact. That is, it is possible that women who are more "empowered" to begin with, perhaps because of greater wealth, higher levels of schooling, or better social connectedness, are those who join collective action programs. Without taking into account the effects of endogeneity of participation, estimates of program impact will be biased. Studies such as those by Pitt and Khandker (1998) use eligibility criteria for participation to control for endogeneity of program participation; others, such as Bouis et al. (1998) and Hallman, Lewis, and Begum (2007), use "with" and "without" comparisons based on treatment and control groups.

There is even less evidence on the long–term impact of collective action because there are very few longitudinal studies in developing countries that observe the same households and individuals over a sufficiently long period of time. Longitudinal data sets allow one to difference–out unobserved characteristics at the individual and family level that may affect both the propensity to participate, as well as to benefit from the program. If the panel covers a sufficiently long period, one may also be able to observe the longer term effects of collective action. The Pitt, Khandker, and Cartwright (2003) study is a panel, but the survey interval (six years) is comparable to the relatively short panels reviewed in Baulch and Hoddinott (2001). While Hallman, Lewis, and Begum (2003) examined the impact of agricultural technologies disseminated through women's groups on a variety of outcomes, including indicators of women's empowerment, the study was conducted only a few years after the initial dissemination of the technologies, perhaps not enough time for the full course of the technologies' impact to be felt. Their study also focused on the impact of the technologies on poverty and vulnerability, and not on collective action per se.

This study adds to the growing literature that goes beyond short–term or medium–term impacts, to examine the longer term impacts of interventions on individual and household–level well–being (for example, Gilligan and Hoddinott 2007; Hoddinott et al. 2008; Maluccio et al. 2009). The panel data set not only builds on the previous evaluation study, but also provides the conditions for a more rigorous evaluation of the impact of these interventions over the long–term. First, we have data on individual, household, and community characteristics during the initial survey that would enable us to control for characteristics that affect the probability of a household's participation in the agricultural technology intervention. Second, the timing of the panel survey, ten years after the initial survey, permits us to look at long–term impacts of the agricultural technology, and to control for unobservable time–invariant characteristics using difference–in–difference techniques. The previous evaluation, conducted only a few years after the technologies were disseminated, looked only at short–term impacts using single–difference analysis, and relied on with–and–without comparisons arising from the evaluation design without explicitly creating a statistical comparison group. Since

the interventions were not randomized, the potential for selection bias contaminating the results still exists. Using panel data does not completely resolve this issue, but allows us to control for unobserved time–invariant effects. Third, we take advantage of the treatment–comparison design of the original evaluation to undertake three types of comparisons using nearest neighbor matching, comparing (1) early and late adopters of the technology; (2) NGO members with access to the technology and those without access to the technology; and (3) NGO members vs. non–NGO members. Heckman, Ichimura, and Todd (1997, 1998) and Abadie and Imbens (2002) show that under certain conditions on the data, all of which are satisfied in this study, matching estimators provide reliable estimates of program impact. Finally, we use insights drawn from the qualitative work conducted as part of the panel study and earlier work conducted in the study sites to obtain additional perspectives on the role of implementation modalities and collective action.

3. DATA AND SAMPLING

3.1 The initial evaluation sample: an overview of the agricultural technology interventions

The initial survey for this study was conducted in 1996–97 by the International Food Policy Research Institute (IFPRI) and Data Analysis and Technical Assistance, Ltd. (DATA) to examine the impacts of improved vegetable and polyculture fish management technologies on household resource allocation, incomes, and nutrition. The initial study also aimed to uncover intrahousehold and gender–differentiated impacts of the new technologies, so extremely detailed information was collected on individuals within households. As mentioned above, households were surveyed in three sites where NGOs and extension programs disseminated the new technologies. These sites were (1) Saturia thana, Manikganj district (referred to below as Saturia); (2) Jessore Sadar thana, Jessore district (referred to below as Jessore); and (3) Gaffargaon thana, Mymensingh district, and Pakundia and Kishoreganj Sadar thanas, Kishoreganj district (referred to below collectively as Mymensingh).[3] The agricultural technologies and extension programs at each site are unique, resulting in three case studies that may be compared (see Table 1).[4] In all of the sites, the technology had been disseminated prior to the initial survey in 1996, so this survey should not be interpreted as a true baseline.

[3] Thana (also upazila) is a subdistrict in subdistrict in the administrative divisions of Bangladesh.

[4] This description draws from Quisumbing and de la Briere (2000), Hallman et al. (2007), and recent field visits by the authors.

Table 1. Study sites, technologies, and approaches

Site	Saturia	Jessore	Mymensingh
Community characteristics	Less than two hours northwest of Dhaka; some access to Dhaka markets; high levels of NGO activity; low–lying flood prone area	Close to western border with India, less socially conservative but politically volatile	Four to five hours north of Dhaka; remote and socially conservative; not flood–prone; some water shortages in dry season
Agricultural technology	Privately grown vegetables on homestead plots	Group–operated polyculture fishponds	Privately operated polyculture fishponds
Institution originating technology	World Vegetable Center	WorldFish Center	WorldFish Center
Dissemination approach	Training and credit to all adopters, all of whom are members of women's groups	Training to some members of each adopter group; credit to all group members	Training to all adopters; credit to poor adopters
Type of disseminating institution	Small local NGO	Medium–sized local NGO	Government ministry extension program
Target group	Women NGO members in households with marginal landholdings	Poor women, NGO members, predominantly landless	Individual or joint pond owners

Source: Updated from Hallman, Lewis, and Begum (2007).
Notes: World Vegetable Center was formerly the Asian Vegetable Research and Development Center (AVRDC); WorldFish Center was formerly the International Center for Living Aquatic Resource Management (ICLARM); NGO, nongovernmental organization

Vegetable intervention: In Saturia, credit and training in small–scale vegetable technology were introduced by a (then small) local NGO Gono Kallayan Trust (GKT) to women who grow vegetables on small plots on or near the household compound. These vegetable varieties were initially developed at the World Vegetable Center in Taiwan (formerly Asian Vegetable Research and Development Center, AVRDC), adapted to Bangladesh conditions at the Bangladesh Agricultural Research Institute (BARI), and introduced by GKT. GKT has been operating in Saturia since 1987, and in March 1994, two years prior to the initial survey, GKT added vegetable production using the improved seeds to their portfolio of income generation programs.[5] Selected GKT extension agents received training in the new vegetable technologies in AVRDC sites outside Bangladesh. GKT has grown over time into a well established local NGO, with its own training and conference center, and the improved vegetables are now grown all over Saturia. While GKT originally disseminated the AVRDC seeds, it now functions primarily as a source of credit and only secondarily as a source of vegetable technology. Many villagers now produce and store their own seeds instead of buying them from GKT (Ahmed and Khondkar 2009).

[5] The improved vegetables introduced include tomato, okra, Indian spinach (pui shak), red amaranth (lal shak), radish, eggplant, amaranth (data), kangkong (kalmi shak), mung bean, and sweet gourd (Hallman et al. 2007: 104).

Fish intervention: In 1988, the WorldFish Center (formerly known as the International Center for Living Aquatic Resource Management or ICLARM) began providing technical advice to the Fisheries Research Institute (FRI) in Mymensingh in regard to polyculture fish production and other fish culture technologies.[6] The polyculture fish technology was disseminated in the Jessore and Mymensingh sites using strikingly different modes of dissemination. Similar to Saturia, dissemination in the Jessore sites is through a medium–sized local NGO, Banchte Shekha. Banchte Shekha has arranged long–term leases of ponds that are managed by groups of women (ranging in number from five to twenty) who received credit and training in polyculture fish production methods. Banchte Shekha extension agents received training from both ICLARM and FRI personnel in pond management for polyculture fish production starting in 1993, so the intervention was three years into implementation when the baseline was conducted. Banchte Shekha continues to train women's groups in fish technologies, although groups have begun to graduate from its credit programs and to manage their fishponds without Banchte Shekha's assistance.

In contrast, in Mymensingh, ponds are owned and managed by single households or households that have shared ownership. In contrast to Saturia, which is close to Dhaka, and Jessore, which is close to the Indian border, Mymensingh is more culturally conservative, and does not have as many NGOs as the other two sites. The Mymensingh Aquaculture Extension Program began operating in July 1990 and was jointly implemented through MAEP extension agents and fifteen Department of Fisheries' extension agents. They provided training to relatively better–off households and training with credit to relatively poorer households, directed at both men and women, but men more often than women. According to Ahmed and Khondkar (2009), MAEP shifted from the individual approach to fish farming to a group approach in its second phase (1993–2000), with groups comprising 10 to 15 members. The shift in approach was initiated mainly to facilitate the provision of support to members, and to reduce the workload of the limited number of project staff. However, compared to the Jessore project site where a group jointly managed a fishpond, fishpond cultivation was still primarily conducted by individuals in Mymensingh, even if these individuals were eventually organized into groups. The DANIDA–funded MAEP program ended in 2003, and the extension function was absorbed by the Department of Fisheries.[7]

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[6] Seven fish species were promoted: silver fish, carp (katla), rohu (rui), mrigel , mirror carp, sharputi, and grass carp. Black fish (kalibouchi), shrimp, and tilapia are also cultivated (Hallman et al. 2007: 106).

[7] The Mymensingh Aquaculture Extension Program was implemented in three phases between 1989 an 2003. Phase I (1989–93) was a pilot project, with the aim of developing an extension system, and to spread the results of Danida-supported aquaculture research to pond owners and people with access to ponds, in order to increase the production of fish protein in selected Upazilas of Mymensingh District. Phase II (1993–2000) was intended to increase fish production and was an extension of Phase I programming. It was implemented through a "crash" programme in selected Upazilas of seven Districts including Mymensingh. Phase III (2000–03) was a Consolidation Phase, which intended to finalize the approach of partner NGOs and the Department of Fisheries (DoF) as initiated in Phase II, and to ensure the self-sustaining capacity of aquaculture extension at Upazila and farmer levels. This phase was extended (at no cost) for an additional year to help ensure a well planned phase-out and adequate documentation (Orbicon and Lamans 2009).

Table 2 shows the extent of adoption of the technologies at the time of the initial survey, based on a census of households. Hallman, Lewis, and Begum (2007) point out that, with the exception of the individual fishpond technologies in Mymensingh, the technologies would have been available to the disseminating institutions in both Saturia and Jessore for only two to three years in each site. Therefore, households in these two sites would have had even shorter experience with the technology at the time of the initial survey.

Table 2. Study sites and extent of adoption

Site	Saturia	Jessore	Mymensingh
Technology	**Vegetables**	**Group ponds**	**Private ponds**
Adopters as percent of households in treatment villages	40	16	50
Year technology introduced	1994	1993	1990
Survey inception year	1996	1996	1996
Elapsed time between introduction of technology and beginning of household survey (years)	2	3	6

Source: Hallman, Lewis, and Begum (2007).

Selection of the initial survey sample: In each of these three sites, selection of households for the survey was preceded by a census of households in two types of villages: (1) case (or treatment) villages, where the disseminating institution had introduced the technology; and (2) comparison villages where the technology had not yet been introduced, but where the dissemination institution had planned to eventually introduce it. In both types of villages, the dissemination institution delivered the same type of supporting service (mainly microfinance). In each site, treatment and comparison households in both village types were affiliated with the same disseminating institution and undertook the same agricultural activities, but those in comparison villages did not have access to the improved technologies. Although the interventions were not randomized across villages, a comparison of village characteristics indicated few significant differences between case and comparison villages in infrastructure and access to services (Bouis et al. 1998); in this paper, we will be able to ensure that treatment and comparison groups are statistically comparable using matching methods (see Section 3).

The household survey then collected data across four different rounds covering a complete agricultural cycle in 1996–97 for three types of households: (1) adopting households in villages with the technology; (2) likely adopter households (NGO members or eligible households who expressed interest in adopting the technology) in the villages where the technology was not yet introduced; and (3) a cross–section of all other nonadopting households representative of the general population in the villages under study (non–NGO members plus NGO members not likely to adopt). In the case of the Mymensingh program, NGOs were not used to disseminate the technology; therefore, strictly

speaking, we refer to program members and nonmembers in this site. For households in each of these groups, a four–round survey collected detailed information on production and other income earning activities by individual family member, expenditures on various food, health, and other items, food and nutrient intakes by individual family member, time allocation patterns, and health and nutritional status by individual family member. In addition, detailed asset data were collected at the individual level. These included current assets, as well as assets that each spouse brought to marriage, because assets at marriage can be viewed as a proxy for bargaining power within marriage. Both the current assets and assets at marriage modules allow asset ownership to be assigned to specific individuals (husband or wife), to be jointly owned, or to be assigned to someone else outside the household. See Bouis et al. (1998), Quisumbing and Maluccio (2003), and Hallman, Lewis, and Begum (2007) for more detail on information collected during the initial survey.

The 2006–07 follow–up

In 2006, IFPRI, DATA and the Chronic Poverty Research Centre (CPRC) began a major study to resurvey the households surveyed in evaluations of three anti-poverty interventions, including the agricultural technology study sites. While the focus of this study was on understanding the drivers and maintainers of chronic poverty in rural Bangladesh, the intervention–comparison groups were maintained from the previous study. In addition, children who had left the original household and set up their own households were tracked as long as they had not migrated from their district.

The IFPRI–CRPC resurvey involved both qualitative studies and a followup longitudinal survey of households included in the IFPRI studies, and involved three sequenced and integrated phases.

Phase I was a qualitative phase designed to examine perceptions of changes (and why these have come about) from women and men in a subsample of our survey communities. This phase involved single-sex focus group discussions to elicit perceptions of changes, perceptions of the interventions under study, and the degree to which these interventions affected people's lives (compared to other events in the community). In the agricultural technology study sites, a total of 32 single-sex focus group discussions, evenly divided between treatment and control villages, were conducted (Davis 2007).

Phase II was a quantitative survey of the original households and new households that have split off from the original households that have been found in the same district. The household survey took place from November, 2006 to March, 2007, the same agricultural season as the original survey. In the agricultural technology sites, these covered 957 core households that took part in the original survey and 280 "splits" from the original household. The household survey questionnaire used was designed to facilitate comparability with the original questionnaire from the evaluation studies; the assets module was administered virtually unchanged, except for the addition of new assets like mobile phones. A community level questionnaire was also administered to key informants at this stage to obtain basic information on each village, and changes since the last survey round. GPS coordinates for all sample households and village facilities were also

collected. Initial analyses of this survey are found in Quisumbing (2007, 2008) and Quisumbing and Baulch (2009).

Phase III consisted of a qualitative study based on life histories of 140 selected households, focusing on the years between the original survey and the most recent survey. Households interviewed were stratified by intervention, and then selected based on the four cells of the poverty transition matrix (poor in both waves, moving into poverty, moving out of poverty, and not poor in both waves). Semi-structured interviews were conducted using life history methods and visualization techniques by a small team of experienced Bengali-speaking researchers to understand the processes and institutional contexts that influence livelihood trajectories. This final phase of field work was completed by September 2007, and is analyzed in Baulch and Davis (2009).

Attrition between baseline and 2006–07 rounds is relatively low, ranging from 0.4 percent per year in the Saturia and Jessore sites and 1.1 percent per year in the Mymensingh site (Table 3).[8] While low, attrition is not random, and is driven by demographic effects: households with a larger proportion of persons older than age 55 were more likely to leave the sample (Quisumbing 2007). Unobserved locational effects are also clearly important determinants of attrition. Households in Manikganj district were significantly less likely to leave the agricultural technology sample, probably reflecting the ease of interviewing in Manikganj, which is close to Dhaka, and where NGOs have been working for a long time. In contrast, the two thanas (subdistricts) in the individual fishpond sites, which are traditionally more conservative, have much higher attrition rates.

[8] Our attrition rates compare quite favorably to the longitudinal data sets reviewed in Alderman et al. (2001), where attrition rates range from 6 to 50 percent between two survey rounds and 1.5 to 23.2 percent per year between survey rounds. While we did not have the resources to track all splits that had migrated to other districts, we obtained names and addresses of migrants from their parents or neighbors. All in all, we were able to track and interview 75 percent of household splits.

Table 3. Distribution of surveyed households, core households, and split, by intervention site, 2006–07

	Number of households in 2006–07 survey round						
	Households lost due to migration, absence, death, or merging	New households due to household division		Original households re-interviewed	Total number of households in 2007 round	Attrition	
		Total	Interviewed			% attrited	% attrited per year
Saturia: Improved vegetables	13	109	96	313	409	4.0	0.4
Jessore: Group fishponds	15	139	124	324	448	4.4	0.4
Mymensingh: Individual fishponds	40	100	60	320	380	11.1	1.1

Household characteristics and adoption status

As mentioned above, three groups of households were chosen in each site: (1) NGO or program members who were able to adopt the new technology early, because it was available in their village; (2) NGO or program members who were not able to adopt the technology initially; and (3) non-NGO or non-program members. Table 4 presents household characteristics for each of the comparison groups by site. In Saturia, the average household head was about 45 years old in 1996–97. Among the NGO members the households were largely male headed; only about four percent of households were headed by females. In contrast, 12 percent of non-NGO households were female-headed in 1996–97. In terms of the head's education level, the three comparison groups were similar, with an average of two years of schooling; about half to a third of the heads had completed at least 4 years of schooling. The non-NGO households had substantially less land than the NGO households. While NGOs usually target households with small landholding sizes, because the vegetable technology required access to homestead land on which vegetables could be grown, it is possible that households that were eligible to adopt the technology may have had larger landholdings than non-NGO member households. Size and composition of the households is similar across the three groups, except that the percentage of women older than 55 years among the non-NGO households was almost double the corresponding number for the two other groups, at seven percent.

Table 4: Household Characteristics of the Comparison Groups by Site

	NGO Members with the technology		NGO members without the technology		Non-NGO members	
Saturia	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
	n=106		**n=103**		**n=103**	
Age of household head	45.27	12.20	43.22	12.23	46.02	13.63
Fraction of female headed hh	0.04	0.19	0.03	0.17	0.12	0.32
Education of hh head (years of schooling)	2.40	3.89	1.84	3.28	2.41	3.71
HH head has at least 4 years of schooling	0.28	0.45	0.24	0.43	0.31	0.47
Area of land owned at baseline	106.54	123.39	110.53	146.79	77.47	112.63
Per capita hh expenditure at baseline, 2007 taka	963.05	534.51	875.87	447.49	935.67	582.11
Household size	5.52	2.06	5.63	2.79	4.86	2.49
Percent males 0–4 years	4.95	9.36	4.76	9.14	5.55	10.83
Percent females 0–4 years	4.32	8.60	6.05	11.55	4.60	10.39
Percent males 5–14 years	14.04	14.40	15.33	15.17	11.47	15.29
Percent females 5–14 years	12.40	15.23	11.76	13.13	10.48	14.67
Percent males 55 years and over	3.75	8.00	2.65	6.03	3.55	7.94
Percent females 55 years and over	3.75	7.65	3.86	7.67	7.00	20.29
Jessore	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
	n=109		**n=109**		**n=106**	
Age of household head	44.70	11.15	42.84	11.64	43.25	12.56
Fraction of female headed hh	0.07	0.26	0.08	0.28	0.04	0.19
Education of hh head (years of schooling)	2.59	3.56	2.63	3.46	2.78	3.70
HH head has at least 4 years of schooling	0.33	0.47	0.36	0.48	0.34	0.48
Area of land owned at baseline	106.98	184.79	92.27	113.13	129.09	202.36
Per capita hh expenditure at baseline, 2007 taka	1117.77	739.82	901.90	480.08	906.44	423.26
Household size	5.01	2.39	5.06	1.99	5.32	2.21
Percent males 0–4 years	3.94	8.61	3.86	8.46	4.47	10.00
Percent females 0–4 years	2.41	6.46	5.50	10.19	4.55	10.31
Percent males 5–14 years	12.04	13.52	13.50	14.65	14.59	15.64
Percent females 5–14 years	11.85	14.48	11.18	13.74	10.85	14.04
Percent males 55 years and over	5.11	9.63	3.77	8.97	4.90	9.14
Percent females 55 years and over	3.34	7.41	3.49	8.03	3.90	9.28

Mymensingh	NGO Members with the technology		NGO members without the technology		Non-NGO members	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	n=106		n=105		n=107	
Age of household head	46.22	12.57	50.40	13.14	41.70	15.00
Fraction of female headed hh	0.00	0.00	0.01	0.10	0.02	0.14
Education of hh head (years of schooling)	5.17	4.57	5.07	4.20	3.14	4.18
HH head has at least 4 years of schooling	0.61	0.49	0.64	0.48	0.36	0.48
Area of land owned at baseline	275.85	253.04	278.86	255.00	78.58	122.02
Per capita hh expenditure at baseline, 2007 taka	943.48	417.45	1036.58	549.11	826.75	466.09
Household size	6.92	2.51	6.23	2.60	4.91	2.22
Percent males 0–4 years	5.16	9.41	3.88	8.01	8.30	12.66
Percent females 0–4 years	4.93	8.24	4.71	8.66	4.64	9.75
Percent males 5–14 years	13.58	13.51	12.04	12.71	11.16	14.34
Percent females 5–14 years	11.85	12.74	10.26	11.85	9.80	13.67
Percent males 55 years and over	6.22	9.05	8.12	12.15	4.90	10.01
Percent females 55 years and over	5.32	8.40	5.99	12.10	6.03	13.85

In Jessore, the three groups were fairly homogenous in terms of initial household characteristics. About 90 percent of household heads were men, and they were about 44 years old on average with 2.5 years of schooling. About a third of household heads had completed at least 4 years of schooling. The big difference across groups is in terms of land owned and per capita household expenditure. The non-NGO households had, on average, 130 decimals of land whereas the NGO households with access to the agricultural technology had 107 decimals and the corresponding number for the NGO households without access to the technology was 92 decimals.[9] This may reflect targeting criteria of the disseminating NGO, Banchte Shekha, which typically targets those with smaller landholdings. In this site, adoption of the technology did not require landownership because landless women were able to avail themselves of World Food Programme assistance to excavate group ponds. However, the household expenditure was largest among the NGO households with access to the technology.

In Mymensingh, household heads in the non-program households were younger than those in program households. There were virtually no households with female heads in this site. Program households had better educated heads than those not in the program, both within Mymensingh and across all other sites. Total land owned by program participants was also much higher on average than other households in Mymensingh as well as in other sites. Indeed, within Mymensingh, program households owned about four times as much land as the non-program

[9] 100 decimals = 1 acre (or 0.4047 of a hectare).

households, which may indicate that the program targeted better-off households first. However, this difference is not reflected in per capita household expenditures across the groups: even though non-program households spend less than the program households, the difference is not as large.

Because implementation modalities may affect the impact of the interventions, we use three alternative definitions of the treatment and comparison groups. The first definition compares early and late adopters: given the long time interval between the introduction of the technology and the most recent survey, one would expect that the technology, if profitable, would have been more widely adopted, not only by potential adopters, but even by those households in the village who may not have been eligible for the program because they were neither members of NGOs nor targets of the aquaculture extension program. The second definition uses the comparison used in Bouis et al. (1998) and Hallman, Lewis, and Begum (2007) short-term impact evaluation, comparing NGO members or program members who had adopted the technology and those who did not yet have access to the technology. The third definition focuses more closely on the role of NGOs, and compares NGO or program members (whether initial or late adopters) to non-NGO members (or non-program members, in the case of Mymensingh). We note that because each site may have different underlying socioeconomic conditions, such as social norms, market access, political activity, and disaster risk, we will not be definitively able to conclude that implementation modalities are responsible for the differential impacts across study sites. Moreover, implementation modalities are themselves endogenous—it is no surprise that group-based methods were chosen in Saturia and Jessore, where NGOs are active and individual dissemination in more culturally conservative Mymensingh. However, these three comparisons allow us to frame the discussion in terms of factors affecting impact—whether it is the adoption process, early access to the technology among (similar) program members, or membership in the program—even if we cannot attribute impact solely to implementation modalities.

4. METHODOLOGY

The purpose of this paper is to measure the impact of adopting improved vegetable and fish polyculture technologies on men's and women's land and asset holdings, covering a wide range of land and nonland assets. A related paper (Kumar and Quisumbing 2010) examines the impact of early adoption of the technologies on a range of outcomes at the household and individual level, including consumption, assets, nutrient availability (at the household level) and nutrient intakes, anthropometric measures, and hemoglobin levels (at the individual level). We expect that new technologies, if they are profitable, will result in increases in household consumption and asset holdings. Depending on the targeting of these technologies to men or to women, they may also differentially change income streams controlled by men and women, resulting in differences in consumption as well as asset accumulation. This paper is concerned with the latter.

We use two alternative definitions of assets, depending on ownership. "Exclusively owned" assets are those that the husband or wife identifies as his or her own. "Exclusive plus jointly owned" assets are the sum of exclusively owned assets and half of jointly owned assets. Exclusively owned assets can be interpreted

as a measure of bargaining power within the household, while jointly held assets are an indicator of one's ability to partake of the benefits of publicly held assets by virtue of household membership. We assume that jointly owned assets can be assigned to husband and wife on a 50–50 basis. Of course, this assumption may not hold in reality—it is typical for household heads to claim ownership and control of jointly owned assets, and for husbands to control jointly held household assets in this specific cultural context—but in the absence of more detailed information, it is a useful starting assumption. Moreover, since these assets were identified by respondents as "joint," we treat them as such but recognize the ambiguity of jointness of decisionmaking over them. We measure impact using the average treatment effect on the treated (ATT), where we explore alternative definitions of the treatment.

We use the nearest-neighbor matching (NNM) technique proposed by Abadie and Imbens (2002) to estimate the average treatment effect. This method matches comparison households with households that were exposed to the treatment on the basis of observable characteristics. We are interested in estimating the average effect of a binary treatment on a continuous or discrete scalar outcome. For households i, i = 1, . . . , N , let {Yi (0), Yi (1)} denote the two potential outcomes: Y_i(1) is the outcome of household i when exposed to the treatment, and Y_i(0) is the outcome of household i when not exposed to the treatment. When we estimate the average treatment effect, only one of the two outcomes is observed.

To estimate the average treatment effect, we estimate the unobserved potential outcome for each observation in the sample. Consider estimating the untreated outcome, Y_i (0), for household i with covariates X_i, that was exposed to the treatment. If the decision to take/get the treatment is purely random for households with similar values of the pretreatment variables or covariates, we could use the average outcome of some similar households that were not treated to estimate the untreated outcome. This is the basic idea behind matching estimators proposed by Abadie et al. (2004), which we use here. For each i, matching estimators impute the missing outcome by finding other households in the data whose covariates are similar but who were exposed to the other treatment.

We use NNM to come up with alternative comparison groups, depending on our definition of the treatment. NNM, as discussed above, allows us to construct a suitable comparison group of households whose outcomes, on average, provide an unbiased estimate of the outcomes that treatment households would have had in the absence of the agricultural technology interventions. Given that adoption of the technology is based on households satisfying certain targeting criteria related to eligibility for NGO membership and possession of key agricultural assets for adoption (agricultural land for vegetables, fishponds for fish technologies, both of which could be correlated with other factors such as household wealth), simple comparisons of outcomes between treatment and comparison households would yield biased estimates of program impact.

Following Abadie and Imbens, let be a household's outcome when it receives an agricultural technology and let be that household's outcome otherwise. The impact of technology adoption is the change in the outcome caused by participating in the program: $\Delta = Y_1 - Y_0$. However, for each household, only or is observed at any given time. Let D be an indicator variable equal to 1 if the household is an adopter and 0 otherwise. The average impact of the treatment on

those that receive it—the average impact of the treatment on the treated (ATT)—is defined as:

$$ATT = E(\Delta \mid X, D=1) = E(Y_1 - Y_0 \mid X, D=1) = E(Y_1 \mid X, D=1) - E(Y_0 \mid X, D=1),$$

where *X* is a vector of control variables. However, we are unable to observe outcomes of those households that are otherwise eligible for the program, but do not participate, that is $E(Y_0 \mid X, D=1)$. In experimental evaluations, households that are eligible for the program $(D=1)$ are randomly selected out for some period of time, providing a reliable estimate of $E(Y_0 \mid X, D=1)$. However, we know that the agricultural technologies were not randomly allocated in the villages where the disseminating institution is working.

We first begin by estimating a propensity score for being in the treatment group to get a balanced sample of treatment and comparison observations.[10] Because we are comparing husbands' and wives' asset holdings, we will be matching based on both individual and household characteristics.[11] This involves estimating a probit model that predicts the probability of: (1) each individual belonging to a household adopting the agricultural technology; and (2) each individual belonging to a household that is a member of the program or NGO disseminating the agricultural technology in each site, as a function of observed individual, household, and community characteristics, for treatment and comparison households. The model specification is checked to test (and confirm) equality of the means of these observed characteristics across the treatment and the comparison group samples. Once we have a balanced sample, we use covariate matching that uses a multidimensional metric of distance between values of the observable characteristics to construct the weighted average difference in outcomes of each spouse in a treatment household and a weighted average of the outcomes of spouses in comparison households. In NNM, treatment observations are matched with the comparison observations whose propensity scores are nearest to their own.[12, 13]

Matching methods provide reliable estimates of program impact provided that (1) a comparable group of comparison observations is available, and (2) there is access to carefully collected household survey data with many variables that are correlated with technology adoption and the outcome variables (Heckman, Ichimura and Todd 1997, 1998). As mentioned above, the initial evaluation survey was designed to include an appropriate comparison group, consisting of members of the

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[10] This methods description draws from Gilligan, Hoddinott, and Seyoum (2008).

[11] When we matched only on household characteristics, very few treatment effects were significant, in contrast to the results reported here, based on individual matching. This suggests that, when examining intrahousehold impacts, it is important to control also for individual characteristics, not just characteristics of the household.

[12] We use nnmatch in Stata10 do estimate our matching estimators (Abadie et al. 2004).

[13] Note that if the intervention was rolled out at the same time to all NGO members in all the villages in the catchment area, this approach would not be feasible as it would not be possible to construct a statistically robust comparison group. However, there is considerable evidence that suggests that because of resource constraints (mainly due to limited implementation capacity at the initial stages of technology dissemination), program access was rationed.

same NGO that disseminated the technology in villages where the technology had not yet been disseminated, as well as other households in the same villages who were not members of the NGO. The same survey questionnaire was administered in 1996–97 and in the 2006–07 followup to adopters, likely adopters, and nonadopters in the same communities, and includes a large set of variables affecting household welfare and technology adoption. These variables include measures of household head age, gender and schooling, household size and other demographic characteristics, landholding size, household level shocks (such as loss of crops, livestock and illness, floods, and so on), and controls for unobserved thana-level effects. These variables also include assets of the husband and wife at the time of marriage, which we use for matching individual observations. We do not use assets measured in 1996–97 because these may already have been influenced by program participation, given that the programs began prior to the initial survey.

Our approach assumes that after controlling for all observable individual, household, and community characteristics that are correlated with technology adoption and the outcome variable, treatment and comparison individuals have the same average outcome as treatment individuals would have had if they did not participate in the intervention (whether defined as adopting the technology early or being a member of the NGO, as the case may be). NNM provides biased estimates of program impact if, for any chosen outcome, it is not feasible to control for enough observable characteristics so that this assumption holds. Drawing both adopting and nonadopting households from the same communities helps to reduce the risks of such bias by providing a similar distribution of unobserved community characteristics such as access to markets or local economic shocks. Because we have information on outcome variables from two points in time (1996–97 and 2006–07), we estimate the impact as the "difference-in-differences" (DID) in the outcome between the treatment and comparison group, rather than the "single difference" in outcomes between these two groups as of the initial survey. Earlier analyses using the 1996–97 data such as Bouis et al. (1998) and Hallman, Lewis, and Begum (2007) were restricted to using single-difference analysis of the initial survey data. Moreover, these studies did not construct a statistical comparison group based on matching methods. DID estimates are known to be less subject to selection bias because they remove the effect of any unobserved time-invariant differences between the treatment and comparison groups. To examine intrahousehold differences, we also compute a quadruple difference, which is the DID between the husbands' and wives' changes in assets and the DID in husband's minus wife's asset growth in treatment vs. control groups.

We also assume that for each treatment household and for all observable characteristics, a comparison group of comparison households with similar propensity scores exists.

5. RESULTS

Determinants of program membership

Tables 5 and 6 present the probit regressions used to generate the propensity scores for two of the comparisons, the NGO member vs. non-NGO member comparison and the early vs. late adopter comparisons. (Probits for the other

comparisons are available from the authors upon request.) In the Mymensingh site, the probit estimates the probability of participating in the fishpond technology program of the Mymensingh Aquaculture Extension Program, not of being an NGO member. The specification varies slightly across sites, but generally includes controls for age and schooling of the household head, educational attainment of household members, age and sex composition of household members, household land as of 1996–97, premarriage assets of husband and wife, shocks experienced by the household, and community variables.[14] Union dummies are included but not reported. (Many of these union dummies are highly significant because of the design of the original evaluation, in which early adopters were in villages (unions) where the technology was first made available by the disseminating institution.) After controlling for these locational effects, in Saturia, early adopters of the improved vegetables tended to have a higher value of livestock held by the wife prior to marriage and a lower value of clothes and jewelry held by the husband before marriage. These households also tend to have fewer male and female members with secondary education but the highest grade obtained is, on average, higher. In Jessore, the highest grade obtained in the household increases the likelihood of being an early adopter whereas the education level of the mother of the head decreases the likelihood. Households with lower value of premarriage livestock holding of the husband and those that did not experience wedding or dowry expenses in the period 1996–2007 were more likely to be early adopters of the improved fish technology. In Mymensingh, the likelihood of being an early adopter increases with the highest grade obtained in the household. We also find that households with larger areas of land owned are more likely to adopt early, however this relation is not linear as indicated by the significant negative coefficient on the land squared term. This is not surprising, since, in Mymensingh households are required to have their own ponds to be able to adopt the technology and therefore, tended to be wealthier than the early adopters in the other two intervention sites.

Table 5. Probit estimates of the probability of being an early adopter, all sites

Variables	Saturia	Jessore	Mymensingh
Total land in Decimals	0.002	-0.000	0.006***
	(0.002)	(0.001)	(0.002)
Total land in Decimals Squared	0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Whether head is between 20–40 years old	0.109	-0.054	0.055
	(0.249)	(0.239)	(0.229)

[14] The difference in specification arises from the different selection criteria of each of the three distinct interventions. If identical specifications were used to construct the propensity score it would have been extremely difficult to get a balanced sample because of these diverse criteria. Some regressors are included that do not necessarily affect the probability of adopting the technology (for example, the proportion experiencing floods in 2002–06) but help in balancing the sample.

Variables	Saturia	Jessore	Mymensingh
Whether head is over 55 years	-0.019	0.000	-0.337
	(0.471)	(0.367)	(0.239)
No. of male members having secondary education	-0.471**		0.029
	(0.201)		(0.188)
No. of female members having secondary education	-1.281*		0.287
	(0.729)		(0.258)
Highest level of education in the household	0.077**	0.075***	0.073**
	(0.037)	(0.027)	(0.035)
Education level of mother of head		-0.071**	-0.055
		(0.033)	(0.034)
Education level of Father of head		0.028	-0.041
		(0.041)	(0.040)
Percent of males 0–4 years old	0.015	-0.002	
	(0.010)	(0.014)	
Percent of males 5–14 years old	0.008	-0.014	
	(0.007)	(0.012)	
Percent of males 15–19 years old	-0.010	0.006	
	(0.009)	(0.014)	
Percent of males 20–34 years old	-0.005	-0.010	
	(0.009)	(0.015)	
Percent of males 35–54 years old	0.003	0.005	
	(0.015)	(0.018)	
Percent of males 55 years and older	0.009	0.003	
	(0.021)	(0.024)	
Percent of females 0–4 years old	0.005	-0.032*	
	(0.010)	(0.017)	
Percent of females 5–14 years old		0.007	
		(0.012)	
Percent of females 15–19 years old	0.005	-0.022	
	(0.011)	(0.015)	
Percent of females 20–34 years old	-0.015	-0.002	
	(0.012)	(0.014)	
Percent of females 35–54 years old	0.002	0.008	
	(0.013)	(0.013)	
Percent of females 55 years and older	-0.005		
	(0.014)		
Household Size			0.018
			(0.045)
Sex ratio			-0.011
			(0.152)

Variables	Saturia	Jessore	Mymensingh
Dependency ratio			-0.040
			(0.134)
Value of livestock held by wife before marriage	0.000**	-0.000	0.000
	(0.000)	(0.000)	(0.000)
Value of clothes and jewelry held by wife before marriage	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Value of livestock held by husband before marriage	0.000	-0.000*	0.000***
	(0.000)	(0.000)	(0.000)
Value of clothes and jewelry held by husband before marriage	-0.000*	-0.000	-0.000
	(0.000)	(0.001)	(0.000)
Whether household experienced flood shock, 1996–2006	-0.336*	-0.626	-0.158
	(0.181)	(0.505)	(0.241)
Whether household experienced livestock shock, 1996–2006	0.090	-0.095	0.083
	(0.175)	(0.191)	(0.215)
Whether household experienced crop loss, 1996–2006	0.062		
	(0.278)		
Whether household experienced legal/political shock, 1996–2006	0.034		
	(0.194)		
Whether household experienced illness shock, 1996–2006	-0.177		
	(0.161)		
Whether the household paid dowry or other wedding expenses, 1996–2006		-0.331*	0.260
		(0.171)	(0.189)
Proportion of households affected by flood, 2002–07			0.001
			(0.005)
Constant	0.897	0.138	-1.297***
	(0.681)	(1.199)	(0.381)
Observations	328	378	307
R-squared	.	.	.

*** p<0.01, ** p<0.05, * p<0.1 and Standard errors in parentheses. Union dummies included in the regressions.

Table 6. Probit estimates of the probability of being an NGO member/ program participant, all sites

Variables	Saturia	Jessore	Mymensingh
Total land in Decimals	0.005**	-0.000	0.006***
	(0.002)	(0.001)	(0.001)
Total land in Decimals Squared	-0.000	0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Whether head is between 20–40 years old	0.020	-0.077	-0.322
	(0.181)	(0.144)	(0.212)
Whether head is over 55 years	-0.439**	0.106	-0.055
	(0.221)	(0.175)	(0.212)
No. of male members having secondary education	-0.584***		
	(0.172)		
No. of female members having secondary education	-1.342***		
	(0.474)		
Highest level of education in the household	0.096***	0.031	0.014
	(0.028)	(0.019)	(0.022)
Household Size	0.031	-0.081**	-0.003
	(0.043)	(0.036)	(0.036)
Sex ratio	0.170*	0.112	0.205
	(0.089)	(0.081)	(0.132)
Dependency ratio	0.401***	-0.094	-0.200
	(0.136)	(0.108)	(0.122)
Whether household experienced flood shock, 1996–2006	0.060		
	(0.144)		
Whether household experienced livestock shock, 1996–2006	-0.007		
	(0.147)		
Whether household experienced legal/political shock, 1996–2006	0.105		
	(0.170)		
Whether household experienced illness shock, 1996–2006	0.357**		
	(0.141)		
Whether the household paid dowry or other wedding expenses, 1996–2006	-0.276*		
	(0.161)		
Value of livestock held by wife before marriage	0.000	0.001**	-0.000
	(0.000)	(0.000)	(0.000)

Variables	Saturia	Jessore	Mymensingh
Value of clothes and jewelry held by wife before marriage	0.000	-0.000*	0.000
	(0.000)	(0.000)	(0.000)
Value of livestock held by husband before marriage	0.000	-0.000	0.000**
	(0.000)	(0.000)	(0.000)
Value of clothes and jewelry held by husband before marriage	-0.000**	-0.001	-0.000
	(0.000)	(0.001)	(0.000)
Constant	-1.597***	0.561**	-0.584*
	(0.499)	(0.286)	(0.333)
Observations	461	509	286
R-squared	.	.	.

*** p<0.01, ** p<0.05, * p<0.1, Standard errors in parentheses. Union dummies included in all regressions.

The determinants of NGO or program membership show some variation across sites. In Saturia, having more land and highest grade obtained in the household increases the probability of being an NGO member. NGO member households, in Saturia, also tend to have younger household heads; more females compared to male members, a high dependency ratio, and are more likely to have experienced an illness shock. They are less likely to have experienced a wedding or dowry shock and the husbands on average have lower value of premarriage clothes and jewelry. The story in Jessore is a bit different. Here, smaller households, and those where wives have a higher value of premarriage livestock holdings and a lower value of premarriage clothes and jewelry, are more likely to be NGO members. In Mymensingh, the only thing that matters to program membership is the household's land holding. Households with larger landholdings are more likely to be part of the aquaculture extension program and as noted in the previous probit, this relation is nonlinear. Husbands' premarriage livestock holdings also have a positive correlation with program participation. If husbands' premarital assets are associated with greater bargaining power of the husband, it may be the case that households where decisionmaking favors the husband are more likely to join the program.

Asset ownership and dynamics

Before discussing the impact estimates, we briefly describe asset levels among husbands and wives in 1996–97 and in the resurvey, by site. These are shown in Table 7. A glance at this table reveals that for most asset categories, women held less than 10 percent of the assets in 1996–97. Land, in particular, is regarded as a male asset, and thus women owned only between one and five percent of the household's land at baseline. Owing to the practice of partible inheritance in which the father's land is divided (mostly among sons, although daughters are entitled to get a share equal to half of their brothers' according to Islamic law), total holdings of owned land have declined over time (particularly for jointly owned and husband's

land), although the size of women's land holdings have increased. Reflecting the notion that jewelry is regarded as a "women's asset" in Bangladesh, wives owned a large portion of exclusively owned jewelry at baseline, with the largest fraction held in Saturia and the lowest fraction held in Mymensingh. In Saturia and Jessore, wives also had a larger share of poultry and other livestock at baseline as compared to wives in Mymensingh. Even when we examine the value of total nonland assets (last row for each site), Saturia and Jessore come out stronger than Mymensingh in terms of women's exclusive ownership, where this fraction is 20 percent compared to 10 percent in Mymensingh. This shows that the initial asset distribution in Mymensingh did not favor women in general.

Table 7: Asset Levels and Growth among Husbands and Wives, by site

	1996–97				2006–07				Percentage Change		
Saturia	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives
Landholdings (in decimals)											
Homestead	1.07	10.61	0.65	0.05	0.87	10.78	0.47	0.04	-18.55	1.60	-28.19
Cultivated Land	9.87	59.38	3.55	0.05	4.12	48.69	2.20	0.04	-58.25	-18.01	-38.21
Other land	0.20	3.28	0.41	0.10	0.51	4.24	0.06	0.01	154.93	29.39	-86.22
Size of Owned land	11.14	73.27	4.61	0.05	5.50	63.71	2.72	0.04	-50.62	-13.05	-41.03
Value of owned land (2007 taka)	33136.86	210481.10	11785.42	0.05	38285.48	571394.90	24421.45	0.04	15.54	171.47	107.22
Nonland Assets (in 2007 taka)											
Consumer durables	1094.21	3046.87	623.17	0.13	7808.71	6776.56	302.73	0.02	613.64	122.41	-51.42
Agricultural durables	882.90	1749.71	16.63	0.01	772.67	988.87	1.52	0.00	-12.49	-43.48	-90.84
Nonagricultural durables	50.47	984.28	43.42	0.04	781.46	8459.24	19.30	0.00	1448.22	759.43	-55.54
Jewelry	10.85	78.91	1531.05	0.94	6122.04	1248.06	3339.34	0.31	56299.50	1481.55	118.11
Poultry	30.06	5.54	312.55	0.90	202.20	103.51	194.57	0.39	572.67	1769.45	-37.75
Other livestock	1461.97	5955.21	1443.36	0.16	8207.62	11842.88	486.26	0.02	461.41	98.87	-66.31
Total livestock	1492.03	5960.75	1755.91	0.19	8409.82	11946.39	680.83	0.03	463.65	100.42	-61.23
Total value of nonland assets	3530.46	11820.52	3970.18	0.21	23894.69	29419.13	4343.73	0.08	576.82	148.88	9.41

	1996–97				2006–07				Percentage Change		
Jessore	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives
Landholdings (in decimals)											
Homestead	1.96	6.00	0.40	0.05	0.94	8.68	0.89	0.09	-52.03	44.65	121.04
Cultivated Land	14.30	59.41	2.13	0.03	4.05	49.55	4.14	0.07	-71.66	-16.58	94.40
Other land	1.64	6.54	0.02	0.00	0.18	4.47	0.16	0.03	-88.76	-31.62	753.55
Size of Owned land	17.89	71.95	2.55	0.03	5.17	62.71	5.19	0.07	-71.08	-12.84	103.40
Value of owned land (2007 taka)	45021.07	185062.70	6261.39	0.03	12082.08	287472.40	23870.81	0.07	-73.16	55.34	281.24
Nonland Assets (in 2007 taka)											
Consumer durables	4724.72	1403.28	62.06	0.01	5894.65	4697.85	493.92	0.04	24.76	234.78	695.83
Agricultural durables	686.41	535.23	0.00	0.00	240.57	473.92	19.45	0.03	-64.95	-11.46	
Nonagricultural durables	644.41	108.84	0.00	0.00	187.96	682.85	224.60	0.21	-70.83	527.39	
Jewelry	225.26	3.14	1125.44	0.83	6242.69	925.63	1383.16	0.16	2671.37	29417.98	22.90
Poultry	94.89	5.49	718.79	0.88	194.66	186.47	334.21	0.47	105.15	3298.22	-53.50
Other livestock	3220.71	3485.67	1677.53	0.20	4210.36	7142.23	1821.04	0.14	30.73	104.90	8.55
Total livestock	3315.60	3491.16	2396.32	0.26	4405.02	7328.71	2155.24	0.16	32.86	109.92	-10.06
Total value of nonland assets	9596.39	5541.65	3583.82	0.19	16970.88	14108.95	4276.36	0.12	76.85	154.60	19.32

	1996–97				2006–07				Percentage Change		
Mymensingh	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives	Frac wives	Joint	Husbands	Wives
Landholdings (in decimals)											
Homestead	2.80	13.82	0.03	0.00	1.90	13.28	0.46	0.03	-32.28	-3.95	1226.24
Cultivated Land	27.94	134.37	1.30	0.01	24.23	106.90	3.29	0.02	-13.26	-20.44	153.02
Other land	0.72	5.73	0.00	0.00	1.03	6.25	0.24	0.03	43.79	8.95	
Size of Owned land	31.46	153.92	1.33	0.01	27.16	126.42	3.99	0.03	-13.65	-17.87	198.97
Value of owned land (2007 taka)	73477.79	354004.50	2658.81	0.01	145467.60	674198.90	20114.11	0.02	97.97	90.45	656.51
Nonland Assets (in 2007 taka)											
Consumer durables	5059.00	1926.85	180.09	0.03	9293.87	6029.75	433.99	0.03	83.71	212.93	140.98
Agricultural durables	1600.82	2392.42	4.79	0.00	337.61	365.65	2.27	0.00	-78.91	-84.72	-52.68
Nonagricultural durables	351.61	542.08	2.13	0.00	432.13	611.00	0.00	0.00	22.90	12.71	-100.00
Jewelry	1039.17	0.80	1850.24	0.64	6426.98	2492.78	1609.54	0.15	518.47	311986.81	-13.01
Poultry	121.76	26.11	418.48	0.74	352.71	144.12	83.76	0.14	189.69	452.03	-79.98
Other livestock	3497.72	7548.59	287.45	0.03	4577.32	7909.79	431.00	0.03	30.87	4.79	49.94
Total livestock	3619.48	7574.69	705.93	0.06	4930.03	8053.92	514.76	0.04	36.21	6.33	-27.08
Total value of nonland assets	11670.07	12436.84	2743.18	0.10	21420.62	17553.10	2560.55	0.06	83.55	41.14	-6.66

Even in a patriarchal society where husbands control most of the household's assets and resources, women's asset ownership is meaningful. Women's assets at marriage, for example, have a positive and significant effect on children's clothing and education expenditures; they also reduce the morbidity of girl children (Quisumbing and de la Briere 2000, Hallman 2000). In societies where a woman's ability to accumulate assets is proscribed, children are probably her most important investment and insurance for the future, thus influencing her preferences (Quisumbing and Maluccio 2003).

The asset levels in the resurvey indicate a general decline in the percentage of assets held by wives. This decline is significantly (and surprisingly) high in the case of jewelry. This fall is consistent throughout the sample and it comes as result of both an increase in joint ownership of jewelry and an increase in jewelry exclusively held by husbands. While this could be attributable to reporting bias, or changes in perceptions regarding jewelry as men's or women's assets, it could also reflect households' purchase of jewelry as a store of value or husbands' buying jewelry in preparation for daughters' weddings, since providing a good dowry to one's daughter and marrying her off well is considered a father's responsibility.[15] Jewelry may also be shared with daughters and/or sold off to purchase other assets. Despite the general decline in the proportion of jewelry held by women, in both Saturia and Jessore, the levels (values) of jewelry owned by wives increased, but in Mymensingh the total value of jewelry owned by women decreased. Thus, on average, even if the absolute values of assets controlled by wives increased over the ten year survey interval, the growth rate of men's assets was larger. Thus, the share of assets controlled by women declined from the initial survey. So, if we find positive effects of the technology or NGO membership on women's assets and asset growth it further supports the argument that building up social capital may help build up tangible assets, even in situations where, on average, the share of tangible assets, and in some cases, the total value of assets controlled by women, decline.

Impact estimates: Household level

In this section we present estimates of the average treatment effect on the treated using nearest-neighbor matching (NNM) and the three alternative treatments discussed above. We denote "early adoption" as the comparison between early adopters of the technology and late and nonadopters; "technology access" as the comparison between NGO members who were initial adopters and NGO members who were unable to adopt initially; and "NGO membership" as the comparison between NGO members (whether early or potential adopters) and non-NGO members. To facilitate contrasts among treatments, we present the results for all sites for each treatment.

Tables 8 to 10 present the impacts of early adoption, technology access, and NGO membership on husbands' and wives' assets, across all sites. In Saturia, early adoption has positive impact on husbands' exclusively held land value, nonlivestock asset value, and value of total assets. A large portion of this increase is attributed to increases in various exclusively held durable assets. The wives, on the other hand, experienced a decline in the value of exclusively held land. Wives also

[15] We thank Sajeda Amin and colleagues at the Population Council for this insight.

experience mixed impacts on the various groups of assets they hold exclusively. For example, early adoption has a negative impact on the value of consumer durables, livestock, poultry, and trees, and a positive impact on agricultural durables and jewelry. However, these opposing impacts seem to offset each other because we do not observe any impact on total asset value. In terms of joint plus exclusive assets, we observe significant negative impact on husbands' assets more than the wives'. In Jessore, early adoption led to a negative impact on the value of wives' exclusively held land, but a positive impact on the total value of exclusively held assets, which can be attributed to an increase in all asset categories (except land and agricultural durables). Husbands in Jessore experience a decline in the value of exclusively held assets as a result of early adoption. The results on joint plus exclusive assets broadly mimic the results for exclusive assets. This decline experienced by early adopters could have occurred because of reallocation of assets within the household—since the intervention targeted women; it may have improved their position and increased ownership of certain assets. The decline in asset levels also could have occurred because of initial investments required in establishing a pond that could have affected ability to acquire other assets, given that these households were on average poorer, even if the costs of these investments were shared within a group. Later adopters of the fishpond technology may have learned from the mistakes of early adopters and adopted tested techniques, enabling them to build up their assets faster than the earlier adopters. In Mymensingh, impacts of early adoption are positive for husbands' and wives' exclusively held assets, but the impacts are larger among husbands.

Table 8. Average impact of early adoption on husbands' and wives' asset holdings, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=222	N=282	N=204	N=196	N=198	N=299
Exclusively owned land and assets						
Exclusively owned land and assets: Change in						
Land value	1.938***	-1.216***	0.465	-8.836***	1.916***	0.804***
	(0.000)	(0.001)	(0.571)	(0.000)	(0.003)	(0.000)
Nonlivestock asset value	7.102***	-0.248	0.443	0.642	3.151***	1.334**
	(0.000)	(0.724	(0.562)	(0.408)	(0.000)	(0.023)
Total value of assets	4.032***	-0.735	-5.342***	6.862***	2.629***	1.207**
	(0.000)	(0.253)	(0.000)	(0.000)	(0.005)	(0.018)
Exclusively owned land: Change in area of						
Homestead land	0.755***	-0.217***	-0.414**	-0.452***	0.180	0.073**
	(0.000)	(0.000)	(0.015)	(0.000)	(0.231)	(0.024)
Cultivated land	-0.649***	-0.133	1.328***	-3.145***	0.033	0.112
	(0.000)	(0.161)	(0.000)	(0.000)	(0.885)	(0.103)
Other land	0.703***	…	-2.095***	0.050***	-0.125	-0.030
	(0.000)		(0.000)	(0.006)	(0.316)	(0.125)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=222	N=282	N=204	N=196	N=198	N=299
Exclusively owned assets: Change in value of						
Consumer durables	3.695*** (0.000)	-2.908*** (0.000)	1.761** (0.020)	4.155*** (0.000)	1.552* (0.064)	0.564 (0.100)
Agricultural durables	4.199*** (0.000)	0.452*** (0.000)	3.893*** (0.000)	-0.383** (0.020)	1.658*** (0.007)	0.243** (0.043)
Nonagricultural durables	3.551*** (0.000)	-0.204 (0.144)	-0.266 (0.527)	0.182*** (0.006)	1.696*** (0.000)	0.000 (…)
Livestock (total)	-2.194 (0.001)***	-1.919*** (0.000)	-2.242** (0.011)	5.637*** (0.000)	4.190*** (0.000)	0.505 (0.264)
Poultry	1.918*** (0.000)	-1.781*** (0.000)	2.075*** (0.000)	3.871*** (0.000)	-0.069 (0.869)	0.018 (0.964)
Other livestock	-5.287*** (0.000)	-0.419 (0.180)	-3.065*** (0.001)	5.557*** (0.000)	4.347*** (0.000)	0.364 (0.377)
Jewelry	0.767** (0.016)	1.931** (0.015)	2.081*** (0.000)	0.173 (0.821)	0.275 (0.556)	0.864 (0.131)
Trees	-1.558*** (0.005)	-0.775*** (0.000)	3.561*** (0.000)	1.992*** (0.000)	0.885 (0.388)	0.180 (0.414)
Exclusively plus jointly owned land and assets						
Exclusively plus jointly owned land and assets: Change in						
Land value	-2.618*** (0.000)	-1.478*** (0.004)	-1.626** (0.046)	-6.790*** (0.000)	1.384*** (0.008)	-0.279 (0.616)
Nonlivestock asset value	-2.316*** (0.000)	-0.392 (0.482)	-1.116** (0.035)	7.066*** (0.000)	-0.124 (0.700)	-0.383 (0.451)
Total value of assets	-2.981*** (0.000)	-0.539 (0.294)	-1.684*** (0.004)	8.327*** (0.000)	0.136 (0.690)	-0.569 (0.280)
Exclusively plus jointly owned assets: Change in value of						
Consumer durables	-3.511*** (0.000)	-2.020*** (0.006)	-0.645 (0.198)	6.306*** (0.000)	-0.628** (0.029)	-1.205** (0.022)
Agricultural durables	2.029*** (0.001)	0.667* (0.059)	3.761*** (0.000)	3.873*** (0.000)	0.939* (0.058)	-0.661 (0.120)
Nonagricultural durables	3.696*** (0.000)	-0.083 (0.738)	-2.543*** (0.000)	0.748 (0.143)	1.453*** (0.004)	-1.362*** (0.000)
Livestock (total)	-5.977*** (0.000)	-0.522 (0.378)	3.060*** (0.001)	6.819*** (0.000)	1.689** (0.011)	-1.959*** (0.000)
Poultry	-1.158** (0.026)	-0.941 (0.042)	1.764*** (0.001)	5.449*** (0.000)	-0.921* (0.082)	-1.431*** (0.002)
Other livestock	-7.990*** (0.000)	0.490 (0.408)	2.083** (0.029)	3.733*** (0.000)	2.877*** (0.000)	-2.022*** (0.002)
Jewelry	-4.386*** (0.000)	2.680*** (0.000)	-4.773*** (0.000)	3.372*** (0.000)	-0.624 (0.295)	0.916 (0.133)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=222	N=282	N=204	N=196	N=198	N=299
Trees	-0.989*	-1.009**	1.972**	2.937***	-0.827	-1.305*
	(0.095)	(0.036)	(0.014)	(0.000)	(0.204)	(0.055)

p-values in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent, respectively

Table 9 reports the impact of access to technology among NGO members for the three sites. In Saturia, access to technology among NGO members has no significant effect on husband's land value, nonlivestock assets as well as total asset accumulation. This is not surprising as the technology was targeted to women. We do observe some reallocation of wealth across various types of assets held by the husbands but no impact on their total exclusive asset holdings. The story is very different for the wives in Saturia. The wives' exclusive assets (nonlivestock and total assets) have increased fourfold as compared to nonadopting wives. Much of this is accounted for by significant increases in livestock and poultry holdings and jewelry. Even though exclusively held land by wives was not significantly affected, jointly held land value decreased significantly. In Jessore, early access to technology among NGO members had significant negative impacts on husbands' and wives' exclusive assets as well as joint plus exclusive assets. The impacts are especially large for husbands, with huge declines in cultivated land, consumer durables, and livestock holdings. In Mymensingh, early access to technology led to a positive growth of husbands' exclusive assets but a negative growth of wives' exclusively held assets. The husbands experience an increase in the value of all asset categories except trees, whereas the wives mostly experience a decline (except for livestock and poultry). Even though both husbands and wives experience a decline in the value of joint plus exclusive assets, the decline is larger for the wives.

Table 9. Average impact of technology access among NGO members on husbands' and wives' asset holdings, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=112	N=102	N=142	N=170	N=141	N=155
	Exclusively owned land and assets					
Exclusively owned land and assets: Change in						
Land value	0.249	0.556	-42.484***	0.561	9.630***	-2.408***
	(0.740)	(0.595)	(0.000)	(0.399)	(0.000)	(0.000)
Nonlivestock asset value	0.370	4.580***	-8.675***	-4.650***	1.703*	-3.269***
	(0.728)	(0.000)	(0.000)	(0.000)	(0.056)	(0.000)
Total value of assets	-0.115	4.976***	-23.715***	-2.693***	5.406***	-1.056
	(0.896)	(0.000)	(0.000)	(0.000)	(0.000)	(0.149)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=112	N=102	N=142	N=170	N=141	N=155
Exclusively owned land: Change in area of						
Homestead land	0.152 (0.335)	0.160** (0.024)	-1.799*** (0.000)	0.150 (0.179)	1.921*** (0.000)	-0.371*** (0.000)
Cultivated land	-0.144 (0.581)	-0.098 (0.774)	-14.636*** (0.000)	0.225 (0.149)	4.349*** (0.000)	-0.753*** (0.000)
Other land	-0.100 0.640)	0.000 (…)	2.989*** (0.000)	0.051* (0.054)	0.177 (0.194)	-0.414*** (0.000)
Exclusively owned assets: Change in value of						
Consumer durables	0.722 (0.516)	0.269 (0.744)	-23.427*** (0.000)	0.663 (0.167)	-0.867 (0.370)	-1.048** (0.011)
Agricultural durables	0.276 (0.715)	-0.036 (0.809)	3.750*** (0.000)	0.764*** (0.000)	1.678** (0.016)	-0.337* (0.059)
Nonagricultural durables	1.162** (0.030)	-0.012 (0.774)	7.055*** (0.000)	-0.157 (0.629)	0.863 (0.201)	0.000 (…)
Livestock (total)	-1.280 (0.213)	3.255*** (0.000)	-36.431*** (0.000)	-4.228*** (0.000)	5.055*** (0.000)	1.404** (0.019)
Poultry	-0.583 (0.124)	3.563*** (0.000)	-8.272*** (0.000)	-3.717*** (0.000)	1.053** (0.014)	1.468** (0.010)
Other livestock	-1.119 (0.289)	-0.369 (0.416)	-30.839*** (0.000)	-1.176 (0.183)	3.987*** (0.000)	-1.736*** (0.001)
Jewelry	-1.861*** (0.000)	4.348*** (0.001)	-1.600*** (0.008)	-5.337*** (0.000)	-0.362 (0.488)	-3.216*** (0.000)
Trees	-2.779*** (0.001)	-0.014 (0.774)	-0.078 (0.922)	0.712* (0.063)	-4.885*** (0.000)	-1.334*** (0.000)
Exclusively plus jointly owned land and assets						
Exclusively plus jointly owned land and assets: Change in						
Land value	-0.544 (0.452)	-6.018*** (0.000)	-42.940*** (0.000)	-1.078 (0.185)	4.190*** (0.000)	-2.509*** (0.000)
Nonlivestock asset value	-0.662 (0.138)	-0.393 (0.538)	-8.409*** (0.000)	-2.285*** (0.000)	-0.953*** (0.009)	-2.957*** (0.000)
Total value of assets	-0.530 (0.280)	-0.580 (0.242)	-18.278*** (0.000)	-2.498*** (0.000)	-1.020*** (0.003)	-2.913*** (0.000)
Own plus jointly owned assets: Change in value of						
Consumer durables	0.142 (0.794)	-0.185 (0.894)	-9.667*** (0.000)	-3.607*** (0.000)	-1.381*** (0.000)	-2.239*** (0.004)
Agricultural durables	-0.508 (0.434)	-2.003*** (0.000)	-4.507*** (0.000)	-2.130*** (0.000)	2.024*** (0.001)	-2.349*** (0.000)
Nonagricultural	1.109** (0.039)	-0.002 (0.993)	7.468*** (0.000)	-1.980*** (0.000)	0.494 (0.506)	-3.880*** (0.000)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=112	N=102	N=142	N=170	N=141	N=155
durables						
Livestock (total)	-1.516*	-1.940*	-29.723***	-4.752***	0.223	-1.100
	(0.073)	(0.057)	(0.000)	(0.000)	(0.746)	(0.153)
Poultry	-1.194*	0.827	6.084***	-1.247**	1.991***	1.038*
	(0.055)	(0.331)	(0.000)	(0.026)	(0.000)	(0.082)
Other livestock	-1.272	-4.072***	-24.380***	-4.463***	-1.687**	-7.353***
	(0.151)	(0.000)	(0.000)	(0.000)	(0.042)	(0.000)
Jewelry	-2.422***	-2.070	8.179***	-3.797***	3.922***	-1.273
	(0.000)	(0.126)	(0.000)	(0.000)	(0.000)	(0.190)
Trees	-2.780	-4.312***	-2.936***	-2.021***	-9.001***	-9.035***
	(0.004)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)

Average impact on the treated (ATT), p-values in parentheses. ***, ** and * indicate significance at 1, 5 and 10 percent, respectively

Table 10 presents estimates of impact of NGO membership (program participation for Mymensingh) on husbands' and wives' assets. In Saturia, NGO membership led to an increase in value of wives' exclusively held land and total assets whereas it led to a significant decline in value of husbands' exclusively held land, nonlivestock assets, as well as total assets. The change in husbands' (wives') total value of assets results from a general decline (increase) in value of all asset categories (except value of exclusively held trees among wives). The impact on joint plus exclusive assets is similar. In Jessore, husbands experience a decline in value of exclusively held land as a result of NGO membership whereas the wives experience an increase in land value. NGO membership led to a positive significant impact on husbands' and wives' value of exclusively held total assets—this increase is almost three times as large for the wives as compared to the husbands. The fact that wives' asset growth is larger than husbands' is reflected across all asset categories (except jewelry).[16] In Mymensingh, program participation led to a decline in value of land exclusively held by husbands and wives. It also led to a decline in husbands' nonlivestock assets and total assets, whereas a significant increase among the wives'. An examination of the impact on various asset categories reveals that the positive impact on wives' total asset holdings can be attributed primarily to the increase in value of exclusively held consumer durables and jewelry. Even though the husbands' total asset value declined as a result of program participation, they did accumulate poultry, trees and land, all of which are productive assets. All in all, in Mymensingh, total wealth increased, but women lost productive assets (trees and land) and gained consumer durables and jewelry, while men gained productive assets. The asset redistribution after the program in Mymensingh—which targeted the technologies to men—therefore reinforced gender disparities, with men strengthening their control of "productive" assets. While

[16] During a field visit to Jessore in August 2008, a woman who had begun fish cultivation with a group pond mentioned that she had used the proceeds from the pond to buy land in her own name, and had started an individual fishpond on the newly acquired land.

program participation increased women's assets levels compared to those not in the program, the impact of membership on women's assets is much less compared to Jessore, where the same technology was introduced. In Mymensingh, the initial disparity in asset holding among husbands and wives was much wider as compared to Jessore. Technology diffused through women's groups had a much bigger impact on women's asset accumulation in Jessore than in Mymensingh. This further reinforces the belief that group-based approaches that are targeted to women can have greater positive impact on women's asset accumulation than approaches that target individuals without regard to gender.

Table 10. Average impact of NGO/program membership on husbands' and wives' asset holdings, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=442	N=338	N=236	N=162	N=160	N=186
	Exclusively owned land and assets					
Exclusively owned land and assets: Change in						
Land value	-1.716*** (0.000)	0.507** (0.032)	-4.784*** (0.000)	6.162*** (0.000)	-2.919*** (0.001)	-2.230*** (0.000)
Nonlivestock assets value	-4.246*** (0.000)	-0.830 (0.152)	0.988 (0.171)	0.531 (0.475)	-5.039*** (0.000)	2.625*** (0.000)
Total value of assets	-3.520*** (0.000)	2.533*** (0.000)	2.737*** (0.006)	8.210*** (0.000)	-4.013*** (0.000)	2.715*** (0.000)
Exclusively owned land: Change in area of						
Homestead land	-0.408*** (0.000)	-0.147*** (0.000)	-0.653*** (0.000)	0.294** (0.049)	-0.699*** (0.002)	-0.343*** (0.000)
Cultivated land	-0.716*** (0.000)	0.318*** (0.000)	-1.478*** (0.000)	1.633*** (0.000)	-0.214 (0.520)	-0.702*** (0.000)
Other land	0.300*** (0.000)	0.019*** (0.006)	0.067 (0.665)	0.000 (…)	1.194*** (0.000)	0.000 (…)
Exclusively owned assets: Change in value of						
Consumer durables	-4.380*** (0.000)	-0.482 (0.295)	-0.032 (0.961)	2.059*** (0.000)	-1.395* (0.091)	1.003** (0.13)
Agricultural durables	-2.244*** (0.000)	1.541*** (0.000)	0.852** (0.046)	1.151*** (0.000)	-3.646*** (0.000)	-0.030 (0.686)
Nonagricultural durables	0.638 (0.128)	-0.083 (0.390)	0.914*** (0.000)	0.946** (0.000)	-2.923*** (0.000)	-0.115*** (0.006)
Livestock (total)	-1.957*** (0.003)	5.062*** (0.000)	2.418*** (0.007)	9.584*** (0.000)	-2.884*** (0.001)	-0.124 (0.841)
Poultry	-0.601* (0.077)	3.580*** (0.000)	1.143*** (0.001)	9.034*** (0.000)	3.349*** (0.000)	-0.578 (0.251)
Other	-1.701**	3.380***	2.355***	6.468***	-2.212**	-1.011

Outcome variable	Saturia		Jessore		Mymensingh	
	Husbands	Wives	Husbands	Wives	Husbands	Wives
	N=442	N=338	N=236	N=162	N=160	N=186
livestock	(0.011)	(0.000)	(0.010)	(0.000)	(0.012)	(0.118)
Jewelry	-1.553***	0.133	1.217***	-2.443***	2.624***	3.688***
	(0.000)	(0.839)	(0.000)	(0.000)	(0.000)	(0.000)
Trees	-1.179***	-0.949***	-4.900***	3.234***	7.856***	-1.007***
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
	Exclusively plus jointly owned land and assets					
Exclusively plus jointly owned land and assets: Change in						
Land value	-1.458***	1.506***	-4.752***	2.528***	-0.826	-1.901***
	(0.000)	(0.001)	(0.000)	(0.008)	(0.191)	(0.003)
Nonlivestock asset value	-2.036***	-0.518	-2.229***	4.027***	2.356***	-2.311***
	(0.000)	(0.366)	(0.000)	(0.000)	(0.000)	(0.000)
Total value of assets	-1.788***	1.671***	-1.266***	4.310***	1.794***	-2.545***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.000)	(0.000)
Exclusively plus jointly owned assets: Change in value of						
Consumer durables	-1.746***	2.863***	-1.763***	4.314***	3.162***	-5.137***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural durables	-1.799***	2.121***	-2.785***	-0.103	3.126***	-5.542***
	(0.000)	(0.000)	(0.000)	(0.853)	(0.000)	(0.000)
Nonagricultural durables	1.115***	0.434**	0.664**	-2.201**	-0.561	1.110***
	(0.005)	(0.035)	(0.052)	(0.001)	(0.279)	(0.000)
Livestock (total)	-0.498	5.259***	2.155***	4.220***	-1.744***	-4.605***
	(0.467)	(0.000)	(0.004)	(0.000)	(0.004)	(0.000)
Poultry	-0.040	3.978***	1.590***	3.537***	5.441***	-1.040***
	(0.901)	(0.000)	(0.000)	(0.000)	(0.000)	(0.027)
Other livestock	-0.177	4.653***	1.853*	8.714***	-0.958	-7.399***
	(0.815)	(0.000)	(0.013)	(0.000)	(0.235)	(0.000)
Jewelry	0.692	-0.539	-2.687***	-5.187***	2.622***	-0.680
	(0.114)	(0.315)	(0.000)	(0.000)	(0.000)	(0.259)
Trees	-1.298***	-1.975***	-6.760***	-2.926***	6.097***	-6.785***
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

P-values in parentheses. ***, **, and * indicate significance at 1, 5 and 10 percent, respectively

Impact estimates: husband–wife comparisons

Comparisons of husbands and wives in different households will not always reveal the impact of the programs and different implementation modalities on gender asset inequality within the household. Even if matching controls for observable individual and household level characteristics, it may not be able to adequately control for unobservable household characteristics that may influence the distribution of assets between husbands and wives (for example, preferences for or against gender equality). A more robust comparison would be to examine the difference between husband and wife assets within the same household at two

different points in time, between treatment and comparison households, or a quadruple difference. That is,

[(Husband–Wife) T 06/07 – (Husband –Wife)T 96/97] – [(Husband–Wife) C 06/07 – (Husband –Wife) C 96/97]

Where T indicates treatment, C indicates comparison, 06/07 indicates the 2006–07 round, and 96/97 indicates the baseline survey round. We use two alternative definitions of the outcome variable. The first is the differential change in levels of husband's and wife's assets within the same household, or

[(Asset h–Assetw) T 06/07 – (Asset h–Assetw) T 96/97] – [(Asset h–Assetw) C 06/07 – (Asset h–Assetw) C 96/79]

The second definition focuses on the different growth of husband's and wife's assets within the same household, where the outcome variable is therefore defined as:

Ln(Asseth_07/Asseth_96) – ln(Assetw_07/Asset w_96)

Note that because we have defined this variable as the difference between husband and wife, a negative average treatment effect means that the level of wife's assets are increasing more than the husband's assets (definition 1), the wife's assets are growing faster than the husband's assets (definition 2), or, given that the initial asset distribution favors husbands, that gender asset inequality is decreasing.

Tables 11 to 13 present the average treatment effects on the differential change and the differential growth of husbands' and wives' assets across all three comparisons for all sites.

Table 11. Average impact of early adoption on husbands' and wives' differential asset change and growth, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=328	N=328	N=378	N=378	N=307	N=307
Exclusively owned land and assets						
Exclusively owned land and assets						
Land value	7000.92	0.016	-130785.50***	-3.491***	215162.20***	1.513**
	(0.898)	(0.980)	(0.000)	(0.000)	(0.005)	(0.049)
Nonlivestock asset value	715.61	-1.781**	542.17	0.385	-3656.27	1.778*
	(0.725)	(0.017)	(0.747)	(0.628)	(0.177)	(0.051)
Total value of assets	1097.60	-0.812	-4414.86	-2.756***	-2025.28	2.024**
	(0.732)	(0.238)	(0.129)	(0.001)	(0.658)	(0.016)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=328	N=328	N=378	N=378	N=307	N=307
Exclusively owned land area						
Homestead land	0.18	-0.008	-4.51***	-0.765***	3.83	0.220
	(0.854)	(0.954)	(0.000)	(0.000)	(0.105)	(0.137)
Cultivated land	-6.12	-0.088	1.44	-0.195	34.32***	0.783***
	(0.308)	(0.651)	(0.858)	(0.499)	(0.000)	(0.004)
Other land	-2.01**	-0.460***	2.02	0.162	4.00***	0.357***
	(0.015)	(0.000)	(0.240)	(0.305)	(0.000)	(0.005)
Exclusively owned assets value						
Consumer durables	3969.19***	-0.878	-1908.86***	0.273	-1551.72	0.441
	(0.000)	(0.223)	(0.006)	(0.695)	(0.358)	(0.598)
Agricultural durables	-484.56	0.620	52.67	-1.317***	-971.07	0.626
	(0.500)	(0.344)	(0.939)	(0.009)	(0.246)	(0.253)
Nonagricultural durables	-1811.63	0.810*	2704.05**	0.877***	1674.88***	0.771**
	(0.210)	(0.052)	(0.023)	(0.005)	(0.001)	(0.031)
Livestock (total)	381.99	2.763***	-4957.03**	-3.865***	1630.99	3.021***
	(0.878)	(0.000)	(0.020)	(0.000)	(0.516)	(0.000)
Poultry	352.53***	3.019***	-313.27***	-2.208***	45.57	0.884
	(0.000)	(0.000)	(0.009)	(0.001)	(0.609)	(0.143)
Other livestock	29.46	1.460*	-4643.76**	-3.913***	1585.41	1.522*
	(0.991)	(0.073)	(0.027)	(0.000)	(0.526)	(0.081)
Jewelry	-957.38	-1.087*	-305.70	0.846	-2808.36**	0.524
	(0.322)	(0.088)	(0.656)	(0.232)	(0.031)	(0.493)
Trees	-5173.82***	-0.317	10446.96***	-0.347	-4021.65	-0.861
	(0.000)	(0.523)	(0.000)	(0.589)	(0.228)	(0.314)
Exclusive plus jointly owned land and assets						
Exclusively plus jointly owned land and assets						
Land value	11426.46	0.210	-148973.20***	-5.252***	281560.10***	1.439
	(0.836)	(0.750)	(0.000)	(0.000)	(0.001)	(0.138)
Nonlivestock asset value	626.01	-0.515	142.66	-1.472**	-2978.05	0.496
	(0.760)	(0.343)	(0.933)	(0.012)	(0.284)	(0.510)
Total value of assets	1006.90	-0.103	-4872.38	-2.323***	-960.19	0.407
	(0.754)	(0.828)	(0.101)	(0.000)	(0.839)	(0.592)
Exclusively plus jointly owned assets value						
Consumer durables	3907.93***	0.225	-2099.84***	-1.527***	-731.87	0.174
	(0.001)	(0.769)	(0.004)	(0.009)	(0.675)	(0.816)
Agricultural durables	-490.44	0.458	37.94	-1.462***	-960.20	0.661
	(0.495)	(0.486)	(0.956)	(0.004)	(0.252)	(0.222)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=328	N=328	N=378	N=378	N=307	N=307
Nonagricultural durables	-1811.63	1.029**	2704.05**	0.877***	1674.88	0.771**
	(0.210)	(0.014)	(0.024)	(0.005)	(0.001)	(0.031)
Livestock (total)	380.89	2.097***	-5015.04**	-3.890***	2017.87	2.113***
	(0.879)	(0.002)	(0.021)	(0.000)	(0.428)	(0.009)
Poultry	351.43***	2.984***	-317.82***	-2.295***	74.20	1.126*
	(0.000)	(0.000)	(0.008)	(0.001)	(0.411)	(0.062)
Other livestock	29.46	1.369*	-4697.22**	-3.709***	1943.67	1.957**
	(0.991)	(0.092)	(0.028)	(0.000)	(0.443)	(0.035)
Jewelry	-979.86	-1.149*	-499.49	0.472	-2960.87**	0.580
	(0.311)	(0.071)	(0.466)	(0.509)	(0.024)	(0.447)
Trees	-5238.91***	-0.070	10366.30***	-0.424	-4339.75	-0.973
	(0.000)	(0.894)	(0.000)	(0.519)	(0.211)	(0.298)

Note: Average impact on the treated (ATT); a negative ATT means that wife's assets are growing faster than husband's assets, or that gender asset inequality is decreasing. ***, **, and * indicate significance at 1, 5 and 10 percent, respectively.

Table 12. Average impact of technology access among NGO members on husbands' and wives' differential asset change and growth, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=158	N=158	N=208	N=208	N=182	N=182
Exclusively owned land and assets						
Exclusively owned land and assets						
Land value	313843.40***	3.151***	141757.90***	2.798**	447061.50***	4.771***
	(0.000)	(0.001)	(0.001)	(0.047)	(0.000)	(0.000)
Nonlivestock asset value	8998.10***	3.129***	2393.09	4.567***	797.07	0.673
	(0.000)	(0.000)	(0.306)	(0.000)	(0.794)	(0.557)
Total value of assets	12208.74***	3.729***	1708.49	2.720**	-1009.84	0.515
	(0.005)	(0.000)	(0.752)	(0.046)	(0.863)	(0.660)
Exclusively owned land area						
Homestead land	6.59***	1.052***	-2.06	-0.260	7.73***	1.014***
	(0.000)	(0.000)	(0.139)	(0.337)	(0.000)	(0.000)
Cultivated land	10.76	-0.662**	25.57***	0.566*	43.74***	1.635***
	(0.267)	(0.027)	(0.002)	(0.058)	(0.000)	(0.000)
Other land	-7.16***	-1.368***	5.93***	0.977***	6.29***	0.745***
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
Exclusively owned assets value						

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=158	N=158	N=208	N=208	N=182	N=182
Consumer durables	585.19	-1.149	2405.74*	3.753***	1145.70	-0.656
	(0.738)	(0.247)	(0.060)	(0.000)	(0.553)	(0.534)
Agricultural durables	5921.73***	4.963***	2506.12***	2.171***	654.79***	1.551**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.045)
Nonagricultural durables	1846.20**	2.422***	329.49	-0.399	-2838.46*	-1.233**
	(0.037)	(0.000)	(0.263)	(0.466)	(0.052)	(0.023)
Livestock (total)	3210.64	5.780***	-684.60	1.333	-1806.90	-0.607
	(0.356)	(0.000)	(0.845)	(0.371)	(0.595)	(0.593)
Poultry	236.56***	0.409	7.51	1.231	-4.20	0.636
	(0.004)	(0.597)	(0.964)	(0.200)	(0.971)	(0.389)
Other livestock	2974.08	6.709***	-692.11	-0.512	-1802.70	-1.052
	(0.392)	(0.000)	(0.839)	(0.765)	(0.594)	(0.362)
Jewelry	644.97	2.719***	-2848.26	0.850	1835.04*	1.653*
	(0.462)	(0.002)	(0.149)	(0.455)	(0.074)	(0.093)
Trees	-2025.51	-2.429***	5817.47**	2.098***	-586.53	-1.589
	(0.312)	(0.000)	(0.021)	(0.005)	(0.880)	(0.200)
Exclusively plus jointly owned land and assets						
Exclusively plus jointly owned land and assets						
Land value	413933.00***	4.423***	140670.80***	2.669*	483914.50***	3.472***
	(0.000)	(0.000)	(0.002)	(0.090)	(0.000)	(0.003)
Nonlivestock asset value	11987.01***	1.626***	1081.21	-0.300	2142.21	0.641
	(0.000)	(0.009)	(0.649)	(0.753)	(0.485)	(0.424)
Total value of assets	16000.12***	1.779***	362.91	0.313	-79.87	0.865
	(0.000)	(0.002)	(0.948)	(0.779)	(0.989)	(0.316)
Exclusively plus jointly owned assets value						
Consumer durables	3197.67*	-3.951***	1808.63	0.364	1864.85	0.460
	(0.077)	(0.000)	(0.173)	(0.698)	(0.336)	(0.565)
Agricultural durables	5933.42***	5.252***	2441.00***	0.085	660.52***	1.639**
	(0.000)	(0.000)	(0.002)	(0.898)	(0.000)	(0.036)
Nonagricultural durables	2210.96**	2.836***	329.49	-0.399	-2838.46*	-1.233**
	(0.013)	(0.000)	(0.263)	(0.466)	(0.052)	(0.023)
Livestock (total)	4013.11	2.045**	-718.30	2.255	-2222.08	-1.144
	(0.248)	(0.022)	(0.843)	(0.113)	(0.514)	(0.252)
Poultry	236.56***	0.306	7.51	1.231	-9.28	0.563
	(0.004)	(0.689)	(0.964)	(0.200)	(0.936)	(0.438)
Other livestock	3776.55	7.109***	-725.81	2.029	-2212.79	-1.138
	(0.277)	(0.002)	(0.837)	(0.197)	(0.513)	(0.318)
Jewelry	644.97	2.719***	-3497.90*	-0.467	2455.30**	1.896*
	(0.462)	(0.002)	(0.077)	(0.688)	(0.017)	(0.054)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=158	N=158	N=208	N=208	N=182	N=182
Trees	-2182.65 (0.277)	-3.891*** (0.000)	5807.36** (0.022)	2.083** (0.012)	-1063.70 (0.785)	-2.141* (0.088)

Note: Average impact on the treated (ATT); a negative ATT means that wife's assets are growing faster than husband's assets, or that gender asset inequality is decreasing. ***, **, and * indicate significance at 1, 5 and 10 percent, respectively.

Table 13. Average impact of NGO or program membership on husbands' and wives' differential asset change and growth, all sites (difference-in-difference estimates of average treatment effects on the treated (ATT), nearest neighbor matching)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=461	N=461	N=498	N=498	N=278	N=278
Exclusively owned land and assets						
Exclusively owned land and assets						
Land value	-37433.34 (0.255)	-0.920 (0.153)	-81901.17*** (0.002)	-0.959 (0.173)	220064.20*** (0.000)	1.327* (0.089)
Nonlivestock asset value	-1836.32 (0.571)	-1.269 (0.102)	-449.99 (0.620)	0.048 (0.940)	-2807.70 (0.177)	0.981 (0.234)
Total value of assets	-2328.85 (0.540)	-1.080 (0.140)	4604.69* (0.053)	0.310 (0.693)	2602.06 (0.422)	2.016*** (0.006)
Exclusively owned land area						
Homestead land	-1.35* (0.056)	-0.194 (0.126)	-0.68 (0.427)	-0.251* (0.075)	6.51*** (0.000)	0.356** (0.036)
Cultivated land	-3.41 (0.256)	-0.066 (0.657)	-8.51 (0.107)	-0.455** (0.025)	30.43*** (0.000)	0.391 (0.165)
Other land	0.85 (0.200)	0.005 (0.955)	3.53*** (0.001)	0.805*** (0.000)	0.87 (0.422)	0.118 (0.368)
Exclusively owned asset value						
Consumer durables	-976.95 (0.277)	-2.705*** (0.001)	-536.21 (0.282)	0.072 (0.908)	466.36 (0.629)	1.167* (0.098)
Agricultural durables	-1583.59*** (0.004)	-0.771 (0.127)	-846.79*** (0.001)	0.551 (0.126)	-2916.13*** (0.006)	0.303 (0.493)
Nonagricultural durables	766.81 (0.839)	0.754* (0.064)	1108.76** (0.019)	0.645*** (0.004)	2285.11*** (0.001)	1.559*** (0.000)
Livestock (total)	-492.54 (0.809)	0.058 (0.932)	5054.68** (0.014)	1.951** (0.018)	5409.76*** (0.005)	3.747*** (0.000)

Outcome variable	Saturia		Jessore		Mymensingh	
	Change	Growth	Change	Growth	Change	Growth
	N=461	N=461	N=498	N=498	N=278	N=278
Poultry	135.66*	0.873*	426.61***	2.418***	258.42	2.066***
	(0.094)	(0.088)	(0.000)	(0.000)	(0.115)	(0.000)
Other livestock	-628.19	-0.062	4628.08**	0.421	5151.34***	1.816**
	(0.757)	(0.928)	(0.022)	(0.566)	(0.006)	(0.021)
Jewelry	-42.58	1.306**	-175.75	1.069**	-2643.04**	-0.770
	(0.977)	(0.035)	(0.696)	(0.039)	(0.017)	(0.291)
Trees	-1199.26	-1.796***	9399.51***	0.985	6492.28	2.271***
	(0.195)	(0.000)	(0.000)	(0.105)	(0.008)	(0.000)
Exclusively plus jointly owned land and assets						
Exclusively plus jointly owned land and assets						
Land value	-46142.38	-0.662	-86021.70***	-0.788	211951.30***	0.992
	(0.177)	(0.328)	(0.001)	(0.283)	(0.000)	(0.307)
Nonlivestock asset value	-2345.78	-1.433**	-576.38	1.286***	-3981.97*	0.804
	(0.470)	(0.024)	(0.543)	(0.001)	(0.066)	(0.313)
Total value of assets	-2907.89	-1.594***	4504.82*	1.116**	1689.05	0.795
	(0.446)	(0.010)	(0.066)	(0.017)	(0.613)	(0.299)
Exclusively plus jointly owned assets value						
Consumer durables	-1378.12	-1.869**	-656.19	2.066***	-713.22	1.110
	(0.135)	(0.020)	(0.212)	(0.000)	(0.524)	(0.161)
Agricultural durables	-1588.44***	-0.959*	-847.28***	0.353	-2915.07***	0.133
	(0.004)	(0.057)	(0.001)	(0.278)	(0.006)	(0.759)
Nonagricultural durables	734.69	0.635	1108.76**	0.658***	2285.11***	1.559***
	(0.846)	(0.119)	(0.019)	(0.002)	(0.001)	(0.000)
Livestock (total)	-562.11	-0.351	5081.20**	1.820**	5671.02***	2.232***
	(0.782)	(0.575)	(0.014)	(0.014)	(0.003)	(0.001)
Poultry	132.75	0.790	418.92***	2.273***	263.47	1.950***
	(0.101)	(0.123)	(0.000)	(0.000)	(0.110)	(0.000)
Other livestock	-694.86	-0.015	4662.28**	0.716	5407.55***	2.162**
	(0.732)	(0.982)	(0.023)	(0.296)	(0.004)	(0.016)
Jewelry	-113.90	1.172*	-181.67	1.067**	-2638.79**	-0.751
	(0.938)	(0.059)	(0.686)	(0.040)	(0.017)	(0.294)
Trees	-1295.93	-1.711***	9424.08***	1.087*	6203.98**	2.162***
	(0.164)	(0.001)	(0.000)	(0.080)	(0.021)	(0.004)

Note: Average impact on the treated (ATT); a negative ATT means that wife's assets are growing faster than husband's assets, or that gender asset inequality is decreasing. ***, **, and * indicate significance at 1, 5 and 10 percent, respectively.

In Saturia, we find that while early adoption increases husbands' nonagricultural durables, livestock and poultry holdings relative to their wives (whether exclusive or including jointly held livestock) within the same household,

husbands' holdings of nonlivestock assets, other land, and jewelry decline relative to their wives. There is, however, no significant difference on the relative growth of total assets among husbands and wives in households that adopted early relative to those that did not. In Jessore, early adoption increases value of wives' land and total assets relative to their husbands. The only positive change the husbands experience is a faster growth of their exclusively held nonagricultural durables relative to their wives and an increase in value of trees held by them over those held by their wives. In Mymensingh, early adoption increases husbands' holdings of nonagricultural durables, livestock, poultry, cultivated land, and other land, and is associated with higher growth of the value of husbands' land and nonland assets. Wives in early adopter households do experience some differential increase in the growth of the value of jewelry held.

Among NGO members, in Saturia, early access to the technology increases the value of husbands' land holding, nonlivestock assets and total assets (both exclusive and including jointly held assets) relative to their wives. The wives experience some relative growth in the value of trees and the value of cultivated and other land they own. Early access to the technology for NGO members, in Jessore, shows similar impacts to Saturia, where husbands' assets grew faster than their wives' assets. Comparisons of program members in Mymensingh with and without initial access to the technology reveals similar patterns, with husbands' holdings of various asset categories increasing faster than those of their wives—homestead, cultivated, and other land with an accompanying change in the value of total land held, agricultural durables and jewelry—to name a few. Increasing gender asset inequality among initial adopters of a technology is not an isolated case. There have been numerous accounts of men initially taking control of introduced technologies, even if originally targeted to women (see, for example, the classic cases of the introduction of irrigated rice in the Gambia (von Braun and Webb 1989) and Cameroon (Jones 1983)).

Finally, we compare NGO member with nonmembers. In Saturia, we find that asset growth predominantly favors wives as seen in the top panel of Table 13. While the coefficients are not significant for the exclusively held assets, they are significant for the exclusive plus joint assets. In Jessore, we find that NGO membership led to no significant difference between asset growth of husbands and wives in terms of total land value, nonlivestock assets and total assets. Wives in households that are NGO members are, however, able to increase their homestead and cultivable land. In Mymensingh, a comparison of program members with nonmembers reveals that the extension program—which has targeted individuals for fishpond technology—has increased husbands' holdings (relative to their wives) of land, livestock, and total value of assets. Comparing these results to Jessore, where fishpond technologies were also disseminated through women's groups, indicates that individual targeting has ended up, by default, targeting husbands and increasing gender asset inequality.

Table 14 provides a summary of our results. All in all, early adoption in Saturia led to an increase in husbands'' assets with a negative to insignificant impact on wives' assets. But when we compare NGO member versus nonmember households we find that husbands experienced a decline in the value of their assets whereas the wives experienced an increase. When examining relative growth of husbands' and wives' assets within the same household, early adoption and NGO

membership leads to faster growth of wives assets although the coefficients are not always significant. In Jessore, the wives experience faster growth of their assets compared to their husbands' assets across all three treatment groups. Early adoption also favored the asset growth of wives over their husbands. In Mymensingh, where early adoption led to an increase in asset values of husbands and wives, the growth in husbands' assets always surpassed that of the wives' assets. Wives are worse off than husbands in the group that had early access to the technology compared to those that were NGO members but without access to technology. Across all three comparisons, husbands' assets are growing faster than those of their wives.

Table 14. Summary table: Impacts on levels of men's and women's exclusively owned land and assets, differential changes in assets, and differential asset growth

Outcome variable	Saturia				Jessore				Mymensingh			
	Husbands	Wives	Change (husband–wife)	Growth (husband–wife)	Husbands	Wives	Change (husband–wife)	Growth (husband–wife)	Husbands	Wives	Change (husband–wife)	Growth (husband–wife)
Effects of early adoption												
Land value	1.938***	-1.216***	7000.92	0.016	0.465	-8.836***	-130785.50***	-3.491***	1.916***	0.804***	215162.20***	1.513**
Nonlive stock asset value	7.102***	-0.248	715.61	-1.781**	0.443	0.642	542.17	0.385	3.151***	1.334**	-3656.27	1.778*
Total value of assets	4.032***	-0.735	1097.60	-0.812	-5.342***	6.862***	-4414.86	-2.756***	2.629***	1.207**	-2025.28	2.024**
Effects of technology access among NGO members												
Land value	0.249	0.556	313843.40***	3.151***	-42.484***	0.561	141757.90***	2.798**	9.630***	-2.408***	447061.50***	4.771***
Nonlive stock asset value	0.370	4.580***	8998.10***	3.129***	-8.675***	-4.650***	2393.09	4.567***	1.703*	-3.269***	797.07	0.673
Total value of assets	-0.115	4.976***	12208.74***	3.729***	-23.715***	-2.693***	1708.49	2.720**	5.406***	-1.056	-1009.84	0.515
Effects of NGO or program membership												
Land value	-1.716***	0.507**	-37433.34	-0.920	-4.784***	6.162***	-81901.17***	-0.959	-2.919***	-2.230***	220064.20***	1.327*
Nonlive stock asset value	-4.246***	-0.830	-1836.32	-1.269	0.988	0.531	-449.99	0.048	-5.039***	2.625***	-2807.70	0.981
Total value of assets	-3.520***	2.533***	-2328.85	-1.080	2.737***	8.210***	4604.69*	0.310	-4.013***	2.715***	2602.06	2.016***

Note: Average impact on the treated (ATT). ***, ** and * indicate significance at 1, 5 and 10 percent, respectively

6. CONCLUSIONS

Our results provide suggestive evidence that implementation modalities are important in determining the impact of new technologies on men's and women's asset accumulation. While the initial gender disparity in asset ownership is not eliminated, women's assets increase more relative to men's when technologies are disseminated through women's groups. These findings are robust to controls for unobserved household-level characteristics when we examine differential changes in levels of assets and differential asset growth of the husband and wife within the same household. While it is possible that the differences across study sites might be attributable to technological differences, the comparison of the individual and group fishpond sites shows, that even with the same polyculture fish technology, dissemination through women's groups reduces gender asset inequality more than individual targeting—which, in fact, increased asset disparities between husbands and wives. In this case, social capital accumulated by women not only serves as a substitute for physical assets in the short run, but helps to build up women's physical asset portfolios in the long run.

Our study may underestimate the impact of the social capital mobilized by women's groups by focusing on tangible physical assets of husband and wife. Qualitative work in Saturia found that some poor and very poor adopters of vegetables distributed produce to family and neighbors as a way of building and maintaining social solidarity, something that women valued but men did not, because men perceived gifts of vegetables to have low status (Hallman, Lewis, and Begum 2007: 118). We also caution that not all aspects of collective action are beneficial; one reason behind the failure of a number of group fishponds in Jessore arose precisely from failure of collective action (Hallman, Lewis, and Begum 2007). The poor women's focus groups conducted in Jessore found that problems among the group members made the technology unsustainable, not the technology itself.

It is also possible that there are other underlying differences in the sociocultural environment between Mymensingh and Jessore, not implementation modality alone, that brought about this result. It is possible that an approach targeting women's groups was not chosen in Mymensingh because such an approach may not have been feasible given the social and cultural setting, making implementation modalities themselves endogenous. Mymensingh has been known to have a more conservative culture that has not been so receptive to NGO-based activities compared to Saturia and Jessore. One manifestation of this conservatism is women's weaker control of resources and greater reluctance of husbands for their wives to be involved in fish production. There are strong status reasons why husbands do not want their wives to be more involved in fish production, because it would increase their exposure to the market, which is regarded as a male domain.[17] Moreover, even during the initial study, there was evidence of greater gender discrimination in the allocation of household resources. Bouis et al. (1998) found

[17]One poor woman said, "fish cultivation is related to the market, so this is dominated by men, and women cannot talk with men" (Hallman et al. 2007, p. 126).

that anemia prevalence was highest in Mymensingh, even if landholding sizes were largest.

Our findings suggest that NGOs or other development agencies seeking to introduce new technologies in areas where women's groups are not active or do not exist may find it useful to begin by building up community support for empowering women. Introducing new technologies without this background work may end up backfiring if the lack of community support leads to the failure of the project. At the same time, development practitioners need to realize that gender norms are complex, and can change in response to shifting economic, political and cultural forces, which can create new opportunities for women and men (Quisumbing and Pandolfelli 2010). Yet, these norms do not change overnight and attempts to directly challenge such norms may unintentionally result in an erosion of women's claims to resources. Thus, development planners who seek to increase women's control of agricultural resources need to consider the tradeoffs entailed in challenging or respecting local gender norms.[18] Strategies that challenge gender norms must be weighed against other project objectives, such as increased food security or better management of natural resources, which, over time, may transform gender norms. Encouraging women to define their needs and preferences prior to the design of projects may help ensure balance between challenging and respecting local norms.

Our findings on asset accumulation are remarkably consistent with those of our related study (Kumar and Quisumbing 2010), where we estimate long-term impacts of the early adoption of the three agricultural interventions on household consumption, assets, and incomes; nutrient availability and intake; and individual nutritional status. Across all three sites, the biggest returns to early adoption are in the individual fishpond site, where there are clear long-term gains in terms of household consumption, assets, and aggregate nutrient availability. Despite positive short-term gains in the improved vegetable and group fishpond sites, long-term impacts on these household level outcomes are either insignificant or negative in comparison to the control group, partly because of the ease of disseminating the vegetable technology (which meant that the comparison would have easily caught up with early adopters) and partly because the gains from the improved fishpond technologies would have to be divided among a large number of members in the group fishponds site.

In contrast, despite insignificant or even negative impacts on household food consumption per capita, many indicators of nutritional status improved in the improved vegetables site. Stunting rates for girls decreased, and women's BMI and hemoglobin levels improved. It is possible that the targeting modality—working through women's groups that emphasize women's empowerment, and disseminating vegetables rich in vitamin-A and iron, which are consumed by women—may have had a positive net impact on nutritional status, despite the insignificant impacts on household-level outcomes. Taken together, these results suggest that social capital, as embodied through women's groups, not only help

[18] In the gender and development literature, this is often referred to as meeting women's practical versus strategic gender needs (Molyneux 1985), and a range of policy approaches, from Women in Development (WID) to Gender and Development (GAD), have focused on strengthening women's economic participation to challenging structural causes of women's disempowerment.

women build physical capital, but also enable them to invest in their own, as well as their children's, nutritional status.

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