Impact Evaluation Report of Integrated Agriculture and Productivity Project: Interim Report

DEVELOPMENT IMPACT EVALUATION (DIME)
The World Bank

Funding for this study generously provided by the Global Agriculture and Food Security Program (GAFSP), the South Asian Food and Nutrition Security Initiative (SAFANSI), and the i2i program for impact evaluation.

This material is funded by aid from the U.K. government through the South Asia Food and Nutrition Security Initiative (SAFANSI) and the i2i Fund for Impact Evaluation, which are administered by the World Bank. The views expressed do not necessarily reflect the U.K. government's official policies or the policies of the World Bank and its Board of Executive Directors.

Executive Summary

This paper presents the medium-term results of the impact evaluation of the Integrated Agriculture and Productivity Project (IAPP), which studies the effect of IAPP's Technology Adoption (for crops and fisheries) component. It also presents the results of a randomized trial of the number of demonstration farmers assigned per village, to determine IAPP's optimal future strategy. This report is based on baseline data and follow-up surveys collected one and two years after participants started receiving project activities. It concentrates on the boro (winter) season, when IAPP activities were most intensive.

Yields on demonstration plots for rice were higher than those on comparison plots during the demonstration year, which spurred adoption of the promoted varieties and some associated technologies at the farmer group level. However, rice yields for non-demonstration farmers (known as "adoption farmers") did not improve in general. For paddy, this is mostly because farmers achieved very high yields even in the absence of project activities. Due to this realization, the IAPP project has shifted to concentrating on improving the yield in the other rice growing seasons (aus and amman), as in these seasons there is greater potential for improvement.

There is evidence that IAPP causes farmers to change their crop mix away toward non-paddy crops promoted by IAPP (principally wheat). IAPP promotes diversification due to its positive effects on soil health, and resilience, but these crop switches result in decrease in incomes from crops during the boro season by around 15.7 percent per household. It is possible that these crop shifts decreased income during the boro season, yet were part of a change of cropping pattern that left full-year income unchanged (or increased). This hypothesis will be explored in an upcoming survey.

For fisheries, participation in IAPP groups increases income from fish by around 46 percent over the baseline value. However, this is driven by increased fish cultivation compared to control. In our sample, we see an increase in 7 percentage points of people reporting harvesting of mature fish. We do not find any increase in fisheries yields. This may be because many farmers in fish groups did not yet have the opportunity to adopt the promoted technologies. Larger effects may be seen in the next survey.

A final evaluation report will be released based on a final round of data collection in late 2015.

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Impact Evaluation Summary

Country Context

Bangladesh has achieved impressive growth and poverty reduction over the last two decades, but still faces many challenges. The country's poverty rate is over 30 percent and it has highest incidence of malnutrition of all countries: in 2008, Bangladesh's food insecure population was estimated at 65.3 million.[1] However, according to the 2010 poverty assessment, poverty declined 1.8 percentage points every year between 2000 and 2005 and 1.7 percentage points every year between 2005 and 2010.

Agricultural growth has also shown encouraging trends. Starting from a low of around 2 percent in the 1980s, agricultural growth improved only marginally (to about 2.2 percent) in the 1990s but then accelerated sharply and steadily throughout the 2000s to peak at about 5 percent in the late 2000s. Although Bangladesh has increased agricultural productivity over the last few decades, yields are far below potential. The estimated yield gap for paddy corresponds to a potential production increase of 24 percent and 55 percent for the boro and aus[2] seasons respectively.[3][4] Additionally, there are opportunities to increase fish yields; in 2005-06 Bangladesh had an average fish productivity of 3.24 tones/ha, which is well below its potential.[5]

Although it has seen recent growth, malnutrition in Bangladesh has remained high. But there has been some progress in this department as well. According to the Demographic Health Survey (DHS) between 2007 and 2011, the prevalence of underweight children declined five percentage points from 41 percent to 36 percent.

The government is pushing for increased use of productive technologies and more intensive agricultural practices to improve food security and sustain economic growth. To that end, IAPP sponsors research to develop improved crop varieties and promote adoption of improved varieties and production practices through the farmer field schools approach (FFS).

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[1] Food and Agricultural Organization of the United Nations (FAO) and World Food Program (WFP). 2008. "FAO/WFP Crop and Food Supply Assessment Mission to Bangladesh."

[2] The boro (winter) season is from roughly December to March. The aus (spring) season is from roughly march to June.

[3] A.H.M.M. Haque, F.A. Elazegui, M.A. Taher Mia, M.M. Kamal and M. Manjurul Haque. "Increase in rice yield through the use of quality seeds in Bangladesh," African Journal of Agricultural Research Vol. 7(26), pp. 3819-3827, 10 July, 2012. http://www.academicjournals.org/ajar/PDF/pdf2012/10%20Jul/Haque%20et%20al.pdf

[4] Sayed Sarwer Hussain. "Bangladesh, Grain and Feed Annual 2012," USDA Foreign Agricultural Service. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Dhaka_Bangladesh_2-22-2012.pdf

[5] Dey M.M., Bose M.L., Alam M.F., 2008. Recommendation Domains for Pond Aquaculture. Country Case Study: Development and Status of Freshwater Aquaculture in Bangladesh. WorldFish Center Studies and Reviews No. 1872. The WorldFish Center, Penang, Malaysia. 73 p.

Integrated Agricultural Productivity Project (IAPP)

IAPP is designed to improve the income and livelihoods of crop, fish, and livestock farmers in Bangladesh. It consists of four separate components:

1. Component 1: Technology Generation and Adaptation
2. Component 2: Technology Adoption
3. Component 3: Water Management
4. Component 4: Project Management

The project is located in eight districts: four in the south, and four in the north. In all, 375 unions (administrative areas) were selected to receive project activities.

This impact evaluation focuses on IAPP's Component 2 (technology adoption) for crops and fisheries.[6] IAPP's approach to technology adoption is adapted from the farmer field school (FFS) approach. IAPP works with farmer groups (of around 20 people) to promote new technologies. For two years farmers receive training in the promoted technologies. In the first year of operation, the "demonstration year", IAPP promotes technologies through two main activities. First, a "demonstration farmer" in the group cultivates a promoted variety on a demonstration plot. This farmer is given all necessary inputs (seed, fertilizer, etc.) to grow the crop, along with training on improved production techniques. The rest of the group is trained in the promoted technologies. During the second year, the rest of the group ("adoption farmers") are encouraged to adopt the promoted technologies. Adoption farmers are given seeds, but must purchase other inputs themselves.

Specifically, the analysis of crops in this report focuses on the Boro (winter) season, as during the evaluation time period, this season received the majority of the project activities.[7]

IAPP began operations in 2012 and will close in 2016. It expects to reach around 300,000 participants.

Evaluation Questions

The Impact Evaluation (IE) of IAPP contributes to understanding the drivers of technology adoption through two lenses. First, the technology adoption component is evaluated using a randomized phase-in of project villages, with a focus on crops and fisheries interventions (referred to as the "technology adoption evaluation"). Second, innovations in technology demonstration were tested through a

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[6] The Technology Adoption component also works with livestock, but this is not covered in the impact evaluation. Therefore, the conclusions of this report are only generalizable to participants in the crop and livestock activities of IAPP. IAPP has achieving new technology adoption of crops for 175,000 farmers, fisheries for 60,000 farmers, and livestock for 60,000 farmers. The IAPP project is also generating new technologies in Component 1, that are planned to be disseminated in the component 2 activities in the final years of the project. This IE will not capture any effects of these new technologies.

[7] Preliminary results from the impact evaluation showed that Boro paddy yields were already quite high, with limited scope for improvement. The project subsequently turned its focus to other seasons (Aus and Amman) as they have more potential for yield increases. Also, the project promoted some shorter-duration varieties. If uptake of these shorter-duration varieties allowed an additional cropping season, then concentration on the Boro season would miss this effect. Anecdotal evidence suggests that the project is no allowing additional cropping seasons, but this will be explored in the final follow-up survey.

randomized control trial to understand what approach to demonstration plots deliver higher results (referred to as the "demonstration plot evaluation"). The demonstration plot evaluation is designed to test a fundamental question about technology adoption: to what extent can "learning by doing" increase technology adoption over "learning by observing"? It compares the relative effectiveness of single demonstration plots (the standard approach) to more distributed demonstration strategies that allow more people to experiment with new technologies. The demonstration plot evaluation focuses only on crops.

The main evaluation questions are:

1. Does participation in an IAPP crop or fisheries group lead to increased technology adoption, yields, and income?
2. Do distributing demonstration packages among many farmers (as opposed to a single demonstration farmer) lead to more technology adoption and higher yields?

The first question speaks to a desire to understand whether certain activities in IAPP were successful as planned. The second question seeks to understand whether the technology dissemination strategy promoted by IAPP can be improved upon.

This impact evaluation is led by the World Bank's Development Impact Evaluation Initiative (DIME), the agriculture Global Practice, and the government of Bangladesh's IAPP project implementation unit, in collaboration with external research partners: the Yale University School of Management and the NGO Innovations for Poverty Action.

Motivation for Impact Evaluation

The Bangladesh government invests in a large network of agricultural extension providers to increase the productivity of crops, fish, and livestock farmers. Under normal circumstances, local extension workers engage in demonstrations and outreach to farmer through scattered demonstration plots and irregular outreach. IAPP provides a more intensive strategy through the farmer field school (FFS) approach, where farmer groups receive bi-weekly courses and within-group technology demonstrations.

The farmer field schools are designed to increase technology adoption and therefore yields among their members and surrounding communities. However, there is little evidence of the effectiveness of this approach. The IAPP evaluation hopes to rigorously evaluate the FFS approach to measure its effectiveness compared to the status quo extension method.

Even within the FFS approach, there are questions on how to best spur technology adoption within groups. In the **(1) standard demonstration plots**, demonstration farmers receive a specified "demonstration package", which is a complete package of seeds, fertilizer, and other inputs needed to effectively cultivate the crop being promoted. (A standard package for paddy includes around 16 kg of seeds, enough to cultivate around 0.7 hectares.) The theory of change is that by observing and interacting with the demonstration farmer, other group members will acquire certain types of knowledge about the new production process. Primarily, this is information about the availability of the demonstrated crop and an example of yields *under certain conditions*. However, farmers considering adopting a new farming process cannot tell if yields they observe on the demonstration plot will compare to yields they would get on their own fields due to differences in soil quality, input usage, cultivation knowledge, etc. In fact, it is well documented that yields on farmer's fields in Bangladesh rarely approach yields on demonstration plots.[8] If demonstration plots do not provide a realistic indication of potential yields from new technologies, this is likely to affect technology adoption. Additionally, it might result in a situation where farmers adopt crops ill-suited to their land, resulting in welfare loss.

One way to overcome this problem may be to simply have **(2) more demonstration farmers**: if farmer group members see more of their neighbors successfully growing a new crop,[9] they are more likely to gain accurate information on their chances of success. Further, this allows more members of the farmer group to 'learn by doing', improving the likelihood of their adopting the new crop. Foster and Rosenszweig,[10] in a study on technology adoption during the green revolution in India, found that farmers' own experiences, and that of their neighbors, were important drivers of technology adoption and income.

The largest impacts of 'demonstration' could potentially come from **(3) complete decentralization**. Under this model, all members of the farmer group are encouraged to cultivate small 'demonstration' plots on their own land, essentially moving from 'learning by observing' to 'learning by doing'. In this case, all participating farmers have an opportunity to learn how to cultivate the new crop, and get a more accurate measure of what the yields would be on their own farms. But demonstration plots are costly to support, requiring the project to invest in seeds, fertilizer, advice, and other inputs. Given fixed amounts of funding, increasing the number of demonstration farmers requires having smaller plots, potentially giving up on economies of scale. It's not clear what the optimal number of demonstration farmers is. In addition, farmers may need additional incentives to participate in this scheme, given that they are not yet confident that the new crop will be an improvement over their old.

Description of Demonstration Approaches

The demonstration plot evaluation determines which approach to crop demonstration will lead to most farmers adopting improved technologies in the following season. The three different demonstration approaches tested are:

1. **Regular demonstration plots:** This is the status quo in IAPP. One demonstration farmer is chosen for each type of technology introduced into the group (1-4 crops). These demonstration farmers receive a 'package' of free seeds, fertilizer, and training. The selected farmers cultivate the promoted crop in the first year, and the rest of the group is expected to learn from this

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[8] Sattar, Shiekh A. "Bridging the Rice Yield Gap in Bangladesh". In Bridging the Rice Yield Gap in the Asia-Pacific Region. By Minas K. Papdemetriou, Frank J. Dent and Edward M. Herath. Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific. Bangkok, Thailand. October 2000.
[9] Note that this "new crop" can be thought of as a different crop or simply a new variety of a previously cultivated crop.
[10] Rosenzweig, Mark R. "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture." University of Chicago Press. Journal of Political Economy, Vol. 103, No. 6 (Dec., 1995), pp. 1176-1209

experience. In the second year, the rest of the farmers are encouraged to grow the crop. Farmers that adopt the technology in the second year receive free seeds, but no inputs or special training.

2. **Shared Demonstration Plots**: In this intervention, each demonstration 'package' (seeds, fertilizer, and training) is shared by two to four group members. Where possible, the selected farmers create demonstration plots on contiguous patches of land (see figure 1 for a schematic). They are encouraged to work together to capture economies of scale. As in the demonstration plot intervention, demonstration farmers receive free seeds, free inputs, and training, but these resources are spread over more farmers.

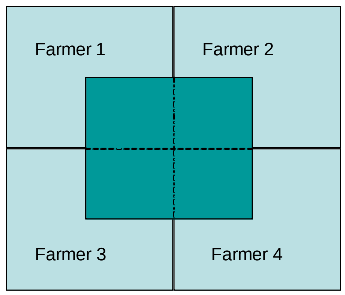


Figure 1: Shared Demonstration Plot – Dark green represents shared area of technology demonstration

3. **Incentives for self-demonstration:** In this intervention, all members of the farmer field group are given the opportunity to grow the promoted variety in the first year. The inputs that are spread out over all farmers who wish to participate. Farmers are encouraged to grow the new crop on a small patch of land to test it out. Farmers who agree to grow the new crop in the first year also receive an additional incentive: if the promoted variety does not perform as well as the old variety, they receive a small cash payment of Bangladeshi taka 1000 ($12.3). The primary purpose of this payment is to send a signal to the farmers that the extension providers are confident that the new seed will perform better than the old. To see whether the payment should be given out, the research team identify reference farms in each village at the beginning of the season that grew traditional varieties of the promoted crop. If output on the reference farm is higher than output of the promoted variety, the farmer receives his small payment.[11] These payments were made by DIME's research partner, the NGO Innovations for Poverty Action (IPA) using their own core research funding for Bangladesh.

[11] Note that this measurement is done during the seeding phase of the plant, which gives a good prediction of the harvest, and is conducted by IPA under supervisions of DIME. For data analysis purposes, yields are measured post-harvest using household surveys. Since the surveys are not tied to the payouts, there should be no incentive to misreport. Additionally, farmers have to sign contracts saying they will cultivate the new crop to the best of their abilities, and this is monitored by the FFS. To the extent that it is observable, farmers will not be able to receive a payout if they purposefully try to obtain poor yields on their demonstration plots.

Evaluation Design

The technology adoption evaluation is a randomized controlled trial, using a randomized phase-in of project villages for identification. The evaluation is designed to test both long-term and medium-term effects of the program.

The technology adoption evaluation is conducted in all eight IAPP districts. For this evaluation, we sample 96 villages that will receive crop and fisheries technologies, along with 110 additional villages selected for crops. Of the 206 villages included in the evaluation, 102 received the project in 2012 (treatment villages), 84 received IAPP 2014 (control villages), and 20 (long-term control) will receive will receive IAPP in 2015. These villages were randomly selected from the list of all villages that were eligible to begin the treatment in 2012. The villages that enter the project in later years will serve as control villages for those that enter the project in earlier years. (More details on sampling are given in the appendix.)

The demonstration plot evaluation is a randomized control trial concentrated in two districts, Rangpur and Barisal. Within these districts, 220 villages took part in the evaluation (of which 110 also contributed to the technology adoption evaluation)., The demonstration plot evaluation in Rangpur was conducted only for Paddy. In Barisal, it was conducted for paddy, wheat, mung, lentil, mustard, and sesame.

The villages were randomly allocated into five treatment arms:

1. **Long-term control (20 villages)**: Standard project activities (demonstration plots) begin in the final year of the project. They will have no project activities until then, but will just receive normal extension services from the government.
2. **Short-term control (36 villages)**: These villages have standard project activities (demonstration plots) beginning in 2014. They have no project activities till then, and just received normal extension services from the government.
3. **Regular demonstration plots (54 villages):** These villages have standard IAPP project activities from 2012.
4. **Shared demonstration plots (56 villages):** These villages have demonstration plots shared among multiple farmers, as described above. These villages started project activities in 2012.
5. **Incentives for self-demonstration (54 villages):** Instead of demonstration plots, all farmer group members were offered incentives to adopt the new crop variety, as described above. These villages started project activities in 2012.

The short-term impact of the various treatment arms on variables of interest will be captured by comparing outcome variables of each treatment group with both control groups, with data taken before the project was rolled out in the short-term control villages in 2014. This report covers analysis using data collected through summer 2014. An additional round of data collection will be taken up in 2015 to assess medium-term impacts.

Data and Sampling

Data is drawn primarily from three rounds of household surveys, and also includes administrative data on group membership and demonstration status.

The comprehensive baseline survey was conducted from July-September 2012 on a sample of 4,597 households. Households were selected based on eligibility for IAPP crop and fisheries activities. A first follow-up survey of 2,245 households was conducted from July-September 2013 to understand outcomes during the demonstration year for crop groups. This survey was less detailed than the baseline, and contained detailed information only on two plots. A second follow-up survey of 5,064 households was conducted in July-September 2014 to analyze the adoption year of IAPP.[12] More details on sampling are in the appendix.

The household surveys contain detailed data on household characteristics, agri/aquaculture, and nutritional outcomes.

We use the concept of "shadow" demonstration villages and farmers for much of the analysis. A village was considered a shadow demonstration village for a certain crop if local agricultural officials stated that the village would demonstrate this crop when they began IAPP activities. Similarly, we designated "shadow" demonstration farmers in each control group; these were farmer groups chosen as most likely to demonstrate when IAPP began in their village.

Table 1 gives the general characteristics of the sample.

Table 1: Data Sample

Survey Round		Total	Control	Regular Treatment	Shared Plot Treatment	Incentives Treatment
Baseline	Households	4901	1462	1569	958	912
	Villages	282	91	94	49	48
Demonstration Year	Households	1947	464	517	487	479
	Villages	265	82	86	49	48
Adoption Year	Households	4558	1361	1462	896	839
	Villages	282	91	94	49	48

Interpreting Charts

In the charts that follow, we compare outcomes in our three treatment groups to those in the control group. While presented as comparisons of means, the graphs are actually based on the results of

[12] These numbers reflect observations used in the analysis. The actual number of people surveyed at baseline and midline were larger than reported due to some targeting errors and an oversampling of demonstration farmers at midline (who we don't use for this analysis). Farmer groups that were incorrectly targeted in the baseline were replaced by the correct group for follow-up surveys, which is why the number of villages increases for the follow-up rounds. Of our sample, 2,749 are present in baseline and midline, while 1,848 are present in all three rounds.

regressions. The regression specifications are explained in detail for each regression in the appendix, but in general they are ANCOVA regressions, including all three treatment dummies and baseline value of the dependent variable as independent variables. The regressions also include district fixed effects; standard errors are clustered at the village level.

In the charts, the leftmost column of each cluster is the measured value of the mean of the outcome variable in the control group. Additional columns represent the treatment effect for treatment groups, and are constructed by adding the estimated treatment effect to the control mean. The height of the bar is near the actual mean of the outcome variable for the treatment group, but will be slightly different due to the controls in the regression.

The error bars represent the 95 percent confidence interval of the treatment effect. When control mean is outside of the error bars, this means that the treatment effect is greater than zero with greater than 95 percent confidence. Confidence of treatment effects is also represented with stars. One, two, and three stars mean the treatment effect is statistically different from zero with 90 percent, 95 percent, or 99 percent confidence respectively.

The demonstration plot evaluation was conducted only on paddy in Rangpur, and for additional crops in Barisal. Any chart analyzing the demonstration plot evaluation for paddy includes only these two districts; and for other crops they only include Barisal.

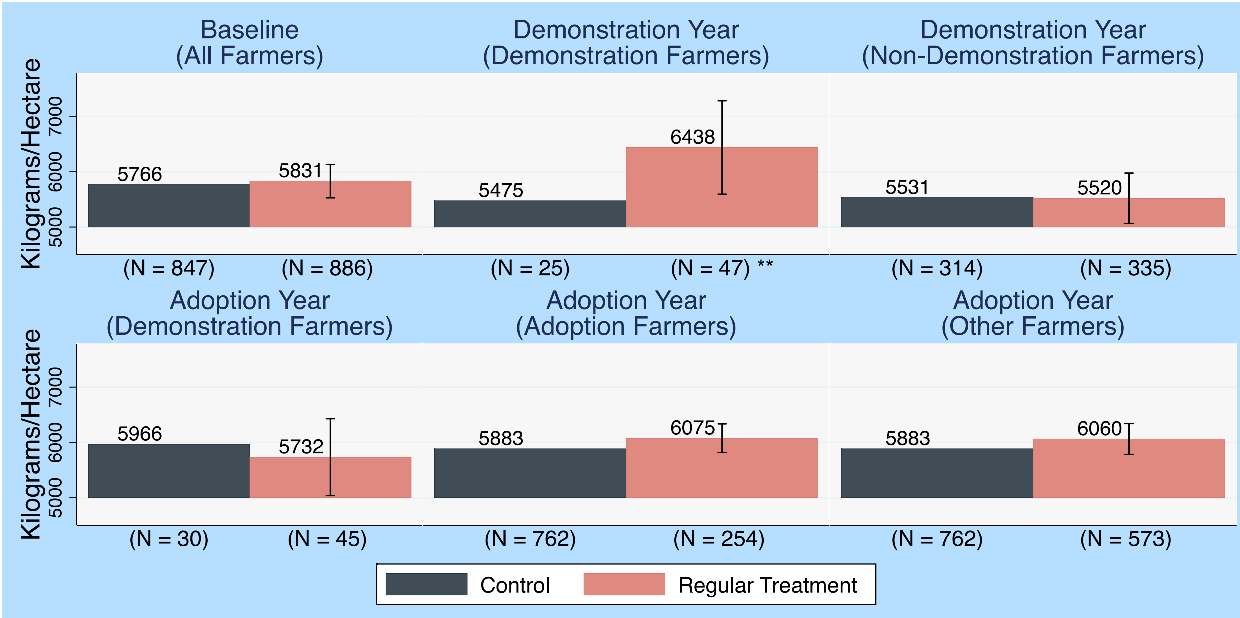
Results

Paddy Yields

The main crop grown by IAPP participants is paddy, and improving paddy yields is a main goal of IAPP. Figure 2 shows the effect of IAPP on paddy yields. As shown in the figure, demonstration farmers succeeded in increasing paddy yields (compared to “shadow” demonstration farmers) in the demonstration year (the first year). Yields for adoption farmers, as expected, are not different from the control. There is no significant difference between treatment and control groups in the adoption year (the second year). There are no effects for any of the three subsets of group members: demonstration farmers, adoption farmers (who received seed from IAPP), and others in the group.

Although demonstration farmers did see an increase in yield, yields at baseline and in the control group are already quite high, at around 5.8 tons/ha. This is well above the project result framework’s initial baseline estimate of 2.2 tons/ha. It suggests that there is not much room for improvement for boro paddy yields.

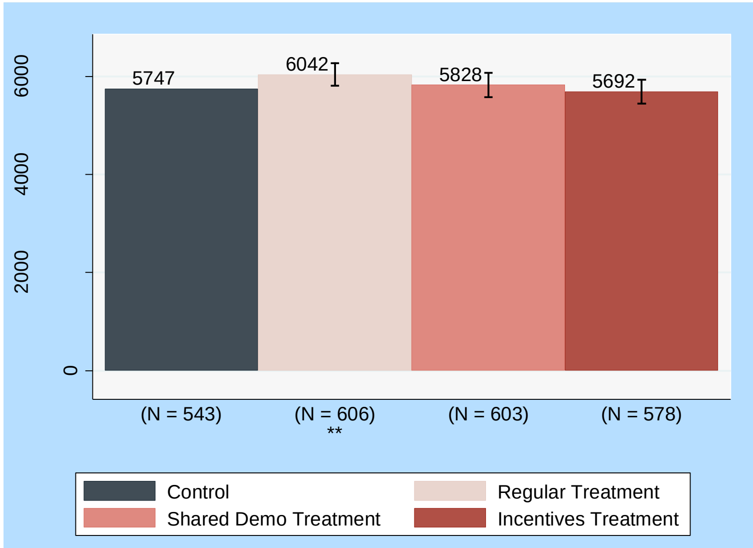
Figure 2: Paddy Yields in Control versus Regular Treatment



Note: The regression is restricted to treatment villages where paddy was demonstrated, as well as control villages where district officials stated paddy would be demonstrated there once they begin IAPP. Yield calculations included mono-cropped plots only. Yield during the demonstration year is calculated only for each household's two 'primary' plots, which may explain differences in yield between this round and the other rounds. Demonstration farmers in control villages are "shadow" demonstration farmers that community facilitators claimed would have demonstrated the crop had the demonstration taken place in this group, and who were also part of the baseline survey. This is a small selected sample, which could explain the lower yield among this group. Adoption farmers are farmers that received inputs from the project during the adoption year. Adoption farmers and other farmers are compared against the same controls, which include all control farmers that are not shadow demonstration farmers. This figure corresponds to appendix table 1. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

The above figure only shows results for the regular treatment group. In Figure 3: Paddy Yields for Different Treatments, Adoption Year, All Farmers we look at the effect of project activities on rice yields, this time for all treatment groups. The analysis is restricted to the two districts (Barisal and Rangpur) where we conducted the demonstration plot evaluation. Here we do find a significant increase in yield for paddy in just the regular treatment group, an increase of around 5%. Results are not significant for Figure 2 since it contains the whole sample of 8 districts, while the analysis in Figure 3 only includes Rangpur and Barisal. Upon further inspection, this increase is driven entirely by Rangpur district, and is not experienced in any other district. It is therefore difficult to conclude whether the rice demonstration is Rangpur was especially effective, or if this is just a statistical fluctuation.

Figure 3: Paddy Yields for Different Treatments, Adoption Year, All Farmers



Notes: This figure shows the difference in paddy yields between control and the three treatment groups, for the Boro season 2013-2014 (the adoption year). Included in the regressions are all villages in treatment groups where paddy was demonstrated, as well as control villages where district officials stated paddy would be demonstrated there once they begin IAPP. Only villages in the districts of Rangpur and Barisal are included. Only farmers who harvested paddy during the Boro season are included, and yield is calculated only for mono-cropped plots. This figure corresponds to appendix table 2.

The above analysis concentrated on paddy, as it is the only crop where we have enough data to analyze the yield on demonstration plots during the demonstration year.[13] However, we can compare yield between treatment and control groups at the adoption year for the five other IAPP crops for which we gathered detailed demonstration information (wheat, mung, lentil, mustard, and sesame). This analysis is provided in the appendix.

Adoption of Promoted Crops/Varieties

The above analysis shows that IAPP succeeds in increasing yields for demonstration farmers in the first year, but that yield gains are not persistent and are not shared by other group members. In the following sections dig deeper into crop adoption and production practices.

We first explore whether participants were more likely to adopt the crops and varieties promoted by IAPP. We study six crops in detail: paddy, wheat, mung, lentil, mustard, and sesame.

We begin by considering adoption of paddy varieties. In Figure 4 we focus on regular treatment groups, and explore adoption of IAPP-promoted varieties over time. We analyze whether farmers adopt any variety of the crop promoted by IAPP. While in theory farmers are encouraged to demonstrate the exact IAPP variety that was demonstrated in their village, in practice this variety was sometimes not available or was no longer recommended by IAPP. In all cases, we consider farmers to have adopted a variety if

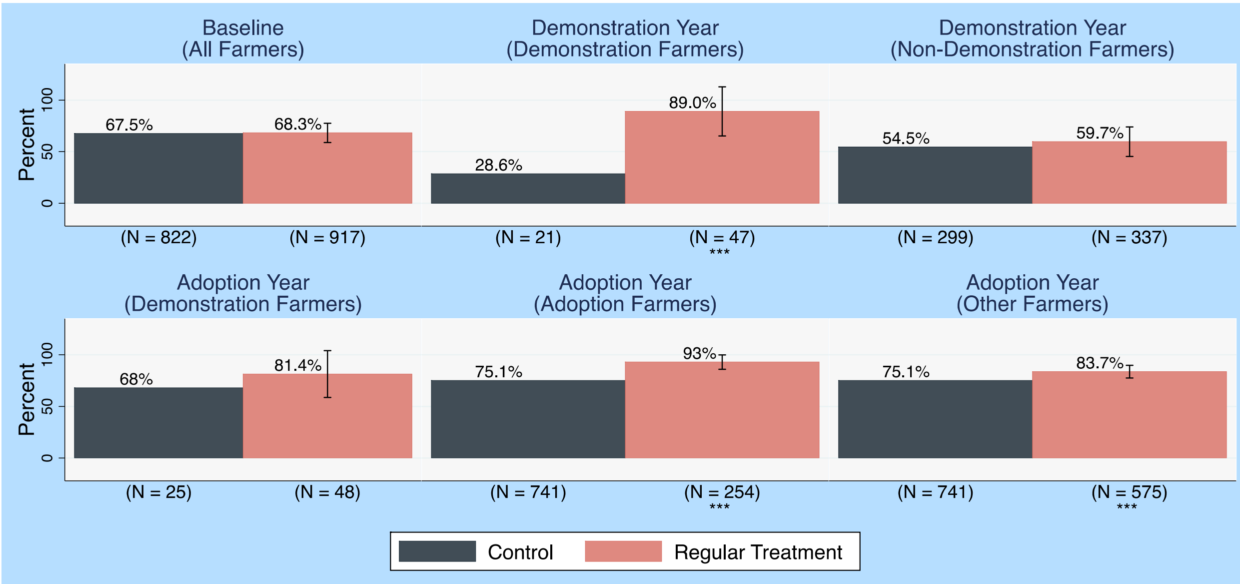
[13] We have the most data on paddy since it is by far the most widely cultivated crop.

they use any of that variety on any of their plots.[14] At baseline, treatment and control villages both cultivated IAPP-promoted varieties at around the same rate (68 percent). At the end of the demonstration year, we observe lower adoption of IAPP varieties in the control group. However, this is likely an artifact of a different surveying approach, and may not actually reflect lowered use of these varieties. (In the first follow-up survey, we only asked for the variety cultivated on two plots, while in the baseline and the second follow-up survey we ask about ten plots. Therefore, the "adoption" of any particular variety is going to be mechanically lower in the first follow-up survey data.) During the demonstration year, we see much higher use of IAPP varieties by demonstration farmers (as expected), and a lower (insignificant) increase among adoption farmers. During the adoption year, we see significantly higher adoption of IAPP varieties from subsets of the farmer group (demonstration, adoption, and other farmers). This suggests that IAPP's technology adoption approach was effective in spurring adoption of paddy varieties. However, this was an increase over an already high proportion of farmers using IAPP varieties at baseline.

It is interesting to note that adoption of IAPP varieties in the adoption year is higher at the adoption year (75.1%) than at baseline. Although the study is not designed to measure spillovers, it is plausible that this increase reflects some spillovers of IAPPs activities.

[14] Differences in the variety promoted from that demonstrated are detailed in the "IAPP Adoption Distribution Monitoring Report 2014", prepared by DIME. For instance, although 95% of groups demonstrating paddy received the same variety for adoption as was demonstrated, only 13% of wheat groups did so. We have similarly done the analysis in Figure 4 defining adoption as using all IAPP varieties for a specific crop, and the results are similar.

Figure 4: Paddy Adoption (of any IAPP Variety) Over Time, Regular Demonstration Treatment

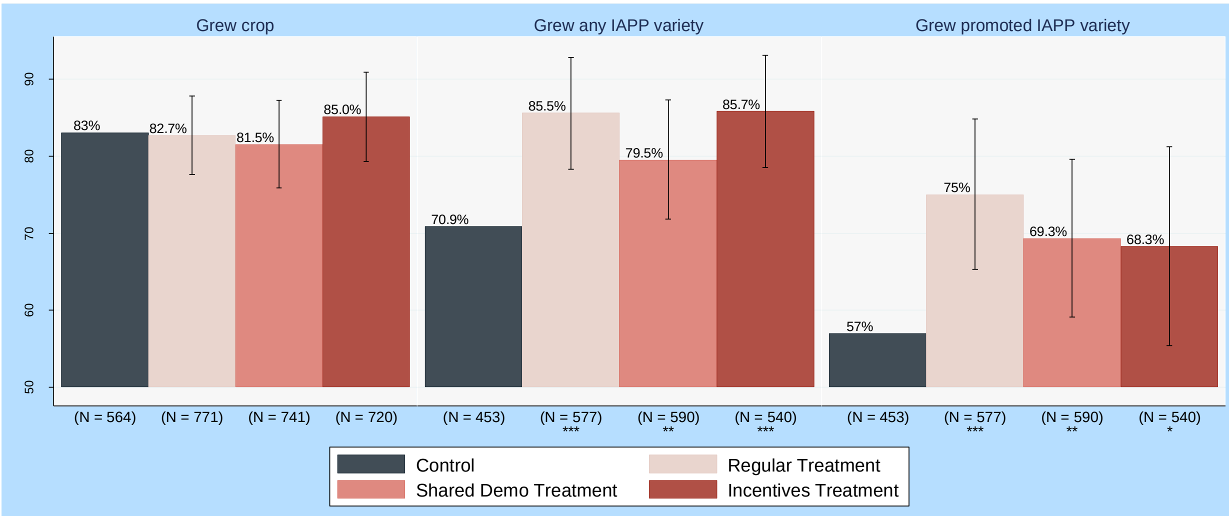


Notes: This figure shows adoption of IAPP-promoted varieties of paddy at baseline, during the demonstration year, and during the adoption year. Households are considered to adopt an IAPP variety if they cultivate any of that variety. In this figure we count adoption of any IAPP-promoted variety, even if it was not the exact variety demonstrated in the village. We include all farmers that grew any paddy, who are either in paddy demonstration villages or in shadow paddy demonstration villages. Demonstration farmers in control villages are "shadow" demonstration farmers that community facilitators claimed would have demonstrated the crop had the demonstration taken place in this group, and who were also part of the baseline survey. This is a small selected sample, which could explain the lower yield among this group. Adoption farmers are farmers that received inputs from the project during the adoption year. Adoption farmers and other farmers are compared against the same controls. This figure corresponds to appendix table 3. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

In Figure 5, we consider three different measures of adoption for paddy, and look at all three treatment groups (again focusing on just the demonstration plot evaluation districts). We group together all farmers, and just consider the adoption year. First, we explore whether farmers are more likely to grow this paddy at all. For a commonly-grown crop like paddy, we do not expect to see much effect for this measure, but we include it for comparison because it is interesting for newly-promoted crops (like wheat). We next analyze whether farmers adopt any variety of paddy by IAPP. Finally, we look at whether farmers adopt the exact variety of paddy that was demonstrated in their villages. Note that all variety measures are self-reported, and it is quite possible that farmers do not know the precise variety of crops they are planting. Therefore, we should treat these estimates with caution.

As expected, there is not much difference across treatment and control with relation to simply cultivating paddy, as paddy is already the most popular crop. However, participants in all treatment groups are more likely to report cultivating an IAPP variety of paddy, with this difference being significant in the regular and incentives groups. The largest effect comes on farmers reporting cultivating the exact variety of paddy demonstrated in their village. The demonstrated variety is grown by 54 percent of farmers in control groups, but famers in the regular demonstration group increased adoption by 13 percentage points to around 67 percent. (There is no significant difference in the shared and incentives treatment.)

Figure 5: Adoption for Paddy during Adoption Year, Different Treatment Groups

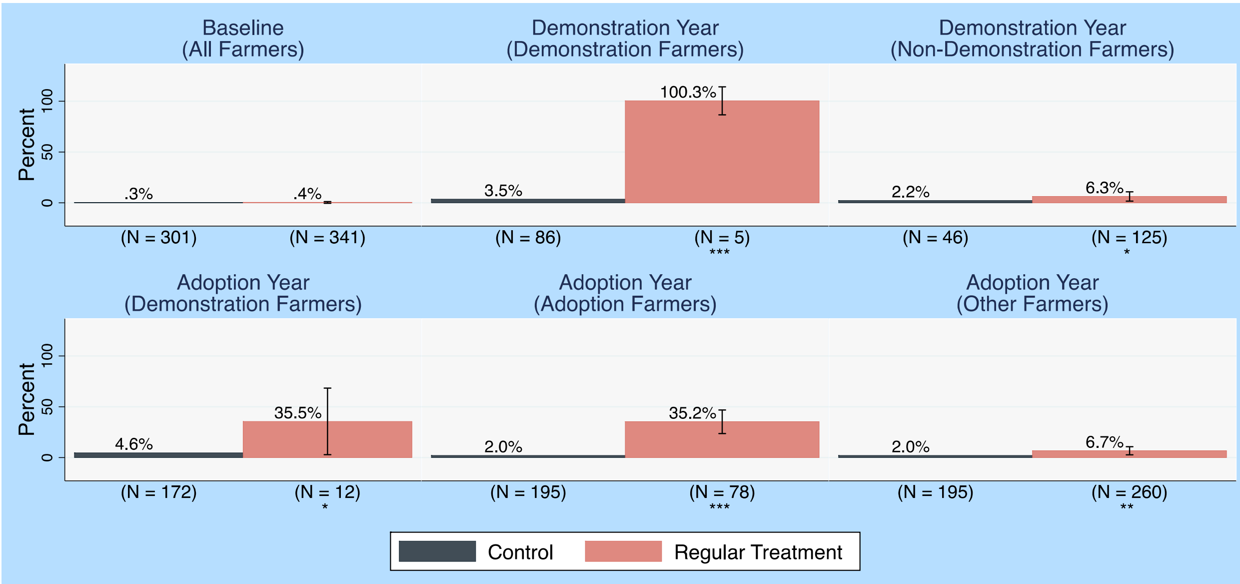


Notes: This figure shows adoption of IAPP varieties of paddy during the Boro 2013-14 season. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. The leftmost set of columns shows adoption of paddy, with the regression restricted to treatment villages where paddy was demonstrated, as well as control villages where district officials stated paddy would be demonstrated there once they begin IAPP. The center and rightmost set of columns are restricted to the same demonstrations, but only for households that cultivated paddy. The center column shows adoption of any IAPP variety of paddy, while the rightmost column shows adoption of the exact variety of paddy that was demonstrated in the village. Only villages in the districts of Rangpur and Barisal are included. This figure corresponds to appendix table 4. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Figure 6 reports on adoption for wheat in the four southern districts. Unlike paddy, very few farmers in control groups cultivated wheat at baseline (only 0.3 percent), so we therefore concentrate on adoption of wheat itself (as opposed to specific varieties). We have only five demonstration farms in our sample at the first follow-up, but as expected these all cultivate wheat.[15] However, it is interesting to note that even in the adoption year there is a significant increase in adoption farmers growing wheat (from 2.2 percent to 6.3 percent). In the adoption year, all groups report significant increases in wheat. 35.5 percent of previous demo farmers report cultivating wheat, compared to 4.6 percent in control. 35.2 percent of adoption farmers and 6.7 percent of other farmers report cultivating wheat, compared to 2 percent in the control group.

[15] The estimated coefficient on wheat adoption brings the estimated value to just over 100 percent, due to the presence of other controls in the regression.

Figure 6: Adoption of Wheat over Time, Southern Districts, Regular Demonstration

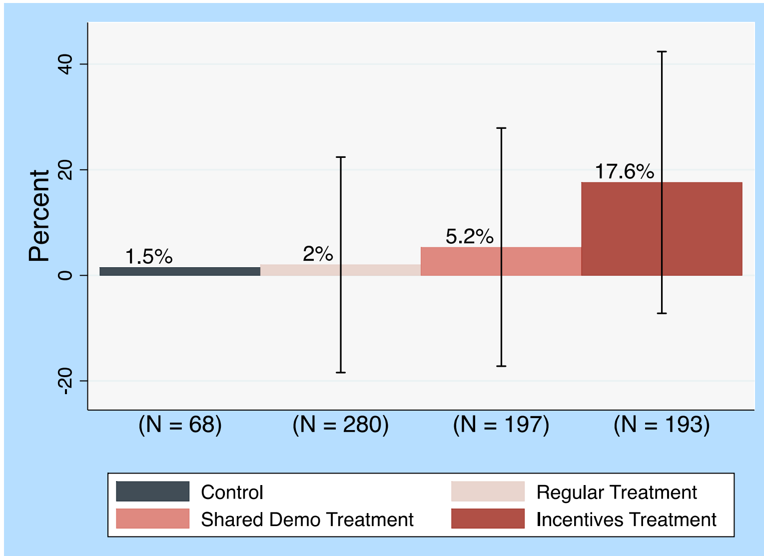


Notes: This figure shows adoption of wheat at baseline, during the demonstration year and during the adoption year. Households are considered to adopt wheat if they cultivated any wheat during this season. In this figure, we count adoption of any IAPP-promoted variety, even if it was not the exact variety demonstrated in the village. We include all farmers in wheat demonstration villages, and "shadow" villages that would have demonstrated wheat had they been part of IAPP. Demonstration farmers in control villages are "shadow" demonstration farmers that community facilitators claimed would have demonstrated the crop had the demonstration taken place in this group, and who were also part of the baseline survey. Adoption farmers are farmers that received inputs from the project during the adoption year. Adoption farmers and other farmers are compared against the same controls, which are all farmers in control villages that are not shadow demonstration farmers. This figure corresponds to appendix table 3. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

In Figure 7, we consider again the three different adoption definitions for wheat, and also look at all three treatment groups. Adoption of wheat is even higher in the incentives and shared demonstration group, 22 percent and 25 percent. (While larger than the 19 percent adoption in the regular demonstration group, the differences between the treatment arms are not statistically significant.)[16]

[16] 44 percent of farmers growing wheat stated that they did not know what variety they were growing. Therefore, it is possible that more farmers than reported were actually growing IAPP varieties.

Figure 7: Adoption of Wheat in Different Treatment Groups



Notes: This figure shows adoption of wheat during the Boro 2013-2014 season, restricted to Barisal district. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. The regression is restricted to treatment villages where wheat was demonstrated, as well as control villages where district officials stated wheat would be demonstrated once they begin IAPP. Only southern districts are included. This figure corresponds to appendix table 4. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Graphs outlining adoption of mung, mustard, and lentil can be found in the appendix. The highest level of adoption for all crops is for the incentives treatment, but the effect is never statistically significant for individual crops.

Input Use for Paddy

The previous sections indicate that although adoption of improved seed does occur, yields do not increase. This section explores use of other inputs. It concentrates on paddy, as it is the crop with sufficient observations for this analysis.

Determining the "correct" amount of input for any crop is complicated, and not easily captured without a detailed model of plant growth. If fact, some recent estimates have suggested that farmers in Bangladesh may be using too much fertilizer. However, we can use simple correlations between input use and crop yields to get a basic idea of whether increases in any input from the average farmer are likely to impact yield. The details of this analysis are in the appendix.

We find that greater use of urea, TSP, and DAP[17] is correlated with higher yields, while other soil additives had insignificant or even negative correlations. For technologies, we find that line planning, double transplantation, and planting fresh seeds are correlated with higher yields, while green manure, IPM[18], and vermi-composting are negatively correlated. (It is possible that some of the technologies are

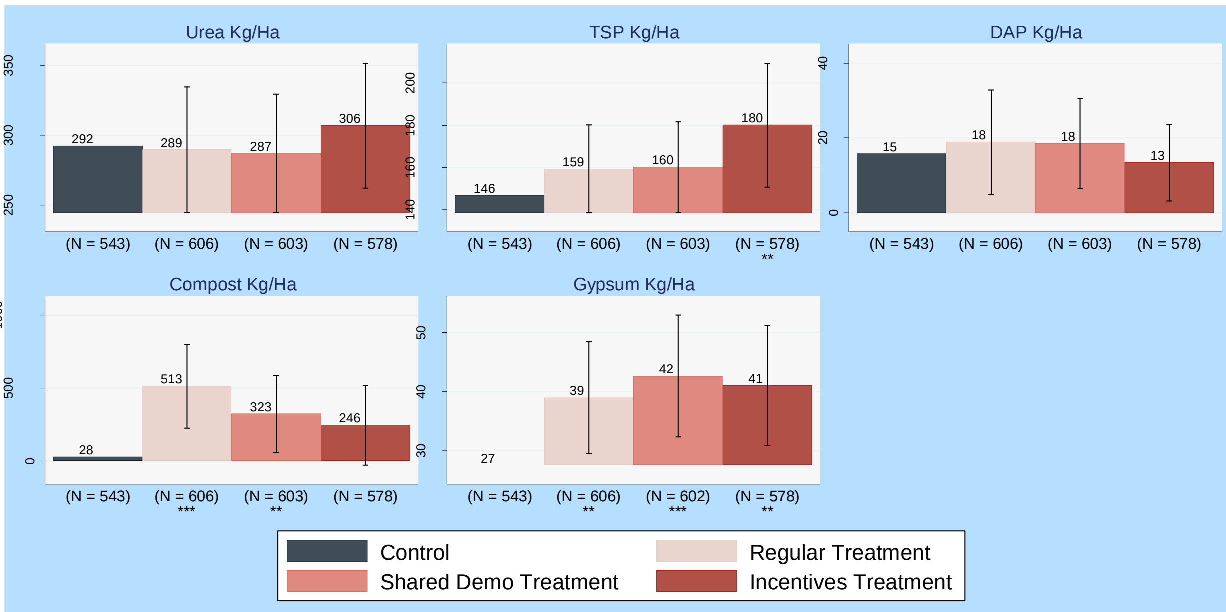
[17] TSP is trisodium phosphate, DAP is diammonium phosphate.

[18] Integrated Pest Management

negatively correlated with yields because they are general applied on less fertile plots. We do not have a way to control for soil quality.) Finally, we find that using new (as opposed to recycled) seeds is correlated with higher yields, though use of the specific varieties promoted by IAPP are correlated with lower yields.

In Figure 8, we look at the use of various fertilizers in treatment groups compared to control groups. We see that use of the three chemical inputs that are correlated with higher yields (urea, TSP, and DAP) are not statistically different in treatment groups compared to control. Treatment groups do use more gypsum and compost (with compost increase only being significant in the regular treatment group.)

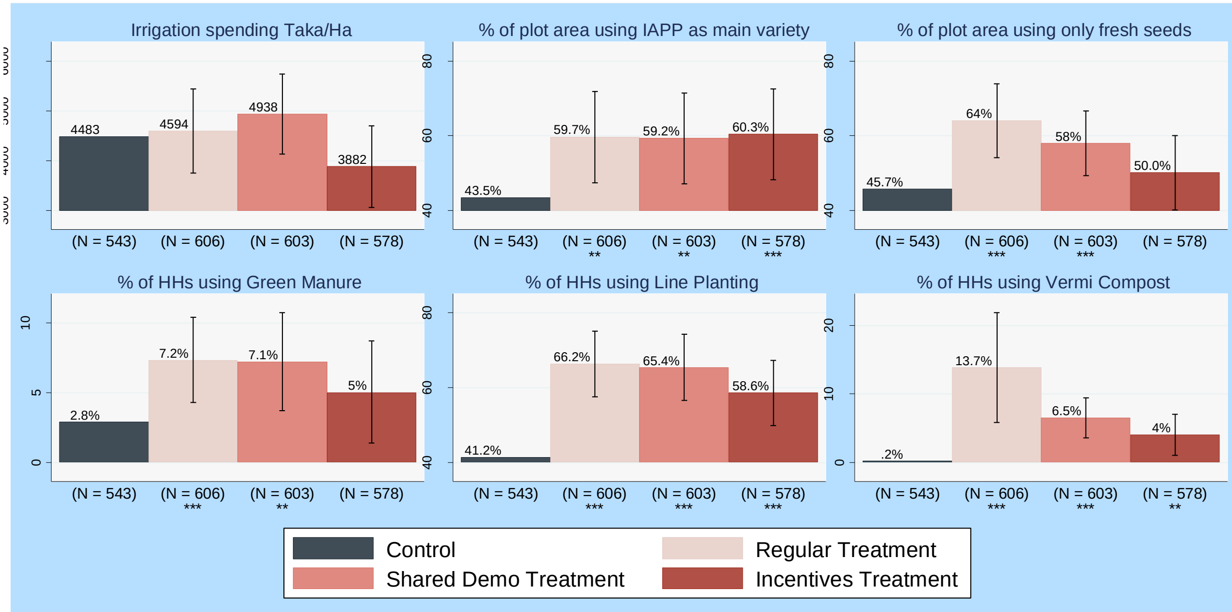
Figure 8: Fertilizer Use for Paddy



Note: This figure details input use for plots that cultivated paddy during the Boro 2013-14 season. The sample is all households that cultivate paddy and are located in paddy demonstration villages (or shadow demonstration villages). Although, only villages in the districts of Rangpur and Barisal are included. The unit is the amount of input use (in kg) per hectare. Households that cultivate paddy but did not report use of an input are included in the analysis, with their use of the input set to zero. Households that only reported use of input in a unit not convertible to kg are not included in the regression. This figure corresponds to appendix table 5. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

In Figure 9 we look at use of other inputs and technological practices. In general, we see increased use of IAPP varieties, new seeds, green manure, line planting, and vermi-composting. We see an increase in irrigation spending, but only for the shared demo group.

Figure 9: Technology use for Paddy



Note: This figure details technology use for plots that mono-cropped paddy during the Boro 2013-14 season. The sample is all households that cultivate paddy plots and are located in paddy demonstration villages (or shadow demonstration villages). Although, only villages in the districts of Rangpur and Barisal are included. The plot share variables are measured as the percentage of area cultivating paddy that uses IAPP/fresh seeds. The remaining variables are dummy variables that take the value of 1 if the household used the technology. This figure corresponds to appendix table 5. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Overall, it appears that although adoption farmers adopt varieties and practices promoted by IAPP, they do not increase use of chemical inputs. Although they adopt some beneficial technologies, it appears not to be large enough to raise yields, at least not in the short run.

Additional Harvest Outcomes

This section explores the effect of IAPP on harvest outcomes aggregated across crops. This is important because IAPP may cause farmers to switch crops, and the effects of this change will not be captured by studying each crop separately. To do this, each crop is assigned a price based on the median reported selling price in its region,[19] and the value of harvest is calculated for each household based on adding up the harvested value of all of their crops grown during the Boro season. While the price does not include all potential benefits and risks of growing a certain crop, using the price allows us to analyze whether farmers are moving to more valuable crop mixes, and also allows us to analyze the productivity of inter-cropped plots (which are removed from the crop-specific yield calculation).

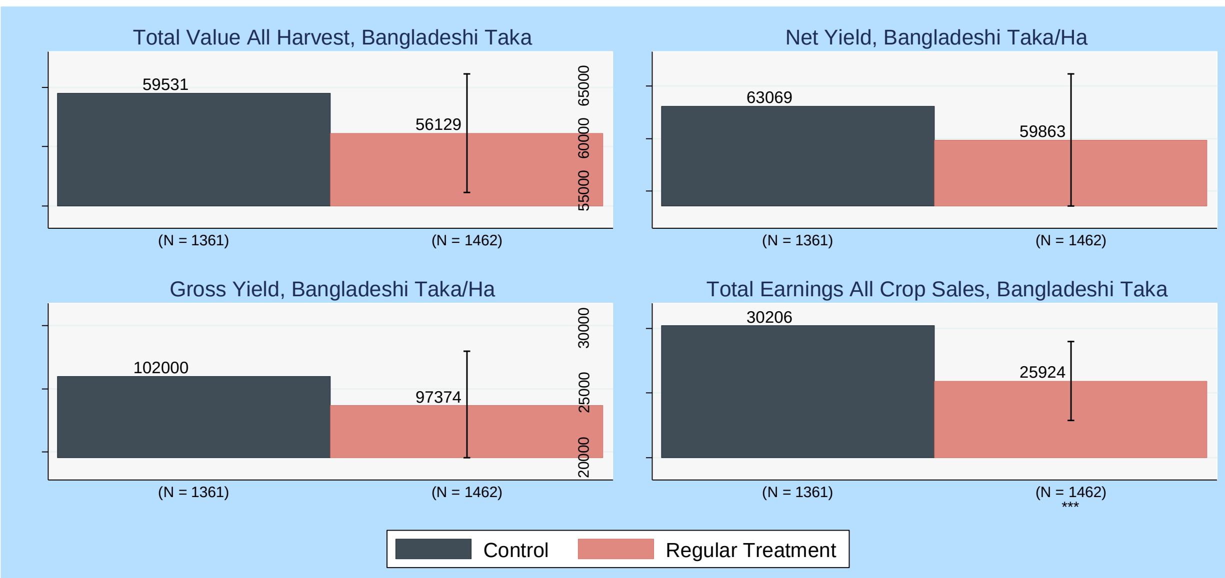
[19] Districts in the north and south of the project area have separate prices.

Figure 10 shows the difference between control and treatment groups for the total harvest value, gross yield (in Bangladeshi taka/ha), net yield (in Bangladeshi taka/ha)[20], and total earnings from selling crops.

The data shows that IAPP participants had lower harvest values, yields, and crop income than farmers in the control group. (Harvest values at baseline were equal across treatment and control.) We do not see a significant difference in input spending or plot size, meaning that differences in yield are caused by differences in harvest value.

Harvest value can decrease for one of two reasons: a decrease in yield or a change to a less valuable crop mix. As shown for IAPP crops in the previous section (and also confirmed through more detailed analysis of a wide variety of crops), yields in the treatment groups do not decrease relative to control. Therefore, the harvest value decrease can be explained through a changing crop mix. We will discuss this further in the following section.

Figure 10: Outcomes for All Crops



Notes: This figure shows changes in yields, harvest value, and total earnings due to IAPP. Total harvest value (in Bangladeshi taka; 1 Taka is equal to about .013 USD at the time of writing the report) is calculated by multiplying the harvest amount of each crop by the median price in the region for that crop. Gross yield (in Bangladeshi taka/ha) is the total harvest value per hectare. Net yield (in Bangladeshi taka/ha) is the total harvest value minus input costs (including labor) per hectare. Total earnings (in Bangladeshi taka) is the amount made from selling crops. This figure corresponds to appendix table 6. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Crop mix

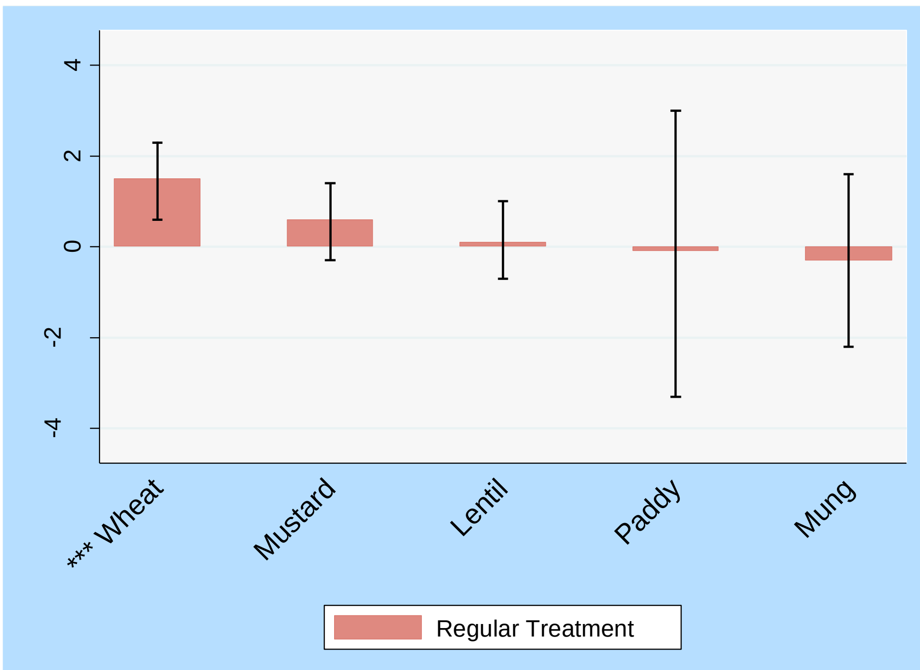
As described in the previous section, total harvest value seems to decrease in the treatment groups, and this is likely due to changing the crop mix.

[20] Net yields in this calculation do not include shadow cost of household labor. However, including this does not change the results significantly.

We analyze this by considering the shares of a farmer's fields dedicated to each crop. To find the effect of IAPP on crop mix, we look at the differences between control and regular treatment of the land dedicated to each crop. This measure includes all respondents (even those who don't grow a specific crop), so it should reflect both the intensive and extensive margins of changing the crop mix.

Figure 11 shows the differences for the five main IAPP crops (paddy, wheat, mung, mustard, and lentil). We see that cultivation of wheat, lentil, and mustard increases while paddy and mung decline (although the change is only significant for wheat). We also see smaller (yet statistically significant) changes for some less common crops.[21]

Figure 11: Change in Crop Mix between Control and Regular Treatment



Notes: This figure shows changes in plot share due to IAPP. Plot share is calculated as the area dedicated to a certain crop divided by total cultivated area. For intercropped plots, we assign each crop equal shares of area for the purpose of this calculation. All estimates are ANCOVA regression estimates. This figure corresponds to appendix table 7. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

The overarching message is that farmers are moving toward traditional crops towards new ones like wheat. IAPP promoted wheat over cultivation of Boro paddy because it would result in better crop diversity, improved soil health, and lower water use; our study does not have the data to measure these outcomes. However, the project also assumed it would result in higher incomes for farmers. Our data

[21] Complete chart is available in the appendix.

shows that this is not the case, as a hectare of wheat produced less value than expected by the project, and was much lower than that of boro paddy.

Table 2 lists the different crops promoted by IAPP, along with their median harvest value per hectare We calculate three measures of yield. Gross yield is the total value of harvested crops (in Bangladeshi taka) per hectare. Net yield is the total value of crops harvested minus the amount spent on inputs for that crop, but not accounting for unpaid (including household) labor. Net yield (including unpaid labor) also accounts for unpaid labor by assigning a price to this labor based on the shadow cost of the agricultural labor market, which is estimated at Bangladeshi taka 200 /day. This estimate is the median reported value of daily wages in the survey, but is likely an overestimate of the actual opportunity cost of household labor, since casual agricultural work is frequently unavailable. This explains why these values are negative for many crops.

The table shows that in general paddy provides the most value per hectare, even when labor costs are taken into account. Therefore, when farmers move away from paddy the value of crops produced on their farm decreases.

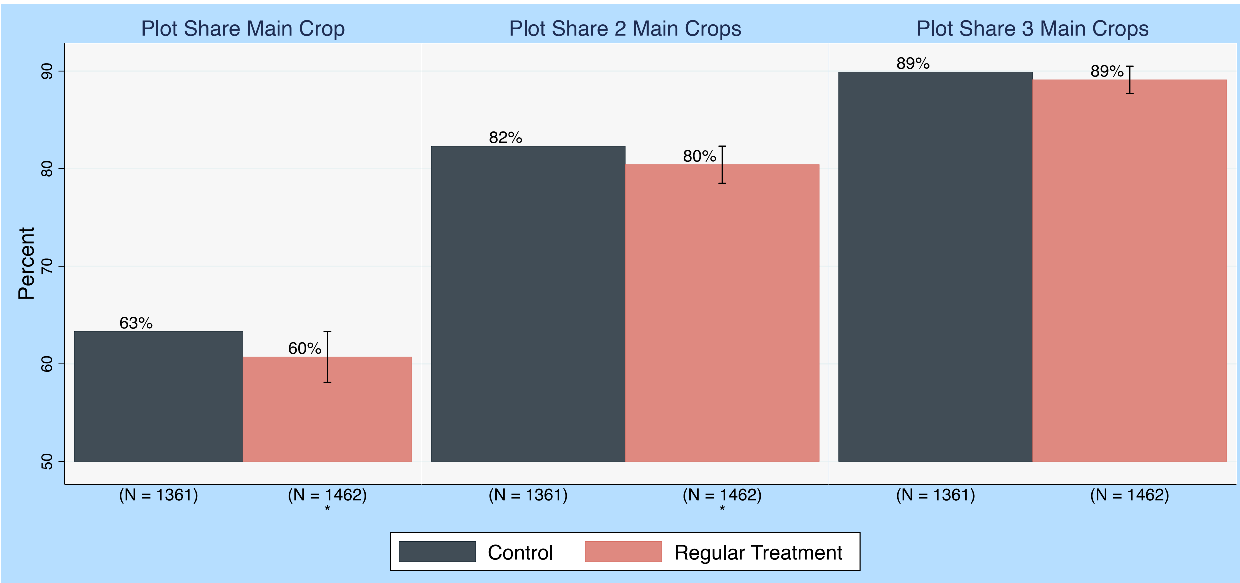
Table 2: Harvest Values of Different Crops

Crop	Region	Median Yield (Kg/Ha)	Median Sales Price (BG Taka / Kg)	Median Gross Yield (BG Taka / Ha)	Median Net Yield (BG Taka / Ha)	Median Net Yield Including Opportunity Cost Of Unpaid Labor (BG Taka / Ha)	Total Labor Days (days / Ha)	Number Of Households Growing Crop
Paddy	South	4943	15	74147	28909	5260	166	603
	North	6036	17.5	105627	59600	30559	210	2455
Wheat	South	1490	22.5	33535	7353	-16365	159	192
	North	2636	20	52727	24096	-7188	185	398
Lentil	South	494	53.3	26363	16684	-9140	134	472
	North	721	53.3	38447	17255	-25292	193	19
Mung	South	494	60	29659	19997	-5951	145	767
	North	300	60	17975	7991	-50358	222	29
Mustard	South	741	40	29659	13007	-10152	126	172
	North	933	40	31089	16366	-5969	122	333

Note: This table presents the median harvest value for the six main IAPP crops. The harvest value is calculated by multiplying the yield in Kg/Ha by the price of the crop. Prices are calculated based on median reported sales prices when there is a large enough sample, while prices from other regions are used in instances of small sample sizes. Prices are reported in Bangladeshi Taka (1 Taka is equal to about .013 USD at the time of writing this report). More details on price selection are given in the appendix. The median net yields are the harvest value minus cost of inputs, divided by plot size used of that crop. The second median net yield includes the opportunity cost of paid labor. The opportunity price of labor (200 Bangladeshi taka per day) is the median price for paid labor reported by the households during adoption year. This is most likely an overestimation as it is not certain that the members of the household would actually get that price if they worked for pay instead of working on their own farms. This helps explain the negative values in median net yield that includes opportunity cost for unpaid labor. Labor days per hectare includes all labor days spent from planting to post-harvest processing and includes paid labor as well as all types of unpaid household labor (male, female, and adult equivalent child labor days).

Although crop value decreases, diversification does increase, which can have positive effects on soil health and resilience (neither of which we measure directly as part of this study). As shown in Figure 12, farmers in the treatment group decreased the proportion of their land dedicated to their most common crop, and to their most common two crops. These decreases are only statistically significant for the plot share of the main crop and two main crops.

Figure 12: Diversification



Note: This table presents three measures of diversification. The first set of columns shows the percentage of all cultivated land within a household dedicated to the crop with the highest percentage of cultivated land. If a household cultivates only one crop, this measure is 100 percent. If it grows N crops of equal area, the measure is equal to 100/N. The second and third set of columns repeats this analysis for the top two and three most cultivated crops in the household. All estimates come from and ANCOVA regression. This figure corresponds to appendix table 8. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

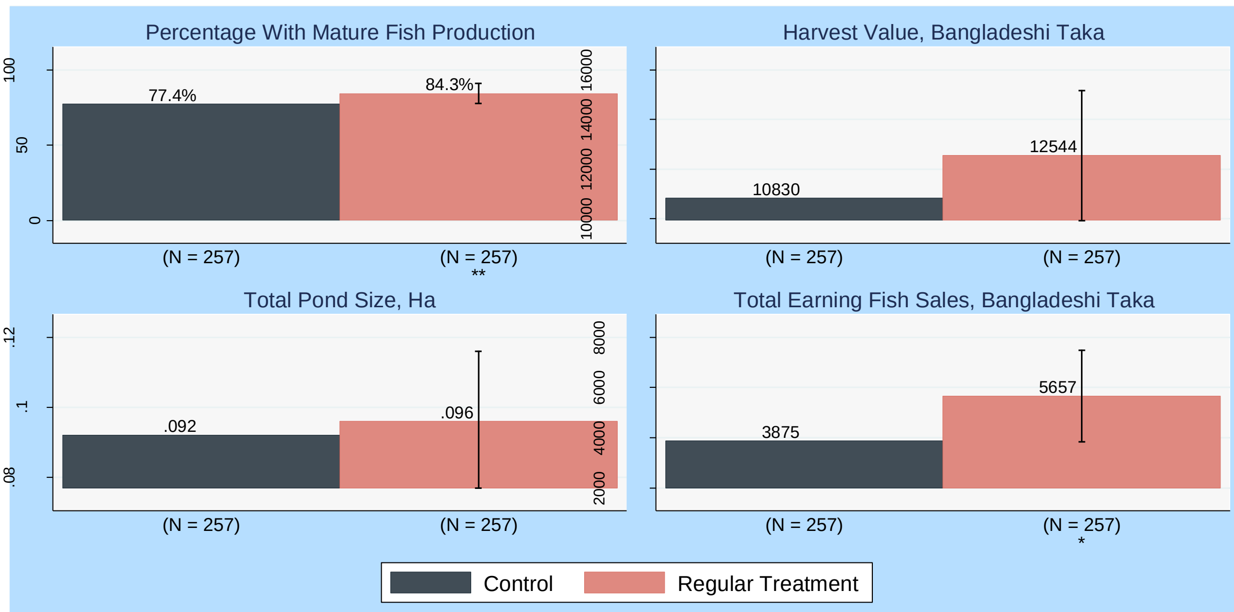
Fisheries

This section presents results on IAPP's fisheries component. Although our survey explicitly sampled many households in both treatment and control villages eligible to participate in IAPP fisheries groups, in reality only a small number actually joined. Therefore, comparing eligible households in treatment and control groups yields very low power. To solve this problem, we use groups of households that joined fisheries groups in our sample, and match them using baseline characteristics to a similar sample in control villages. After trimming for outliers, we are left with a total of 514 observations, 257 in treatment and 257 in control. (The matching procedure is explained in more detail in the appendix.)

IAPP's fisheries activities began later than crop activities, so the data in this section represents less exposure to IAPP than the crops component. Due to the later start of fisheries activities, the 2013 survey to gather information for crops was too early to gather information on fisheries. Instead, for this analysis, we use data from the 2014 survey. By this time, adoption practices for the fisheries components were underway, but only 34 people in our sample report cultivating a pond where they received fingerlings from IAPP. It is therefore possible that larger effects will be seen in the next follow-up survey.

Figure 13 shows the effect of IAPP fisheries group participation on harvest outcomes. We find that participation in IAPP causes people who did not previously cultivate fish to begin cultivation. Since cultivation of fingerlings in our sample is small, we concentrate on production of mature fish. At the time of the follow-up survey, 84 percent of households in the control group cultivated fish, while in the treatment group, 77 percent cultivated. Total fish harvested in kilos, fish value in Bangladeshi taka, and earnings from fish also increased. Earnings from fish increased 46 percent over the amount in the control group.

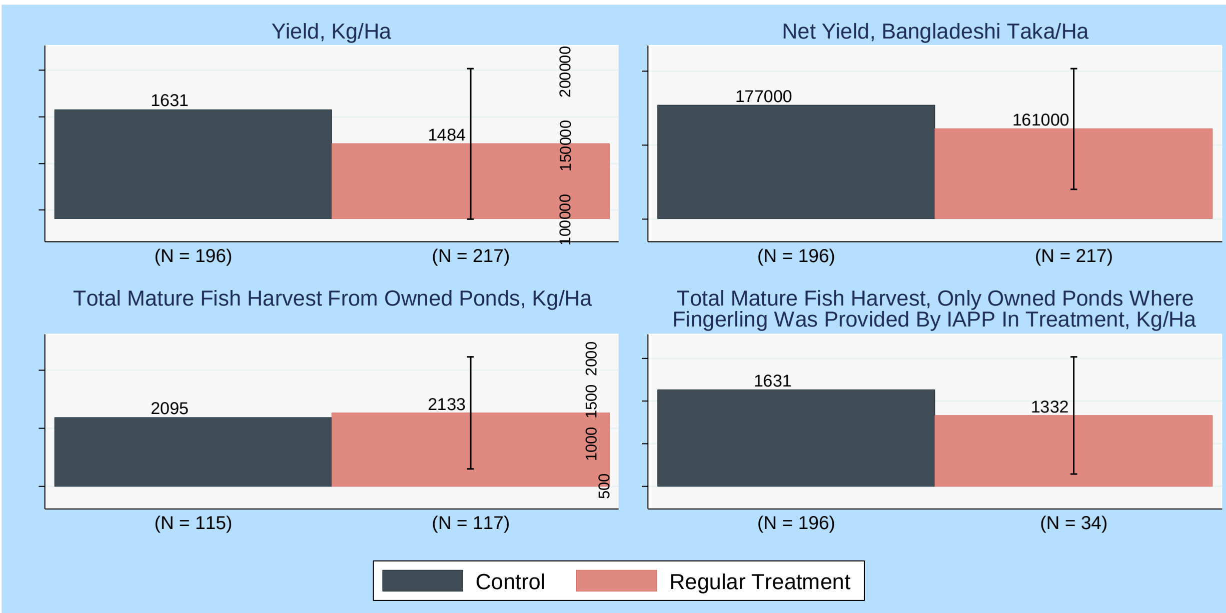
Figure 13: Fish Production and Earnings



Note: This table shows treatment effects of fisheries group participation. For "Percentage with mature fish production," the dependent variable is a dummy that takes the value of 1 if the household reported any mature fish production. Total harvest value (In Bangladeshi taka) is calculated by multiplying the harvest amount of each fish by the median price in the region for that fish. Total earnings (in Bangladeshi taka) is the amount made from selling fish. 1 Taka is equal to about .013 USD at the time of writing this report. All regressions are ANCOVA. This figure corresponds to appendix table 9. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Figure 14 details the effects of group participation on fisheries yields. The top row shows that both gross and net fisheries yield (which are only measured for households that cultivate fish) do not increase as a result of the program. One issue is that the levels of fish yields in our sample (around 1.6 tons/ha) are much lower than the baseline values estimated by IAPP (around 2.7 tons/ha). This is likely because the DIME survey asks about all ponds, while the IAPP data takes into account only full-year ponds that are actively cultivated. Unfortunately, the survey does not have explicit data to identify these ponds in the sample, but we use a proxy by concentrating on owned ponds that harvested only mature fish.[22] (In our data, these ponds have a yield of around 2.2 tons/ha). However, even on these ponds we find no significant difference between treatment and control ponds. Finally, we look at ponds where the respondent reported receiving fingerlings from IAPP. We also do not find a difference in yield between these ponds and ponds in control villages.

Figure 14: Fisheries Yield and Income



Note: This table shows treatment effects of fisheries group participation. Kilogram yield (in Kg/Ha) is the total harvest amount in kilograms per hectare. Net yield (in Bangladeshi Taka/Ha) is the total harvest value minus input costs per hectare. 1 Taka is equal to about .013 USD at the time of writing this report. Total mature fish harvest from owned ponds is the same as yield, but restricted to harvest of mature fish from ponds owned by the household. The last graph also is the same as yield, but restricted in treatment to harvest of mature fish from ponds owned by the household *and* where fingerlings provide by IAPP was used as input. All regressions are ANCOVA. This figure corresponds to appendix table 9. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Overall, the data shows that participation in IAPP has improved farmers' welfare by production and income from fisheries. However, this is driven by expanding production rather than increasing productivity.

Nutrition

This section explores whether participation in crop or fisheries groups affected nutrition or food security.[23] The survey takes three measures of nutrition/food security. The women's dietary diversity

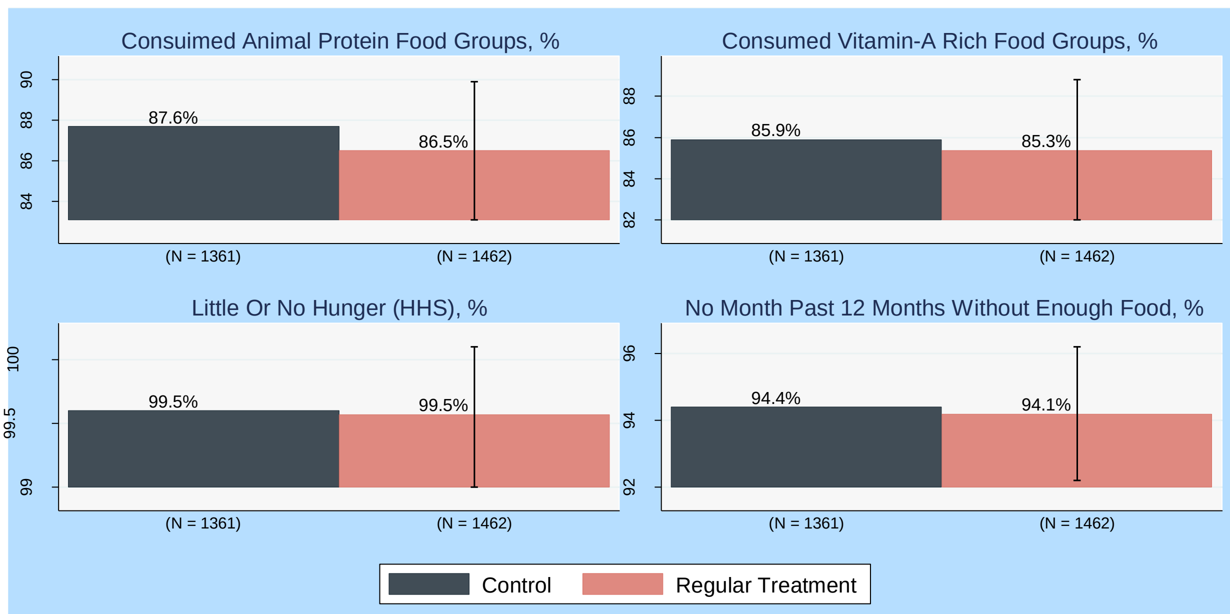
[22] IAPP also promotes fingerling production, but few people in our sample reported producing fingerlings so we eliminate this from the analysis.

[23] Other components of IAPP that may affect nutrition, such as livestock promotion, were not included in this analysis.

module records food consumed by an adult female in the house during the previous day. Based on this, we create dummies for whether the woman consumed foods with vitamin A and foods with animal protein. We also use the household hunger scale (HHS) as a standard measure of hunger.[24] Finally, we asked households about which months they experienced hunger, and created a measure on whether households reported not having enough food during any month. These values are available for only a portion of the overall sample, as they were answered only if an adult female who planned meals was available to answer the questions at the time of the survey. Overall, reported values of food insecurity were very low.

Figure 15 shows the effect of IAPP participation in crop groups on each of these outcomes. In all cases, participation in crops groups does not have a significant effect on nutrition and food security outcomes.

Figure 15: Nutrition Outcomes for Crop Groups

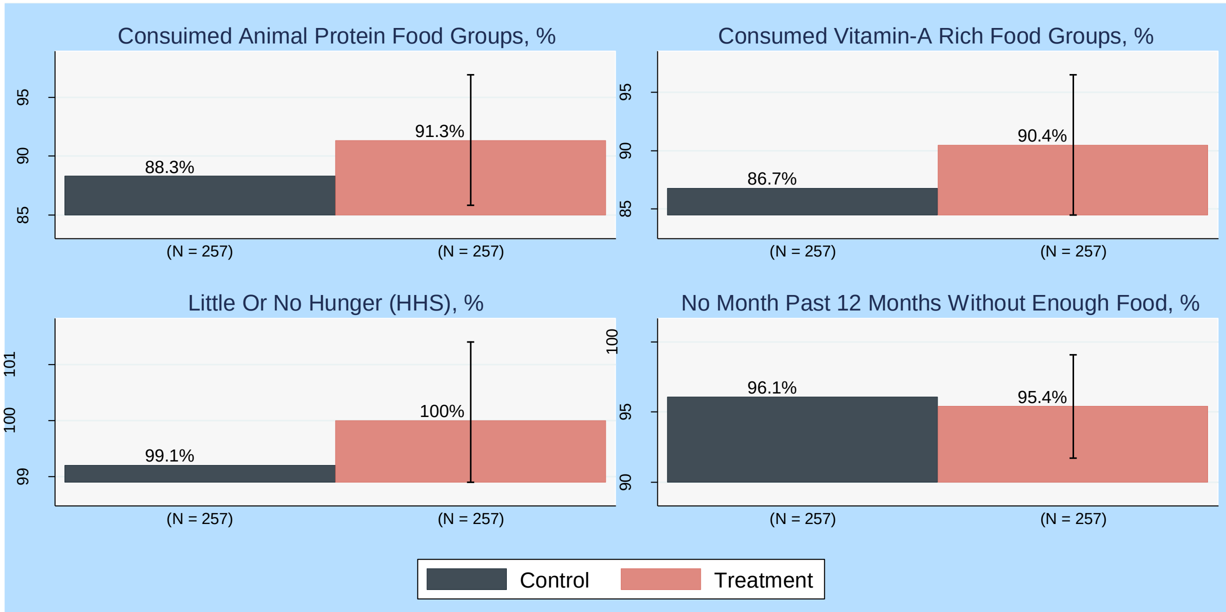


Note: This figure shows four nutrition and food security outcomes: consuming animal proteins; consuming vitamin A-rich food; little or no hunger, according to the household hunger score; and households with no month during the past year with food insecurity. Consuming animal protein and consumed vitamin A food are both categories of the women's dietary diversity score. Consumption of animal protein includes consumption of flesh meat, organ meat, fish, or egg over the previous day. Consumption of vitamin A-rich food groups includes consumption of leafy green vegetables, yellow/orange vegetables, tubers, and other vitamin A-rich fruits over the previous day. Little or no hunger is a category in the household hunger score (HHS). HHS is based on how frequently there was no food in the household the past 30 days, how frequently any household member went to sleep hungry the past 30 days, and how frequently a household member went a full day without any food the past 30 days. The answers are converted to a scale a that range from 0 to 6 where 0 and 1 is considered little or no hunger, which in practice means that maximum one of the three events mentioned above had happened as often as rarely or sometimes. The last variable is defined as households that did report having enough food all of the past twelve months. This figure corresponds to appendix table 11. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

[24] The HHS measure was developed by USAID. More details are available here: http://www.fantaproject.org/monitoring-and-evaluation/household-hunger-scale-hhs

Figure 16 repeats the analysis for fisheries groups. Fisheries participants showed small improvements in dietary diversity and reported hunger, but these gains were not statistically significant.

Figure 16: Nutrition Outcomes for Fisheries Groups



Note: This figure shows four nutrition and food security outcomes for households in our sample that joined fisheries groups and matched households in control villages (see fisheries section in appendix for details): consuming animal proteins; consuming vitamin A-rich food; little or no hunger according to the household hunger score; and households with no month during the past year with food insecurity. Consuming animal protein and consumed vitamin A food are both categories of the women's dietary diversity score. Consumption of animal protein includes consumption of flesh meat, organ meat, fish, or egg over the previous day. Consumption of vitamin A-rich food groups includes consumption of leafy green vegetables, yellow/orange vegetables, tubers and other vitamin A-rich fruits over the previous day. Little or no hunger is a category in the household hunger score (HHS). HHS is based on how frequently there was no food in the household the past 30 days, how frequently any household member went to sleep hungry the past 30 days, and how frequently a household member went a full day without any food the past 30 days. The answers are converted to a scale a that range from 0 to 6 where 0 and 1 is considered little or no hunger, which in practice means that maximum one of the three events mentioned above had happened as often as rarely or sometimes. The last variable is defined as households that did report having enough food all of the past twelve months. This figure corresponds to appendix table 12.*,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Conclusion

This report analyzes the effectiveness of the crops and fisheries sub-components of the Technology Adoption component of IAPP. IAPP was successful in promoting adoption of many new crops and technologies, but this adoption has not led to increases in yield or income for crops. For fisheries, participation in IAPP has led to increased fish cultivation, but no increase in yields. This suggests that after two years of project participation, IAPP group members are not experiencing much of the improvement in living standards that the project hoped to achieve.

The data available can shed some light on why the studies components are not having the desired impact. Consistent with findings on missions, it appears the project has a heavy concentration of resources on conducting demonstrations, and less on ensuring that adoption farmers see project benefits. The problem does not seem to be caused by a lack of inputs or adoption: for crops, DIME monitoring showed that most villages received and distributed seeds during the adoption phases, and these seeds were adopted by farmers. For fisheries, we see more farmers taking up fish cultivation.

However, despite correct distribution of inputs and adoption, increases in yields failed to materialize. This is likely because the farmers did not correctly utilize the new technologies, either due to lack of training or lack of complementary inputs. In fact, reported yields of all non-paddy crops as well as fisheries are well below what was expected by IAPP. This suggests that even though the project has had some success in promoting new technologies, these technologies have not delivered on their promise for project participants.

This suggests, going forward, heavier concentration on adoption farmers, with more training and visits to ensure that they are actually benefitting from the technology they are adopting.

Appendix

Sampling

The Baseline Household Survey was implemented in all eight project districts: Rangpur, Kurigram, Nilfamari, and Lalmonirhat districts in the North and Barisal, Patuakhali, Barguna, and Jhalokathi districts in the South.

Six districts (Kurigram, Nilfamari, Lalmonirhat, Patuakhali, Barguna, and Jhalokati) are only part of the technology adoption evaluation. In these six districts, eight unions were selected for the impact evaluation surveys. Within each union, two villages were surveyed. Each of these villages is eligible for all four components of the IAPP (crops, fisheries, livestock, and water management interventions). In each union, one of the sampled villages received IAPP interventions in 2012 and the other did not receive interventions until 2014.

Prior to the baseline survey, a full census of the sampled villages in these six districts was conducted to identify households eligible for and likely to participate in IAPP. IAPP interventions are based at the level of the farmer group, but at the time of the baseline survey, farmer groups were not yet formed. For that reason, census data was used to construct a sampling frame of likely participants in IAPP crop and fisheries groups. In each village, 16 households were sampled, half of which were selected as eligible for the crops groups and half for the fisheries groups. Eligibility was determined by IAPP targeting criteria, prioritizing crop farmers with marginal or small landholdings, and fishermen with access to ponds between 15-50 decimals. After sampling, the IAPP teams reached out to sampled farmers and attempted to involve them in IAPP groups. However, very few sampled farmers ended up joining livestock groups. Therefore, our sample did not contain sufficient livestock group members to do analysis on livestock.

Two districts (Rangpur and Barisal) are included in both the technology adoption evaluation and the demonstration plots evaluation, and as such the sampling strategy in these districts was slightly different. Significantly more villages had to be sampled in these districts because of the DPE tests variations in project implementation. In all, 110 villages were sampled in each district. Household selection in Rangpur and Barisal also differed. In these districts, the baseline survey was conducted concurrently with the IAPP group formation (for the DPE districts, the baseline occurred just before group formation). Of the total IAPP group members, 15 were randomly selected for the baseline survey.[25]

The sample in the six districts in the technology adoption evaluation, the sample is representative of farmers who were eligible for participation in IAPP and were invited to join. The sample in the two additional technology adoption districts is representative of farmers who were eligible for participation in IAPP and were part of the initial IAPP group formation. Although more farmers in the demonstration

[25] A miscommunication led to sampling the wrong farmer group (a group that had previously existed, not the new group formed by IAPP) in eight treatment villages and 12 control DPE villages. These villages were dropped for the purpose of the baseline analysis. However, the sample was redrawn during follow-up surveys.

plot evaluation remained in groups after 1 year (68% versus 48%), we don't notice any difference in outcomes between farmers who remained in groups and those that left. Therefore, we group these two groups together for much of the analysis.

Specification Details

The regression specification used for all results is an ANCOVA specification, described by the following equation:

$$Outcome_{i,t} = \alpha + \beta_1 Treat_i + \beta_2 Outcome_{i,t-1} + \beta_3 Controls + \varepsilon_{i,t}$$

The control variables consist of dummies signifying whether baseline data was unavailable and a set of district dummies. If the observation did not have a valid measure of outcome variable at time t-1, the lagged outcome is set to zero (and its effect on the outcome is absorbed by a dummy). The error term is assumed to be correlated across villages but otherwise iid, so the specifications cluster standard errors at the village level.

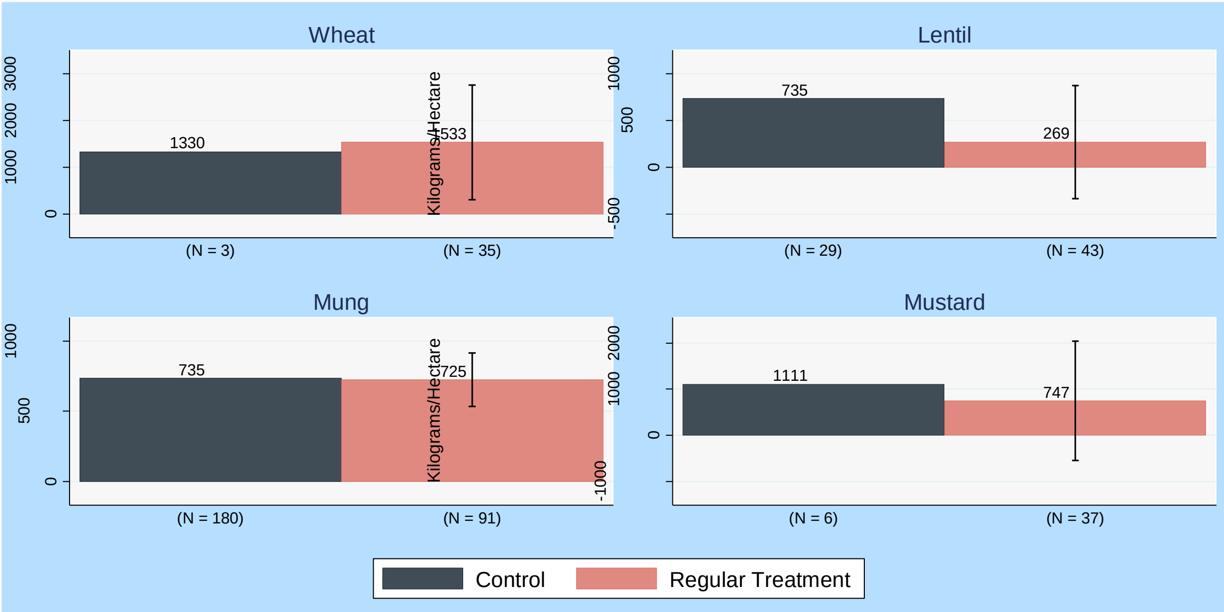
Kg Yields

Appendix Table 1: Rice Yield over Time

	Paddy yield (Kilograms per Hectare)					
	Baseline	Demonstration Year		Adoption Year		
	All Farmers	Demonstration Farmers	Non-Demonstration Farmers	Demonstration Farmers	Adoption Farmers	Other Farmers
Regular Treatment	65.22	962.9**	-11.19	-234.2	191.4	177
	[153.80]	[430.73]	[233.04]	[354.28]	[131.92]	[141.81]
Lag of Dependent Variable		0.121	0.227***	0.0831	0.209***	0.220***
		[0.17]	[0.05]	[0.12]	[0.04]	[0.04]
Control Mean	5766.3	5475.6	5531.6	5966.7	5883.7	5883.7
Control Number of Obs	847	25	314	30	762	762
Control Standard Deviation	1359.2	1262.7	1412	1424.5	1485.4	1485.4
Total Number of Observations	1733	72	649	75	1016	1335

Note: These results correspond to figure 2 in the main text. Yield calculations included mono-cropped plots only. Yield during the demonstration year is calculated only for each household's two 'primary' plots. The baseline regression is an OLS regression and the other five regressions are ANCOVAs on paddy yield (Kg/Ha). Only households in villages where rice was demonstrated (treatment) or shadow demonstrated (control) and grew paddy during the respective years are included in the sample. Demonstration farmers in control villages are "shadow" demonstration farmers that community facilitators claimed would have demonstrated the crop had the demonstration taken place in this group, and who were also part of the baseline survey. This is a small selected sample, which could explain the lower yield among this group. Adoption farmers are farmers that received inputs from the project during the adoption year. Adoption farmers and other farmers are compared against the same controls. All regressions contain fixed effect for districts and standard errors are clustered at village level. All ANCOVA regressions have dummies identifying households not surveyed at baseline and those that did not cultivate paddy at baseline. All variables are winsorized on the 99 percent level on the upper tail. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Figure 1: Yield All Crops (Kg/Ha)



Notes: This figure corresponds to appendix table 2 and shows the difference in crop-specific yields between control and the three treatment groups, for the Boro season 2013-14 (the adoption year). Included in the regressions are all villages in treatment groups where paddy was demonstrated, as well as control villages where district officials stated paddy would be demonstrated once they begin IAPP. Only farmers who harvested the crop during the Boro season are included, and yield is calculated only for mono-cropped plots. Only southern districts are included. No yields in any of the three treatment groups are significantly different from yields in control, and none of the treatment groups are significantly different from each other. All specifications are ANCOVA.

Appendix Table 2: Crop Specific Yield (Kg/Ha) – IAPP Crops

	Yield (Kilograms per Hectare)				
	Paddy	Wheat	Lentil	Mung	Mustard
Regular Treatment	295.8**	203.1	-465.8	-10.3	-364.3
	[119.20]	[626.90]	[309.32]	[97.70]	[659.52]
Shared Demo Treatment	80.9				
	[125.10]				
Incentives Treatment	-55.05				
	[126.47]				
Lag of Dependent Variable	0.246***	.	0.177	0.283	0.433
	[0.02]	.	[0.63]	[0.19]	.
Baseline Mean	5764.8	.	431.6	542.6	1208.3
Baseline Number of Observations	2202	0	19	132	3
Control Mean	5747.2	1330.8	735.7	735.9	1111.4
Control Number of Observations	543	3	29	180	6
Control Standard Deviation	1526.1	164.6	688.9	586.9	600
Total Number of Observations	2330	38	72	271	43

Note: These results correspond to figure 3 in the main text and figure 1 in the appendix. Yield calculations included mono-cropped plots only. All regressions are ANCOVAs and only households in villages where the respective crop was demonstrated (treatment) or shadow demonstrated (control) and actually grew the crop during the adoption year are included in the sample. All regressions contain fixed effect for districts and standard errors are clustered at village level. All regressions have dummies identifying households not surveyed at baseline and those that did not cultivate the crop at baseline. Only southern districts are included for non-paddy crops and only the districts of Barisal and Rangpur are included for paddy. All variables are winsorized on the 99 percent level on the upper tail. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Adoption

Appendix Table 3: Adoption of Paddy and Wheat

Adoption of IAPP Paddy Varieties

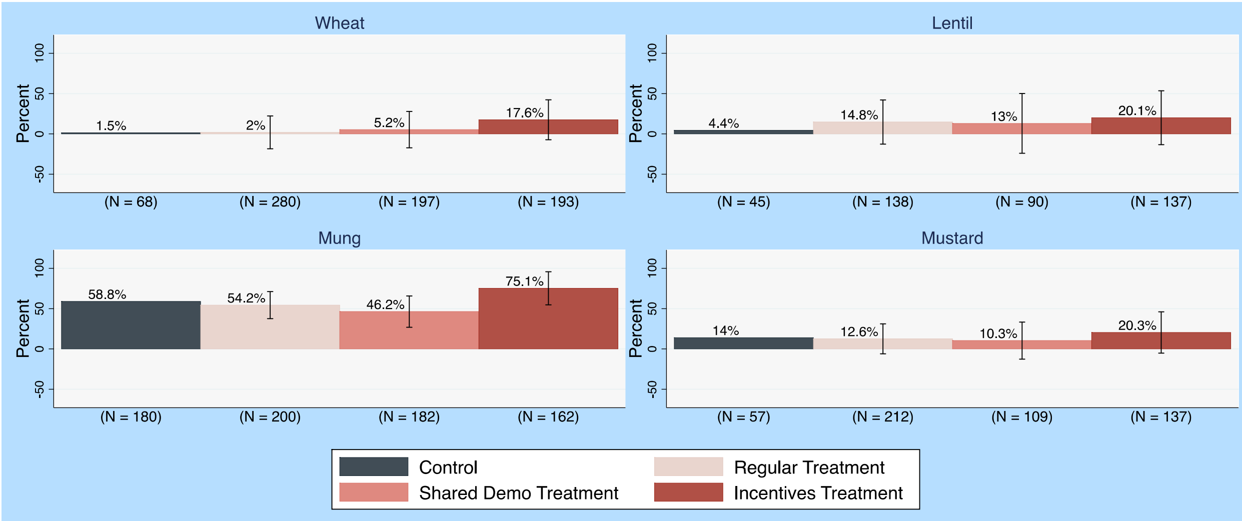
	Baseline	Demonstration Year		Adoption Year		
	All Farmers	Demonstration Farmers	Non-Demonstration Farmers	Demonstration Farmers	Adoption Farmers	Other Farmers
Regular Treatment	0.00629	0.605***	0.0519	0.134	0.178***	0.0852***
	[0.05]	[0.12]	[0.07]	[0.12]	[0.04]	[0.03]
Lag of Dependent Variable		0.236**	0.292***	0.135	0.202***	0.200***
		[0.11]	[0.05]	[0.12]	[0.03]	[0.02]
Control Mean	0.286	0.286	0.545	0.68	0.752	0.752
Control Number of Observations	21	21	299	25	741	741
Control Standard Deviation	0.463	0.463	0.499	0.476	0.432	0.432
Total Number of Observations	68	68	636	73	995	1316

Adoption of Growing Wheat

	Baseline	Demonstration Year		Adoption Year		
	All Farmers	Demonstration Farmers	Non-Demonstration Farmers	Demonstration Farmers	Adoption Farmers	Other Farmers
Regular Treatment	0.000452	0.969***	0.0409*	0.309*	0.332***	0.0463**
	[0.00]	[0.07]	[0.02]	[0.17]	[0.06]	[0.02]
Lag of Dependent Variable		.	.	0.904***	.	.
		.	.	[0.04]	.	.
Control Mean	0.00332	0.0349	0.0217	0.0465	0.0205	0.0205
Control Number of Observations	301	86	46	172	195	195
Control Standard Deviation	0.0576	0.185	0.147	0.211	0.142	0.142
Total Number of Observations	642	91	171	184	273	455

Note: These results correspond to figures 4 and figure 6 in the main text. The baseline regression is an OLS regression and the other three regressions are ANCOVAs on paddy yield (kg/ha). Only households in villages where paddy or wheat respectively were demonstrated (treatment) or shadow demonstrated (control) and grew paddy during the respective year are included in the sample. Demonstration farmers in control villages are “shadow” demonstration farmers that community facilitators claimed would have demonstrated the crop had the demonstration taken place in this group, and who were also part of the baseline survey. This is a small selected sample, which could explain the lower yield among this group. Adoption farmers are farmers that received inputs from the project during the adoption year. Adoption farmers and other farmers are compared against the same controls. All regressions contain fixed effect for districts and standard errors are clustered at village level. Some estimates for the lag of the dependent variable are not available due to the low number of wheat cultivators at baseline. All ANCOVA regressions have dummies identifying households not surveyed at baseline and those that did not cultivate paddy at baseline. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Figure 2: Adoption of Other Crops



Notes: This figure shows adoption of IAPP varieties of wheat, lentil, mung, and mustard. Households are considered to adopt a specific crop if they grow any of that crop. The regression restricted to treatment villages where the crop was demonstrated, as well as control villages, where district officials stated the crop would be demonstrated once they begin IAPP. Only southern districts are included. This figure corresponds to appendix table 4. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Table 4: Adoption – Five IAPP Crops

	Paddy			Wheat	Lentil	Mung	Mustard
	Grew Crop	Grew Any IAPP Variety	Grew Promoted IAPP Variety	Grew Crop	Grew Crop	Grew Crop	Grew Crop
Regular Treatment	-0.00279	0.147***	0.181***	0.00552	0.103	-0.0455	-0.0148
	[0.03]	[0.04]	[0.05]	[0.10]	[0.14]	[0.09]	[0.09]
Shared Demo Treatment	-0.0147	0.0869**	0.124**	0.0387	0.086	-0.126	-0.0374
	[0.03]	[0.04]	[0.05]	[0.11]	[0.19]	[0.10]	[0.12]
Incentives Treatment	0.0212	0.149***	0.113*	0.161	0.157	0.163	0.0639
	[0.03]	[0.04]	[0.07]	[0.13]	[0.17]	[0.10]	[0.13]
Lag of Dependent Variable	0.487***	0.215***	0.326***	0.356***	0.298***	0.398***	0.222**
	[0.04]	[0.02]	[0.03]	[0.11]	[0.05]	[0.05]	[0.09]
Control Mean	0.83	0.709	0.57	0.0147	0.0444	0.589	0.14
Control Number of Observations	564	453	453	68	45	180	57
Control Standard Deviation	0.376	0.455	0.496	0.121	0.208	0.493	0.35
Total Number of Observations	2796	2160	2160	738	410	724	515

Note: These results correspond to figure 5 and figure 7 in the main text as well as appendix figures 2. Seed variety data was only collected for paddy in baseline. All regressions are ANCOVAs. Only households in villages where the respective crop was demonstrated (treatment) or shadow demonstrated (control) for the 'Grew Crop' regression. For the other regressions, the sample is also restricted to households that actually grew the crop. Only southern districts are included for non-paddy crops and only the districts of Barisal and Rangpur are included for paddy. All regressions contain fixed effect for districts and standard errors are clustered at village level. All ANCOVA regressions have dummies identifying households not surveyed at baseline and those that did not cultivate the crop at baseline. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Input usage

Appendix Table 5: Input Usage on Paddy Plots

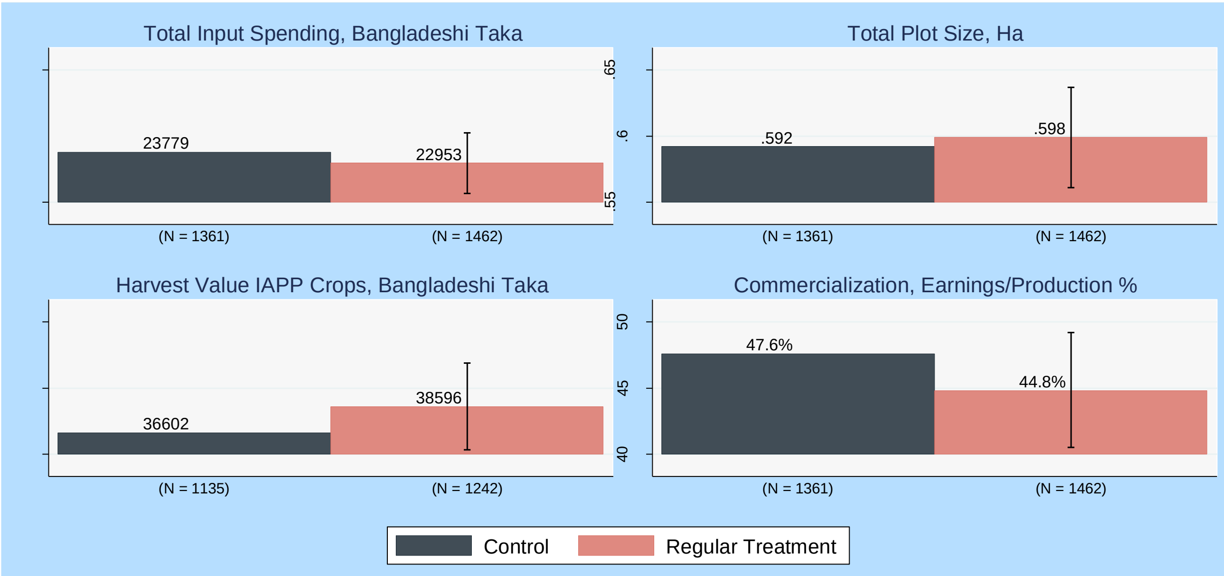
	Urea per Hectare	TSP per Hectare	MOP per Hectare	Gypsum per Hectare	Zinc per Hectare	Borax per Hectare	Lime per Hectare	Compost per Hectare	Manure per Hectare	FYM per Hectare	NPKS per Hectare	Pesticides (Solid) per Hectare	Pesticides (Liquid) per Hectare	Phere-mones per Hectare	DAP per Hectare	Ammonia per Hectare
Regular treatment	-2.362	12.55	8.017	11.43**	1.117*	-0.0859	0.139	484.9***	-292.3	27.6	0.284	-0.167	0.914*		3.077	0.0177
	[22.89]	[10.56]	[9.91]	[4.81]	[0.67]	[0.34]	[0.72]	[146.73]	[356.96]	[55.41]	[0.58]	[0.58]	[0.48]		[7.08]	[0.02]
Shared Demo Treatment	-5.113	13.32	5.47	15.09***	0.863	0.23	-0.113	294.8**	-136	1.84	-0.228	0.557	0.36		2.705	0.0171
	[21.65]	[10.98]	[11.50]	[5.24]	[0.70]	[0.36]	[0.75]	[134.35]	[392.31]	[41.20]	[0.15]	[0.65]	[0.30]		[6.18]	[0.02]
Incentives Treatment	14.65	33.25**	9.521	13.48**	1.158	0.158	-0.676	217.5	440.4	-2.893	-0.123	0.261	0.286		-2.377	-0.000635
	[22.78]	[14.94]	[11.17]	[5.18]	[0.78]	[0.41]	[0.45]	[139.71]	[412.01]	[46.50]	[0.17]	[0.53]	[0.23]		[5.22]	[0.00]
Control Mean	292.2	146.8	109.5	27.59	3.017	0.721	0.722	28.53	2638	41.31	0.273	3.561	0.97	0	15.82	0
Control Number of Observations	543	543	543	543	543	543	543	543	543	543	543	543	543	543	543	542
Control Standard Deviation	363.7	104.7	85.59	49.97	6.631	3.564	8.388	373.5	4525.1	413.4	3.738	6.438	2.424	0	67.61	0
Total Number of Observations	2330	2330	2330	2329	2330	2330	2329	2330	2329	2330	2330	2330	2330	2330	2330	2329

	Vitamins per Hectare	Potassium per Hectare	Paid Labor Days per Hectare	Unpaid Labor Days per Hectare	Irrigation Spending per Hectare	Used Irrigation	% Plots With IAPP Variety	% Plots With Fresh Seed	Interaction Fresh Seed and IAAP Variety	Used Green Manure	Used Line Planting	Used IPM	Used Vermi-Compost	Used Double Transplant	Used Dapog	Used Alternative Wet/Dry Method
Regular treatment	-0.516	2.895	4.262	14.36	111	-0.00165	0.162**	0.182***	0.222***	0.0440***	0.251***	0.0396	0.136***	0.0481	0.0123*	0.002
	[0.40]	[4.29]	[5.04]	[17.55]	[429.57]	[0.00]	[0.06]	[0.05]	[0.05]	[0.02]	[0.04]	[0.04]	[0.04]	[0.08]	[0.01]	[0.00]
Shared Demo Treatment	-0.00717	3.327	0.2	-0.907	455.1	-0.00108	0.158**	0.122***	0.194***	0.0423**	0.242***	0.0826*	0.0634***	0.106	0.0137**	0.0187**
	[0.53]	[5.12]	[5.03]	[16.23]	[409.02]	[0.00]	[0.06]	[0.04]	[0.04]	[0.02]	[0.05]	[0.05]	[0.01]	[0.07]	[0.01]	[0.01]
Incentives Treatment	-0.114	5.997	1.287	15.92	-600.7	0.0000104	0.169***	0.0427	0.157***	0.021	0.173***	0.110**	0.0382**	-0.0156	0.0184*	0.0099
	[0.41]	[4.67]	[5.46]	[15.52]	[417.04]	[0.00]	[0.06]	[0.05]	[0.04]	[0.02]	[0.04]	[0.05]	[0.02]	[0.07]	[0.01]	[0.01]
Control Mean	1.938	8.832	74.33	145	4483.2	0.998	0.435	0.458	0.198	0.0295	0.413	0.335	0.00184	0.285	0	0
Control Number of Observations	543	543	543	543	543	543	543	543	543	543	543	543	543	543	543	543
Control Standard Deviation	4.664	41.64	43.21	121.2	3722.2	0.0429	0.412	0.466	0.334	0.169	0.493	0.472	0.0429	0.452	0	0
Total Number of Observations	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330	2330

Note: These results correspond to figure 8 and figure 9 in the main text. All regressions are only on crop instances where paddy was grown. Variables are kg/liter per hectare for regressions with 'per hectare' the regression title. Variables are dummy variables (take the value of 1 for yes and value of 0 for no) for regression with “used” in the title. All other regression has percent as their unit. All regressions contain fixed effect for districts and standard errors are clustered at village level. These regression only includes Barisal and Rangpur district. All continuous variables are winsorized on the 99 percent level on the upper tail. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Agricultural Outcomes:

Appendix Figure 3: Outcomes for All Crops



Notes: This figure shows changes in input spending, total cultivated area, harvest value for the IAPP crops, and commercialization. Input spending (in Bangladeshi taka) includes spending on fertilizers, irrigation, equipment, and paid labor. It does not include the opportunity cost of household labor. Total plot size (in hectares) is the farm total cultivated area for all crops. Harvest value IAPP crops (in Bangladeshi taka) is calculated by multiplying the harvest amount of IAPP crops by the median price in the region for that crop. Commercialization is calculated as the total earnings divided by the total production and is a measure on how much a household produces for its own production and for economic return. 1 Taka equals .013 USD at the time of writing this report. This figure corresponds to appendix table 6. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Table 6: Farm Total Agriculture Outcomes

	Total Value All Harvest (BG Taka)	Net Yield (BG Taka/Ha)	Gross Yield (BG Taka/Ha)	Total Earnings All Crop Sales (BG Taka)	Total Input Spending (BG Taka)	Total Plotsize (Ha)	Harvest Value IAPP Crops (BG Taka)	Commercialization (Earnings/Production)
Regular treatment	-3402.1	-3206	-4758	-4281.3***	-825.8	0.00624	1994.5	-0.0272
	[2557.62]	[3198.41]	[4205.31]	[1561.84]	[1169.19]	[0.02]	[1677.79]	[0.02]
Lag of Dependent Variable	0.574***	0.104***	0.203***	0.487***	1.455***	0.568***	0.631***	0.176***
	[0.04]	[0.03]	[0.04]	[0.04]	[0.11]	[0.03]	[0.03]	[0.06]
Baseline Mean	52583.6	71962.4	84809.3	25414.8	7914.3	0.599	36777.3	0.445
Baseline Number of Observations	2492	2492	2492	2492	2492	2492	2221	2492
Control Mean	59531.2	63069.7	102132.7	30206	23779.2	0.592	36602.2	0.476
Control Number of Observations	1361	1361	1361	1361	1361	1361	1135	1361
Control Standard Deviation	62624.8	66225.3	76392.6	39235.9	25027.3	0.439	35367.2	0.468
Total Number of Observations	2823	2823	2823	2823	2823	2823	2377	2823

Note: These results correspond to figure 10 in the main text and appendix table 3. All variables are aggregates of all crops on all plots of the household. Taka is the Bangladeshi currency. All regressions are ANCOVAs, contain fixed effect for districts and standard errors are clustered at village level and have dummies identifying households not surveyed at baseline. All variables are winsorized on the 99 percent level on the upper tail. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Crop's Share of Total Cultivated Area

Appendix Table 7: Individual Crop's Cultivated Areas as a Share of Total Area

	Aus (Broadcast)	Aman (Broadcast)	T.Aman	T.Aus	Boro	Wheat	Maize	Dhonche	Jute	Bamboo	Lentil	Mung	Black Gram	Khesari	Chick Pea (Chhola)	Field Pea (Motor)
Regular Treatment	-0.000518	0.0011	-0.00091	0.00365	-0.00122	0.0149***	-0.00608	-0.00102	0.000498	-0.00413	0.00138	-0.00269	0.000106	-0.0131	0.000403	-0.0000281
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]
Shared Demo Treatment	0.0044	-0.000507	-0.00350*	-0.00245	-0.0113	0.00699	-0.000393	0.000173	0.00603	-0.00243	-0.00096	0.0131	-0.0000988	-0.00815	0.000208	0.0000896
	[0.01]	[0.00]	[0.00]	[0.00]	[0.03]	[0.01]	[0.01]	[0.00]	[0.01]	[0.00]	[0.01]	[0.01]	[0.00]	[0.02]	[0.00]	[0.00]
Incentives Treatment	-0.00117	0.000777	-0.00329*	0.0027	-0.018	0.0109**	0.00442	-0.00181	0.00406	0.00276	0.00582	0.00701	0.000983	-0.0008	0.000812	-0.0000157
	[0.00]	[0.00]	[0.00]	[0.01]	[0.02]	[0.01]	[0.01]	[0.00]	[0.00]	[0.01]	[0.01]	[0.01]	[0.00]	[0.02]	[0.00]	[0.00]
Lag of Dependent Variable	0.167***	-0.00139	-0.00466**	-0.0102*	0.517***	0.232***	0.531***	0.00303	0.0187*	-0.666***	0.281***	0.464***	0.00102	0.300***	0.222**	-0.000126
	[0.05]	[0.00]	[0.00]	[0.01]	[0.02]	[0.07]	[0.06]	[0.00]	[0.01]	[0.16]	[0.04]	[0.03]	[0.00]	[0.02]	[0.10]	[0.00]
Control Mean	0.00185	0	0.002	0.00157	0.404	0.0102	0.0462	0.00205	0.00326	0.0207	0.0154	0.0743	0.000189	0.106	0.0021	0.0000327
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.0226	0	0.0291	0.0244	0.365	0.0504	0.144	0.0253	0.0241	0.0804	0.065	0.198	0.00497	0.226	0.0181	0.00103
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

	Gori Kalai/ Kali Motor	Other Pulse	Sesame	Linseed	Mustard	Groundnut/ peanut	Soybean	Chili	Onion	Garlic	Tumeric	Ginger	Coriander	Pumpkin	Bringal (Eggplant)	Pointed Gourd
Regular Treatment	-0.000133	0.00017	0.00383**	-0.0000539	0.00571	-0.00117	0.000832	0.000859	0.00035	0.00107*	0.000205	0.0000895	-0.000191	-0.000129	0.000267	0.000401
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Shared Demo Treatment	-0.000155	-0.0000873	0.00282	0.0000162	-0.000951	-0.00326	0.000607	0.000287	0.00162	0.000649	0.000257	0.0000411	0.000491	0.000416	0.000287	0.00181
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Incentives Treatment	-0.000028	-0.000088	0.00531***	-0.00021	0.00494	-0.00344	0.000465	0.000454	0.00153	0.00043	0.0000237	-0.0000266	0.000312	0.000398	-0.00185	0.00139
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Lag of Dependent Variable	-0.00455	-0.000141	0.0983	-0.00526	0.104***	0.561***	-0.0168**	0.107***	0.0525**	0.0445	-0.00159	0.0274	0.0302	-0.00355**	0.116*	0.267***
	[0.00]	[0.00]	[0.07]	[0.02]	[0.03]	[0.12]	[0.01]	[0.02]	[0.03]	[0.04]	[0.00]	[0.04]	[0.03]	[0.00]	[0.06]	[0.09]
Control Mean	0.000151	0.00000474	0.00275	0.000385	0.0172	0.0113	0.000255	0.011	0.00198	0.00101	0.000433	0.0000298	0.000969	0.000695	0.0107	0.000903
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.00346	0.000175	0.0236	0.0101	0.0665	0.0661	0.00563	0.0384	0.0166	0.00736	0.00555	0.00101	0.019	0.0116	0.0376	0.0091
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

	Okra	Ridge Gourd	Bitter Gourd	Arum / Latiraj	Ash Gourd	Cucumber	Carrot	Cow Pea	Snake Gourd	Danta	Plantain	Cauliflower	Water Gourd	Sweet Gourd	Tomato	Radish
Regular Treatment	-0.000295	-0.000371	-0.00192**	-0.00193*	0.00125	0.000135	-0.0000457	-0.00113**	-0.000684	0.000259	0.000458	0.00015	-0.000195	0.000474	-0.00156	0.00045
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Shared Demo Treatment	0.000185	-0.000207	-0.000545	-0.00153	0.00144*	0.00103	-0.0000355	-0.000532	0.00000869	-0.000495	-0.000498	0.00141	-0.000486	-0.00061	0.000218	0.00089
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Incentives Treatment	-0.000311	0.00031	0.00294	-0.000784	0.00133	0.000146	-0.0000261	-0.00101*	-0.000349	-0.000588	-0.000816	0.0032	-0.00037	0.000783	-0.00125	0.000117
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Lag of Dependent Variable	0.143*	-0.00367	0.235**	0.209	0.00357	0.0721**	-0.000125	0.0530**	0.0148	-0.00335	-0.00666*	0.280**	0.0101	0.0502	0.105**	0.0793
	[0.08]	[0.00]	[0.10]	[0.14]	[0.01]	[0.03]	[0.00]	[0.03]	[0.02]	[0.00]	[0.00]	[0.12]	[0.01]	[0.04]	[0.04]	[0.06]
Control Mean	0.0048	0.00188	0.00573	0.00376	0.00379	0.00187	0.000124	0.0023	0.00228	0.00138	0.00113	0.000809	0.00122	0.00747	0.00758	0.00471
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.0268	0.0201	0.0246	0.0227	0.0213	0.0141	0.00329	0.0148	0.0185	0.0126	0.0171	0.00778	0.011	0.0335	0.0307	0.0269
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

Appendix Table 7: Individual Crop's Cultivated Areas as a Share of Total Area – Continued

	Turnip	Green Papaya	Kakrol	Country Bean	Coriander Leaf	Other Green Vegetables	Pui Shak	Spinach	Lal Shak	Kalmi Shak	Danta Shak	Kachu Shak	Lau Shak	Mula Shak	Khesari Shak	Potato Leaves
Regular Treatment	-0.000304	0.000325	-0.000777	-0.00025	-0.0000152	0.0000323	0.00207	0.0000345	0.00285*	0.0000216	0.000368**	-0.0000404	0.000223***	-0.000153	0.0000664	0.000410*
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Shared Demo Treatment	-0.000444	0.0000777	-0.00105	0.0000961	0.000684	0.0000082	0.00104	-0.000492	0.000962	-0.000204	0.0001	0.0000299	-0.0000161	-0.0000826	-0.00017	0.000108
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Incentives Treatment	-0.000744*	0.000562	-0.00121	0.00189*	0.0000661	0.0000175	0.00131	0.000167	0.000593	0.000732	-0.0000776	0.0000307	0.000268	0.000056	-0.0000616	0.000127
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Lag of Dependent Variable	0.0657***	0.00279	0.148***	0.27	0.0783	-0.0000358	0.0583**	0.0251	0.0575*	0.117	-0.00316**	-0.00111*	0.0131	0.00697		
	[0.02]	[0.00]	[0.06]	[0.20]	[0.08]	[0.00]	[0.03]	[0.03]	[0.03]	[0.12]	[0.00]	[0.00]	[0.01]	[0.01]		
Control Mean	0.00131	0.000632	0.00117	0.00298	0.00129	0	0.00735	0.00323	0.0098	0.000553	0.000272	0.0000485	0.0000472	0.000316	0.0000671	0
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.0128	0.00668	0.0115	0.0299	0.0108	0	0.0288	0.017	0.0313	0.00392	0.00347	0.00101	0.000673	0.00361	0.00248	0
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

	Cabbage	Other Green Leafy Vegetables	Banana	Mango	Jackfruit	Papaya	Water-melon	Musk Melon	Lychee	Guava	Lemon	Boroi	Hog Plum	Olive (Wild)	Coconut	Other Fruits
Regular treatment	-0.000618	0.000124	0.00370*	0.000981	-0.000935	-0.000471	-0.00142	-0.000251	0.0000352	0.000568*	-0.000675	0.000369	0.000151	-0.00029	-0.00109	0.0000922
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Shared Demo Treatment	0.000494	0.000369	0.00261	-0.00119	-0.000338	0.000336	-0.000345	-0.000121	-0.000182	0.000457	-0.000854	-0.0000117	-0.0000106	-0.000103	-0.000644	-0.0000503
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Incentives Treatment	-0.000438	-0.000068	0.000598	-0.00164	-0.00142	-0.00021	-0.00103	-0.000169	-0.000104	0.00033	-0.00102	-0.000279	0.00008	-0.000131	-0.00202	-0.0000552
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Lag of Dependent Variable	0.175***	-0.000253	0.128***	0.0541	-0.00207	-0.00142	0.248**	-0.00567**	-0.000812			0.668***		-0.0131*		-0.00416
	[0.05]	[0.00]	[0.04]	[0.05]	[0.00]	[0.00]	[0.10]	[0.00]	[0.00]			[0.00]		[0.01]		[0.00]
Control Mean	0.00192	0	0.00646	0.00226	0.00208	0.000952	0.00403	0.000495	0.000305	0.000301	0.00152	0.00052	0.000049	0.000429	0.00844	0.00000612
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.0146	0	0.04	0.0179	0.0281	0.0119	0.0434	0.00763	0.00703	0.0061	0.0147	0.00957	0.00181	0.00942	0.059	0.000226
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

	Potato	Sweet Potato	Sugarcane	Tobacco	Bettlenut	Bettleleaf	Napier Grass	Para Grass	Fodder Crops	Bottle Gourd	Sunflower	Other Crop
Regular treatment	-0.00486	0.00186***	0.000939	-0.00154	-0.00359	-0.00145	-0.00000068	0.000139	-0.000415	-0.0004	0.00338	0.00867**
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Shared Demo Treatment	0.00816	0.00107*	0.00327*	-0.0051	-0.00531	-0.00507	0.000134	0.0000863	-0.0000483	-0.000973	0.00201	0.00234
	[0.01]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Incentives Treatment	-0.00492	0.00179***	0.00484	-0.00361	-0.00575	-0.00557	-0.0000263	0.0000774	-0.000198	0.00118	0.00272	0.00393
	[0.01]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Lag of Dependent Variable	0.506***	0.0558*	0.00132	0.581***	0.344***	-0.0682**	4.928***			0.00983	-0.00265	
	[0.03]	[0.03]	[0.05]	[0.05]	[0.04]	[0.03]	[0.86]			[0.02]	[0.01]	
Control Mean	0.0704	0.00079	0.000703	0.0242	0.0167	0.00538	0.000284	0	0.000441	0.00619	0.0019	0.0133
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.136	0.00684	0.00974	0.098	0.0751	0.0523	0.00756	0	0.0163	0.029	0.0193	0.0573
Total Number of Observations	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558	4558

Note: These results correspond to figure 11 in the main text. Plot share is calculated as the area dedicated to a certain crop, divided by total cultivated area. For intercropped plots, we assign each crop equal shares of area for the purpose of this calculation. The value is set to zero if a household did not grow the crop. All regressions are ANCOVAs, contain fixed effect for districts, standard errors are clustered at village level and have dummies identifying households not surveyed at baseline. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Table 8: Diversification of Crops

		Share Of Total Cultivated Area For:			
	Number of Crops	Main Crop	2 Main Crops	3 Main Crops	4 Main Crops
Regular treatment	0.239	-0.0256*	-0.0188*	-0.00861	-0.00163
	[0.26]	[0.01]	[0.01]	[0.01]	[0.01]
Lag of Dependent Variable	0.456***	0.314***	0.258***	0.206***	0.135***
	[0.04]	[0.02]	[0.03]	[0.04]	[0.04]
Control Mean	6.409	0.633	0.823	0.899	0.936
Control Number of Observations	1361	1361	1361	1361	1361
Control Standard Deviation	3.9	0.229	0.172	0.13	0.097
Total Number of Observations	2823	2823	2823	2823	2823

Note: These results correspond to figure 12 in the main text. Number of crops is the number of types of crops grown by the household, two instances of the same crop is counted once. The share of the main crop(s) area of total cultivated area includes both mono-cropped and intercropped crops. All regressions are ANCOVAs, contain fixed effect for districts, standard errors are clustered at village level and have dummies identifying households not surveyed at baseline. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Fisheries

Although the sampling strategy targeting farmers eligible for the fisheries component of IAPP, only 8 percent of the households in treatment villages ended up joining fisheries groups. The randomization of our sample ensures that all our treatment households are, on average, identical to all of our controls before the project implementation, which is fundamental to interpret regression coefficients as the impact of the treatment. However, we have no way to be sure that the 8 percent that joined fisheries groups are identical to all controls. To be able to interpret the regression coefficients as the impact of the treatment, we attempt to find which households in the control villages are most similar to the 8 percent at baseline. We use a method propensity score matching (PSM) to identify these households in control villages.

For a PSM, we run a probit regression that includes many characteristics describing a household as independent variables. The dependent variable is the binary variable for which we would like to find a way to predict if a household fulfills or not, in our case this variable is a dummy variable for being a member in a fisheries group or not. The estimated model can thereafter be used to assign a probability of joining a fisheries group to any household in the sample. This probability is the propensity score. The households in treatment villages that actually joined groups have a counterfactual household matched to them by finding the household that has the most similar propensity score. Note that it is not the controls households with the highest probability that are selected as counterfactuals; instead we select the control households with the most similar propensity score. We do this to account for some households among the treatment households predicted as unlikely to join fisheries groups that joined anyway, and some households that were likely to join that did not. This way we will have a selection of control households that are similar at baseline to our 8 percent of treatment households that ended up joining a fisheries group, allowing us to interpret treatment effects as causal.

Appendix Table 9: Fish Outcome Regressions

	Any Fishery Harvest	Any Mature Fish Harvest	Total Harvest Value	Gross Value Yield	Harvest in Kg	Kg Yield	Total Pond Size	Total Fishery Earnings	Fishery Input Spending	Net Value Yield
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Treatment	0.0464	0.0685**	1714.1	-8991.1	11.96	-146.8	0.00395	1782.1*	440.4	-16139.7
	[0.03]	[0.03]	[1338.66]	[19999.75]	[11.13]	[164.93]	[0.01]	[926.35]	[331.39]	[21045.46]
Lag of Dependent Variable	0.027	0.11	0.284***	0.366***	0.295***	0.410***	0.377***	0.406***	0.139***	0.187
	[0.09]	[0.10]	[0.09]	[0.11]	[0.09]	[0.11]	[0.09]	[0.09]	[0.05]	[0.12]
Control Mean	0.821	0.774	10830.1	198481	86.76	1631.4	0.0924	3875.7	1474.7	177022.8
Control Number of Observations	257	257	257	196	257	196	257	257	257	196
Control Standard Deviation	0.384	0.419	16636	200463.7	134.8	1745.3	0.12	10191.1	3178.7	191733
Total Number of Observations	514	514	514	413	514	413	514	514	514	413

	Commercialization (Sales/Production)	Mean Kg Price Of Sold Fish	Kg Yield Owned Pond	Kg Yield On Ponds With Fingerling Input	Kg Yield On Owned Ponds With Only Mature Harvest	Kg Yield On Owned Ponds With Only Mature Harvest And Fingerling Input	Kg Yield Of Ponds Where Fingerling Were Provided By IAPP
	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Treatment	0.0327	7.866	-114.3	-95.99	37.81	-287.5	-299.3
	[0.02]	[12.18]	[222.82]	[210.31]	[246.74]	[250.48]	[350.46]
Lag of Dependent Variable	0.382***	-0.0499**	0.341***	0.341***	0.339***	0.215***	0.335***
	[0.08]	[0.02]	[0.09]	[0.12]	[0.12]	[0.05]	[0.07]
Control Mean	0.157	131.6	2050.5	1734.3	2095.4	2254	1631.4
Control Number of Observations	257	72	135	146	115	86	196
Control Standard Deviation	0.284	71.93	1843.3	1719.9	1847.1	1841.7	1745.3
Total Number of Observations	514	166	270	300	232	167	230

Note: These results correspond to figures 13 and 14 in the main text. All variables in the top table are from all operated ponds. All yield regressions are restricted to households that harvested mature fish and reported harvests at least once in kg (93 households did not harvest any mature fish and 8 reported in units not convertible to kg). Mean price regression is restricted to households that sold any fish. The lower tables are restricted to households that had at least one pond that fits the definition in the title. All regression in the lower half of the table compare the same constructed variable between treatment and control apart from the last one which has regular kg yield for all households in control as IAPP only provide fingerlings in treatment. All regressions are ANCOVA regressions, contain fixed effect for districts and standard errors are clustered at village level. Only households that joined fisheries groups are included in treatment. Controls are selected as being counterfactuals to joining fisheries groups by propensity score matching. All values (except yield variables) are set to zero if the household did not produce. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Table 10: Fish Yield by Cultivation Strategy, in Tons/Ha

Full Sample	Mean	Median	Number Of Observations	
	All Households	All Households	All Households	
Carp Polyculture	1674.5	1062.8	2492	69%
Primarily Tilapia	1658	856.8	50	1%
Primarily Koi	546.3	151.4	54	2%
Primarily Pangash	3251.3	1359.4	45	1%
Other Types Of Cultivation	916.3	469.6	1475	41%

PSM Sample	Mean		Median		Number Of Observations			
	Control	Treatment	Control	Treatment	Control		Treatment	
Carp Polyculture	1864.5	1578.7	1437.6	1112.2	160	82%	163	75%
Primarily Tilapia		1961.9		1812.5	0	0%	7	3%
Primarily Koi	138.3	1130.1	138.3	148.3	2	1%	4	2%
Primarily Pangash	2348	4237.3	3130.7	803.3	3	2%	3	1%
Other Types Of Cultivation	865.5	801.7	474.5	401.6	57	29%	73	34%

Note: This table shows mean yields of four different fisheries techniques promoted by IAPP. The top panel shows the mean for the full sample. The lower panel shows the difference between means in households that joined fisheries groups in treatment compared to the matched households in control. Each of the four cultivation types are defined as ponds where the most numerous fish harvested was the named species.

Nutrition

Appendix Table 11: Nutrition and Food Security for Crop Groups

	Diversified Food Consumption (WDDS) b/se	Consumed Vitamin A Rich Food Groups (WDDS) b/se	Consumed Animal Protein Food Groups (WDDS) b/se	Number Of WDDS Food Groups Consumed b/se	Little Or No Hunger (HHS) b/se	No Month During Last Twelve Months Without Enough Food b/se	No More Than One Month Last Twelve Months Without Enough Food b/se
Regular Treatment	0.000517	-0.00526	-0.0115	0.0681	-0.00063	-0.00224	-0.00639
	[0.01]	[0.02]	[0.02]	[0.09]	[0.00]	[0.01]	[0.01]
Lag of Dependent Variable	0.103*	0.0233	0.0467	0.179***	0.0172	0.0820***	0.0422**
	[0.05]	[0.05]	[0.05]	[0.06]	[0.02]	[0.02]	[0.02]
Control Mean	0.927	0.859	0.877	5.519	0.996	0.944	0.985
Control Number of Observations	1361	1361	1361	1361	1361	1361	1361
Control Standard Deviation	0.261	0.348	0.329	1.422	0.0605	0.23	0.123
Total Number of Observations	2823	2823	2823	2823	2823	2823	2823

Note: These results correspond to figure 15 in the main text. Diversified food consumption, consuming animal protein, and consumed vitamin A food are all categories of the Women's Dietary Diversity Score (WDDS). Diversified food consumption is defined as consuming more than three out of the nine food groups in WDDS the previous day. Consumption of animal protein includes consumption of flesh meat, organ meat, fish, or egg over the previous day. Consumption of vitamin A-rich food groups includes consumption of leafy green vegetables, yellow/orange vegetables, tubers, and other vitamin A-rich fruits over the previous days. Number of WDDS food groups consumed includes the WDDS food groups consumed the previous day. Little or no hunger is a category in the household hunger score (HHS). HHS is based on how frequently there was no food in the household the past 30 days, how frequently any household member went to sleep hungry the past 30 days, and how frequently a household member went a full day without any food the past 30 days. The answers are converted to a scale a that range from 0 to 6 where 0 and 1 is considered little or no hunger, which in practice means that maximum one of the three events mentioned above had happened as often as rarely or sometimes. The last two variables are defined as households that did report having enough food all of the past twelve and households that reported being without enough food during one month at most. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Appendix Table 12: Nutrition and Food Security for Fisheries Groups

	Diversified Food Consumption (WDDS) b/se	Consumed Vitamin A Rich Food Groups (WDDS) b/se	Consumed Animal Protein Food Groups (WDDS) b/se	Number Of WDDS Food Groups Consumed b/se	Little Or No Hunger (HHS) b/se	No Month During Last Twelve Months Without Enough Food b/se	No More Than One Month Last Twelve Months Without Enough Food b/se
Treatment	0.0162	0.0371	0.03	0.152	0.00915	-0.007	-0.00455
	[0.02]	[0.03]	[0.03]	[0.14]	[0.01]	[0.02]	[0.01]
Lag of Dependent Variable	0.114	0.00218	-0.0872**	0.166	0.0476	0.0654	0.027
	[0.10]	[0.09]	[0.04]	[0.11]	[0.05]	[0.04]	[0.04]
Control Mean	0.942	0.868	0.883	5.626	0.992	0.961	0.988
Control Number of Observations	257	257	257	257	257	257	257
Control Standard Deviation	0.235	0.339	0.322	1.477	0.088	0.194	0.108
Total Number of Observations	514	514	514	514	514	514	514

Note: These results correspond to figure 16 in the main text. This table shows nutrition and food security outcomes for households in our sample that joined fisheries groups and matched households in control villages (see fisheries section in appendix for details). Diversified food consumption, consuming animal protein, and consumed vitamin A food are all categories of the Women's Dietary Diversity Score (WDDS). Diversified food consumption is defined as consuming more than three out of the nine food groups in WDDS the previous day. Consumption of animal protein includes consumption of flesh meat, organ meat, fish, or egg over the previous day. Consumption of vitamin A-rich food groups includes consumption of leafy green vegetables, yellow/orange vegetables, tubers, and other vitamin A-rich fruits over the previous days. Number of WDDS food groups consumed includes the WDDS food groups consumed the previous day. Little or no hunger is a category in the household hunger score (HHS). HHS is based on how frequently there was no food in the household the past 30 days, how frequently any household member went to sleep hungry the past 30 days, and how frequently a household member went a full day without any food the past 30 days. The answers are converted to a scale a that range from 0 to 6 where 0 and 1 is considered little or no hunger, which in practice means that maximum one of the three events mentioned above had happened as often as rarely or sometimes. The last two variables are defined as households that did report having enough food all of the past twelve and households that reported being without enough food during one month at most. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.

Prices

We need to assign a monetary value to harvested amounts to compare harvests between households growing different crops. We need to generate a unit price for all crops grown and use that to calculate harvest values. Agricultural earnings are not sufficient as a large part of the harvest is grown for consumption. We generated separate unit prices for the northern districts and for the southern districts to allow for regional differences.

We asked households if they sold any crops and if so, how much and how much they sold that amount for. Using this information we can calculate a unit price for each household. For some crops we do not have many data points to base our regional unit price on. Therefore, we would risk having outliers and typos greatly bias our prices if we calculate the regional price as simple mean across the sample. We most often used the median price of the sample as the median is not as sensitive to outliers as the mean. But in small samples, not even the median is fully reliable. We therefore carefully selected the unit price we ended up using for the analysis using the median price, mean price, standard errors of mean price, mode price, and frequency of the price. Most final prices are the median price. When the sales data are based on very few observations in one region, then the price in the other region is used. If there are few observation in both regions than no unit price is used and the crop is excluded from the analysis. The final price used in the analysis as well as the number of crop instances sold and grown, the median price, the mean price and the mode price in the adoption year survey are listed in appendix table 10 below.

Appendix Table 13: Unit Prices All Crops

Crop	Unit	Region	Number Of Crop Instances With Sales/Production Data: Sale Frequency	Production Frequency	Selected Price Used In Analysis	Descriptive Stats On Data As Reported By Households: Median Price	Mean Price	Mode Price
Boro	Kg	South	867	2945	15.0	15.0	17.0	15.0
		North	4139	10122	17.5	17.5	18.3	17.5
Wheat	Kg	South	88	323	22.5	22.5	24.3	20.0
		North	374	511	20.0	20.0	21.4	20.0
Maize	Kg	South	14	48	15.6	15.6	17.2	15.0
		North	1237	1943	12.5	12.5	13.2	15.0
Jute	Kg	South	6	28	19.5	19.5	20.8	10.0
		North	15	45	15.0	15.0	15.3	10.0
	Bundles	South	8	14	5.0	4.8	6.3	5.0
		North	3	8	5.0	5.0	6.7	5.0
Bamboo	Number	South	147	447	100.0	100.0	115.9	100.0
		North	619	1561	100.0	100.0	115.1	100.0
Lentil (Moshur)	Kg	South	410	1227	53.3	53.3	63.4	50.0
		North	2	22	53.3	65.0	65.0	62.5
Mung	Kg	South	1025	2361	60.0	60.0	62.7	50.0
		North	4	42	60.0	61.3	53.1	20.0
Black Gram (Mashkalai)	Kg	South	8	12	22.5	22.5	23.8	20.0
		North	3	8	20.0	20.0	27.7	13.0
Chickling Vetch (Khesari)	Kg	South	1496	3035	22.5	22.5	29.3	20.0
		North	0	1	22.5			
Chick Pea (Chhola)	Kg	South	41	215	40.0	40.0	41.2	50.0
		North	0	1	40.0			
Sesame	Kg	South	51	216	40.0	40.0	43.1	40.0
		North	9	64	40.0	40.0	72.7	27.5
Mustard	Kg	South	122	539	40.0	40.0	45.5	30.0
		North	381	542	33.3	33.3	36.5	30.0
Groundnut/ peanut	Kg	South	54	166	50.0	50.0	91.0	50.0
		North	112	212	43.8	43.8	44.0	40.0
Soybean	Kg	South	19	23	27.5	27.5	28.1	27.5
		North	5	8	30.0	30.0	30.0	30.0
Chili	Kg	South	219	780	80.0	80.0	1327.0	100.0
		North	133	334	35.0	35.0	44.6	25.0
Onion	Kg	South	9	67	20.0	20.0	20.5	20.0
		North	78	364	25.0	25.0	25.0	25.0
Garlic	Kg	South	2	42	42.5	50.0	50.0	50.0
		North	35	336	42.5	42.5	42.4	60.0
Dhania/ Coriander	Kg	South	36	80	50.8	50.8	67.5	50.0
		North	11	46	33.3	33.3	44.5	20.0
	Bundles	South	11	15	5.0	5.0	6.9	5.0
		North	4	10	5.0	7.5	6.7	10.0
Pumpkin	Number	South	44	101	21.1	21.1	28.8	20.0
		North	3	38	21.1	25.0	26.5	10.0

Crop	Unit	Region	Number Of Crop Instances With Sales/Production Data: Sale Frequency	Production Frequency	Selected Price Used In Analysis	Descriptive Stats On Data As Reported By Households: Median Price	Mean Price	Mode Price
Bringal (Eggplant)	Kg	South	426	1057	20.0	20.0	23.6	20.0
		North	124	350	17.5	17.5	17.6	20.0
Patal/ Pointed Gourd	Kg	South	2	7	32.5	32.5	32.5	30.0
		North	147	175	15.0	15.0	16.0	20.0
Okra	Kg	South	284	575	20.0	20.0	20.8	20.0
		North	15	84	16.7	16.7	16.3	20.0
Ridge Gourd	Kg	South	72	165	20.0	20.0	19.4	20.0
		North	8	45	11.0	11.0	10.7	15.0
Bitter Gourd	Kg	South	288	481	26.3	26.3	35.0	20.0
		North	100	209	20.0	15.0	32.9	20.0
Arum/Latiraj	Kg	South	8	42	20.0	20.0	23.8	20.0
		North	33	54	19.7	19.7	18.8	15.0
	Number	South	7	23	10.0	10.0	16.6	10.0
		North	5	8	10.0	10.0	11.5	10.0
Ash Gourd	Kg	South	9	14	15.0	15.0	15.3	10.0
		North	0	2	15.0			
	Number	South	237	443	20.0	25.0	25.9	20.0
		North	52	272	20.0	20.0	26.1	20.0
Cucumber	Kg	South	74	123	15.1	15.1	18.4	20.0
		North	66	125	10.0	10.0	10.6	5.0
Cow Pea/ Yard Long Bean	Kg	South	101	226	20.0	20.0	28.6	20.0
		North	23	73	15.0	15.0	16.0	10.0
Snake Gourd	Kg	South	46	154	20.0	20.0	23.1	20.0
		North	23	143	15.0	15.0	16.0	20.0
Danta	Kg	South	32	114	15.0	15.0	17.9	10.0
		North	5	25	10.0	10.0	9.0	5.0
	Bundles	South	24	46	10.0	10.0	11.9	10.0
		North	3	16	5.0	5.0	5.6	3.8
Green Banana/ Plantain	Number	South	10	18	95.0	95.0	93.8	100.0
		North	0	1	95.0			
	Bundles	South	32	43	200.0	200.0	175.4	200.0
		North	8	16	200.0	175.0	175.1	200.0
Cauliflower	Kg	South	16	24	17.5	17.5	17.5	20.0
		North	22	32	10.0	10.0	13.3	8.8
	Number	South	79	106	10.0	10.0	13.6	10.0
		North	43	64	8.0	8.0	27.1	5.0
Water Gourd	Number	South	21	41	18.2	18.2	27.2	20.0
		North	44	151	10.0	10.0	14.8	10.0
Sweet Gourd	Kg	South	17	36	20.0	20.0	1207.9	20.0
		North	1	5	20.0	33.3	33.3	33.3
	Number	South	272	650	30.0	30.0	32.5	20.0
		North	92	355	20.0	20.0	22.8	20.0

Appendix Table 13: Unit Prices All Crops – Continued

Crop	Unit	Region	Number Of Crop Instances With Sales/Production Data: Sale Frequency	Production Frequency	Selected Price Used In Analysis	Descriptive Stats On Data As Reported By Households: Median Price	Mean Price	Mode Price
Tomato	Kg	South	383	842	15.0	15.0	43.7	20.0
		North	51	235	15.0	15.0	15.5	10.0
Radish	Kg	South	188	367	10.0	10.0	17.4	10.0
		North	95	305	10.0	10.0	10.1	10.0
	Number	South	17	28	2.5	2.5	3.3	2.5
	Bundles	South	20	29	12.0	12.0	13.5	10.0
		North	0	3	12.0			
Turnip	Kg	South	78	116	10.0	10.0	12.9	10.0
		North	1	2	10.0	20.0	20.0	20.0
	Number	South	16	29	5.5	5.5	8.0	5.0
Green Papaya	Kg	South	17	39	12.5	10.0	13.4	10.0
		North	1	29	12.5	12.5	12.5	12.5
Kakrol	Kg	South	34	46	30.0	30.0	30.9	30.0
		North	19	27	15.0	15.0	16.6	25.0
Bean/ Country Bean	Kg	South	99	247	20.0	20.0	19.9	20.0
		North	59	250	20.0	20.0	21.9	20.0
Coriander Leaf	Kg	South	76	157	61.1	61.1	126.1	100.0
		North	23	86	25.0	25.0	34.1	20.0
	Bundles	South	26	52	5.0	5.0	7.9	5.0
		North	7	43	5.0	10.0	8.9	10.0
Indian Spinach/ Pui Shak	Kg	South	266	674	13.3	13.3	15.3	10.0
		North	95	460	10.0	10.0	11.0	10.0
	Bundles	South	67	146	10.0	10.0	11.6	10.0
		North	53	165	10.0	10.0	9.8	10.0
Palang Shak (Spinach)	Kg	South	65	189	15.0	15.0	19.6	20.0
		North	54	284	11.6	11.6	14.0	10.0
	Bundles	South	59	113	10.0	10.0	8.7	10.0
		North	26	125	6.8	6.8	7.2	10.0
Lal Shak/Red Amaranth	Kg	South	242	599	20.0	20.0	23.3	20.0
		North	151	586	10.0	10.0	14.6	10.0
	Bundles	South	226	402	8.4	8.4	8.3	10.0
		North	82	280	5.0	5.0	7.4	5.0
Kalmi Shak	Kg	South	3	21	10.0	16.0	18.7	10.0
		North	20	100	10.0	10.0	11.4	10.0
	Bundles	South	7	12	5.0	5.0	5.2	5.0
		North	8	32	5.0	6.5	6.6	5.0
Danta Shak	Kg	South	10	41	13.5	13.5	15.0	10.0
		North	7	18	10.0	10.0	10.9	10.0
	Bundles	South	16	22	10.0	10.0	9.3	10.0
		North	3	13	10.0	10.0	8.3	10.0
Lau Shak	Kg	South	1	6	14.3	20.0	20.0	20.0
		North	7	37	14.3	14.3	15.5	10.0
Mula Shak	Kg	South	7	11	12.5	12.5	31.7	15.0
		North	10	37	9.2	9.2	8.8	10.0

Crop	Unit	Region	Number Of Crop Instances With Sales/Production Data: Sale Frequency	Production Frequency	Selected Price Used In Analysis	Descriptive Stats On Data As Reported By Households: Median Price	Mean Price	Mode Price
Cabbage	Kg	South	12	19	11.0	15.2	24.4	10.0
		North	16	23	11.0	11.0	85.8	10.0
	Number	South	104	143	10.0	10.0	10.7	10.0
		North	44	75	10.0	5.3	25.9	5.0
Banana	Number	South	65	130	98.7	54.0	98.7	2.0
		North	15	40	175.0	175.0	151.9	200.0
	Bundles	South	112	207	150.0	150.0	179.5	100.0
		North	51	102	187.5	187.5	171.2	200.0
Mango	Kg	South	9	247	30.0	30.0	34.2	20.0
		North	1	7	30.0	96.0	96.0	96.0
Jackfruit	Number	South	28	159	80.0	80.0	80.3	50.0
		North	1	7	80.0	800.0	800.0	800.0
Papaya	Kg	South	29	85	10.0	10.0	29.0	10.0
		North	13	31	10.0	15.0	14.1	10.0
	Number	South	6	12	78.8	78.8	86.7	12.5
		North	0	2	78.8			
Watermelon	Number	South	47	51	25.0	25.0	46.7	20.0
Bangi/ Phuti/ Musk Melon	Number	South	27	39	20.0	20.0	21.8	30.0
		North	1	2	20.0	80.0	80.0	80.0
Guava	Kg	South	13	104	20.0	20.0	19.1	20.0
		North	1	41	20.0	5.0	5.0	5.0
Lemon	Number	South	33	128	2.0	2.0	2.3	2.0
		North	17	49	2.0	2.0	2.7	2.0
Boroi (Bitter Plum)	Kg	South	6	24	30.0	30.0	35.8	30.0
		North	7	25	20.0	20.0	18.3	20.0
Coconut/ Green Coconut	Number	South	144	430	20.0	20.0	22.0	20.0
		North	21	75	30.0	30.0	27.0	30.0
Potato	Kg	South	110	294	10.0	10.0	11.0	10.0
		North	2143	3424	7.8	7.8	8.6	10.0
Sweet Potato	Kg	South	69	130	12.5	12.5	13.2	10.0
		North	13	23	12.5	13.0	13.4	15.0
Sugarcane	Kg	South	1	1	2.9	12.5	12.5	12.5
		North	7	7	2.9	2.9	3.0	1.9
Tobacco	Kg	North	733	758	75.0	75.0	89.7	75.0
Bettlenut	Kg	South	53	118	183.3	183.3	181.9	200.0
		North	9	13	183.3	294.1	202.9	300.0
	Number	South	576	981	1.0	1.0	1.6	1.0
		North	247	473	2.0	2.0	2.4	2.0
Bettleleaf	Number	South	33	35	0.7	0.7	2.6	0.3
		North	3	10	0.7	0.1	0.3	0.0
	Bundles	South	172	172	37.5	37.5	339.8	30.0
		North	15	32	20.0	20.0	35.3	6.0
Bottle Gourd	Number	South	303	528	25.0	25.0	25.3	20.0
		North	141	445	20.0	20.0	17.5	20.0
Sunflower	Kg	South	33	106	32.0	32.0	42.6	30.0
		North	6	8	26.6	26.6	27.4	32.5

Note: Frequencies are not households but crop instances. A household with two instances of the same crop is counted twice. When there is more than one mode, only then is the maximum mode included in this table. However, all modes were considered in selecting the price for the analysis.

Crop Model

Appendix Table 14: Crop Production Model

	Yield (Kg/Ha)				
	Paddy b/se	Wheat b/se	Lentil b/se	Mung b/se	Mustard b/se
Logged Amount of Paid Labor Day per Hectare	0.0230***	0.153***	0.207***	0.0984***	0.130***
	[0.01]	[0.04]	[0.04]	[0.02]	[0.04]
Logged Amount of Unpaid Labor Days per Hectare	0.00318	0.0605	-0.0623	0.0859**	0.0696
	[0.01]	[0.04]	[0.05]	[0.03]	[0.05]
Logged Amount of Urea Applied per Hectare	0.0447***	0.02	-0.0107	-0.0118	0.0447**
	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]
Logged Amount of TSP Applied per Hectare	0.0153***	0.0394**	0.0271	0.0448***	0.0156
	[0.01]	[0.02]	[0.02]	[0.02]	[0.03]
Logged Amount of MOP Applied per Hectare	0.00591	-0.0182	0.00729	-0.0121	-0.0327
	[0.01]	[0.01]	[0.02]	[0.02]	[0.02]
Logged Amount of Gypsum Applied per Hectare	-0.000452	0.0137			0.0286
	[0.00]	[0.01]			[0.02]
Logged Amount of Zinc Applied per Hectare	0.00706	-0.027			-0.053
	[0.01]	[0.02]			[0.03]
Logged Amount of Borax Applied per Hectare	-0.0025				
	[0.01]				
Logged Amount of Compost Applied per Hectare	0.000427				
	[0.00]				
Logged Amount of Manure Applied per Hectare	-0.0022	-0.00326	0.00489	0.00453	-0.000214
	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]
Logged Amount of Solid Pesticides Applied per Hectare	0.00852	0.0876***	0.0132	-0.00445	0.0248
	[0.01]	[0.02]	[0.06]	[0.04]	[0.04]
Logged Amount of Liquid Pesticides Applied per Hectare	0.01	-0.0386	0.194**	0.208***	0.0946
	[0.01]	[0.05]	[0.09]	[0.05]	[0.06]
Logged Amount of DAP Applied per Hectare	0.0146***	0.0508**	0.014	0.0761**	-0.00138
	[0.01]	[0.02]	[0.03]	[0.03]	[0.04]
Logged Amount of Vitamins Applied per Hectare	-0.000228	-0.0277			-0.0143
	[0.01]	[0.04]			[0.06]
Logged Amount of Potassium Applied per Hectare	0.0104	-0.0193			-0.0113
	[0.01]	[0.02]			[0.03]
Logged Amount of Irrigiation Spending Applied per Hectare	0.0173	0.0417***	-0.000883	0.0375**	0.0238*
	[0.01]	[0.02]	[0.03]	[0.02]	[0.01]
Used Green Manure	-0.0696**	-0.205*	-0.0379	-0.063	-0.215*
	[0.03]	[0.11]	[0.19]	[0.16]	[0.13]
Used Line Planting	0.0334**	-0.0153	0.0325	-0.000647	0.0107
	[0.01]	[0.06]	[0.09]	[0.07]	[0.08]
Used Integrated Pest Management	-0.0383***	-0.031	-0.131*	-0.153**	-0.0191
	[0.01]	[0.07]	[0.07]	[0.07]	[0.07]
Used Vermicomposting	-0.0531**	0.314**	0.119	-0.289	-0.0576
	[0.03]	[0.15]	[0.13]	[0.22]	[0.12]
Used Double Transplanting	0.0309**				
	[0.01]				
Plot Share On Which Fresh Seeds Supplied By IAPP Were Used	-0.0335	-0.282	-0.262	0.0578	0.218
	[0.03]	[0.39]	[0.33]	[0.33]	[0.27]
Plot Share On Which Seeds Supplied By IAPP Were Used	-0.0530*	0.195	0.137	-0.104	-0.241
	[0.03]	[0.38]	[0.15]	[0.26]	[0.20]
Plot Share On Which Any Fresh Seeds Were Used	0.0672**	0.0651	0.115	-0.183**	-0.0843
	[0.03]	[0.06]	[0.10]	[0.08]	[0.07]
R-Squared	0.141	0.33	0.0695	0.151	0.132
Number Of Observations	3784	710	673	1035	638

Note: This production model explains the effect on crop yield by several inputs and technology usage. Inputs that were used by less than 5 percent of the household that grew the crop were removed from the production model of that crop to avoid identifying false effects due to over-specification. Amount variables are converted through price to the most commonly used unit for that input. All variables except technology usage dummies and plot share percentages are logged. Only households that grew the crop are included and only mono-cropped crop instances are used for the yield calculations. *,**,*** signify that the estimate of the treatment effect (compared to control) is greater than zero at a confidence level of 90 percent, 95 percent, or 99 percent respectively.