Integrated Agriculture and Productivity Project

Impact Evaluation Comprehensive Endline 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. 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 report presents the endline results of the impact evaluation (IE) of the Integrated Agriculture and Productivity Project (IAPP), which studies the effect of IAPP's Technology Adoption component. The impact evaluation findings are based on extensive household survey data: baseline data, a follow-up survey collected two years after participants started receiving project activities, and an endline survey conducted in the final year of the project.

This report is one of two final impact evaluation reports. The other report, shared in August 2016, presents the findings from a randomized control trial of crop demonstration strategies. Preliminary IE results were shared in 2015, through an interim report presenting analysis of the midterm data. The interim report focused specifically on Boro (winter). This final IE report presents results on the overall impact of the project on a broader set of outcomes, such as crops, fisheries, livestock, food security, and household income.

The proposed Project Development Objectives (PDO) of IAPP are to, "enhance the productivity of agriculture (crops, livestock and fisheries) in pilot areas, and move farmers out of a traditional, low-input/low-output and high-variability production system."[1] We find that IAPP was largely successful in achieving these primary objectives. The main results are highlighted below.

Crops

For all farmers in IAPP villages, compared to all farmers in control villages:

- IAPP farmers are 19 p.p. more likely to adopt the paddy varieties promoted by IAPP
- IAPP farmers' are 20 p.p. more likely to cultivate mung
- In Aus season, IAPP farmers earn 128% more from crops than farmers in control villages
- Commercialization of harvest increases by 8% in Boro and 1.6% in Aman season

Fisheries

For all farmers in IAPP fishery groups, compared to similar farmers in control villages:

- Fish production is 19 p.p. higher
- Average pond area cultivated is 150% greater
- Fish harvest value increased 170%
- Total earnings from fisheries are nearly 200% higher

Livestock

For all farmers in IAPP livestock (cow) group, compared to similar farmers in control villages:

- Milk productivity of cows more than doubles (147% increase).

[1] World Bank. 2011. *Bangladesh – Integrated Agricultural Productivity Project*. Washington, DC: World Bank Group.

- Milk consumption nearly doubles (96% increase)
- Milk sales increase four-fold, and earnings from milk sales increase five-fold

Nutrition & Income

For all farmers in IAPP villages, compared to all farmers in control villages:

- There is no evidence of significant differences in nutrition
- Total annual income for households in IAPP fisheries groups increases by 37%

Overall, it is clear that IAPP had significant impact across a range of agricultural indicators, i.e., productivity of crops, fisheries, and livestock; and household income as a secondary impact. Adoption of varieties of paddy and a major crop like mung means optimal use of agricultural land which is crucial for the fertility of land. Better productivity of crops and fisheries not only help farmers with better incomes (a poverty concern) but also set them on path of sustainable agricultural practices.

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IAPP Impact Evaluation Background & Design

Country Context

Bangladesh has achieved impressive growth and poverty reduction over the last two decades, but still faces many challenges. With a population of 161 million (in 2015), the country's poverty rate is at 31.5%.[2] According to an analysis by the 2010 Household Income and Expenditure Survey (HIES), approximately 41 percent of the population do not get the nutritional requirement of 2,122 kilo-calories per day.[3] At the country-level, 41 percent of children below age 5 are stunted due to chronic malnutrition.[4]

Agricultural growth has shown encouraging trends, accelerating 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 seasons respectively. [5,6,7]

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, the Ministry of Agriculture developed the Integrated Agricultural Productivity Project (IAPP), which sponsors research to develop improved crop varieties and promote adoption of improved varieties and production practices through a farmer field school approach (FFS). Under the FFS approach, 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 will rigorously evaluate the FFS approach to measure its effectiveness compared to the status quo extension method.

[2] http://data.worldbank.org/country/bangladesh
[3] Bangladesh Bureau of Statistics, Ministry of Planning, 2010, "Bangladesh – Household Income and Expenditure Survey 2010."
[4] National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. 2013. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International.
[5] The boro (winter) season is from roughly December to March. The aus (spring) season is from roughly march to June.
[6] 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.
[7] Sayed Sarwer Hussain. "Bangladesh, Grain and Feed Annual 2012," USDA Foreign Agricultural Service.

Integrated Agricultural Productivity Project (IAPP)

IAPP is designed to improve the income and livelihoods of crop, fish, and livestock farmers in Bangladesh. The project started in 2011 and closes in 2016. It consists of four 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.

The impact evaluation focuses on IAPP's Component 2 (technology adoption) for crops, fisheries, and livestock.[8] IAPP's approach to technology adoption is adapted from the farmer field school (FFS) methodology. IAPP works with farmer groups (of around 20 people) to promote new technologies. For two years farmers receive training in the promoted technologies, and they are provided with all necessary inputs (seed, fertilizer, etc.).

Impact Evaluation Questions

The Impact Evaluation (IE) of IAPP had two primary objectives. First, the overall impacts of the project were tested using a randomized phase-in of project villages, with a focus on crops, fisheries, and livestock interventions. Second, innovations in technology demonstration were tested through a randomized control trial to understand what approach to demonstration plots delivers best results (referred to as the "demonstration plot evaluation").[9] This report focuses on overall project impacts, measured by comparing households in villages that received IAPP in the first year to households in villages that would receive IAPP later. The main evaluation question is: Does participation in an IAPP group lead to increased technology adoption, improved yields, and/or higher income?

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: Yale University and the NGO Innovations for Poverty Action.

[8] This brief provides results on livestock, which were not part of the analysis in the interim (2014-15) report.

[9] 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: adoption of new varieties of existing crops and cultivation of less-common crops.

Evaluation Design

The IAPP evaluation is a randomized phase-in at the village level, carried out in all eight districts but concentrated in two districts, Rangpur and Barisal. The villages were randomly allocated into two treatment arms[10]:

1. **Control (20 villages)**: IAPP activities began in 2016, after the endline survey was completed. Until then, villages receive standard normal services from the government.[11]
2. **IAPP treatment (54 villages):** IAPP project activities started in 2012.

In the first year, IAPP treatment intervention included provision of quality seed, fertilizers, small equipment, machinery and seed storage to farmers. Meanwhile, a facilitator assisted with record or bookkeeping, and closely supervising demonstration on farmers' fields. In subsequent years of intervention evaluation, the project provided smaller packages of quality seeds, support for storage and technical assistance.

This endline report focuses on the final IE analysis, and is supplemented with results from the midterm survey in Appendix B.

Farmer Group

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. Two districts (Rangpur and Barisal) are the focus of IAPP evaluation during endline survey.

IAPP interventions are based at the level of the farmer group. 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.

The baseline survey was conducted concurrently with the IAPP group formation (for Rangpur and Barisal districts, the baseline occurred just before group formation). Of the total IAPP group members, 15 were randomly selected for the baseline survey.[12] The IAPP evaluation sample is representative of farmers who were eligible for participation in IAPP and were part of the initial IAPP group formation.

[10] There was originally a third treatment arm, of 'short-term controls', which were villages that would phase into IAPP after the midline survey. Those villages are dropped from the endline analysis. In the analysis is this report, we sometimes restrict the midterm analysis to endline sample. This means that the treatment arm households are the same as ones being part of endline analysis, and the control arm households from the villages in 2015.

[11] These villages are also called long-term control because the IAPP activities begin towards the end of IAPP project in 2016.

[12] 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.

Data and Sampling

The impact evaluation draws on data from four rounds of household surveys, and administrative data on group membership and demonstration status. The household surveys contain detailed data on household characteristics, agricultural production, livestock, fisheries, household socioeconomic status, and nutrition outcomes.

For the analysis in this report, we use two different constructs of panel datasets, constructed from three rounds of household surveys: first construct is a panel of baseline (2012) and endline (2015), second construct is a panel of baseline (2012) and midline round 2 (2014).[13] The endline survey was conducted in Barisal and Rangpur only, for a sample of 1,393 households.[14]

For the endline survey, the household sample was increased to reflect the project team's request for additional data on fisheries and livestock. The fisheries treatment sample at endline consists of 73 households, from the districts of Rangpur, Barisal, Kurigram, and Lalmonirhat. Out of the 73 households, 45 are sampled in baseline and meet the restrictions of endline analysis, thus making part of the baseline – endline panel. The livestock treatment sample at endline consists of 298 households. These households were not sampled in the baseline round.

Table 1 shows the allocation of the sample across treatment arms.

[13] A midline round 1 survey was done in 2013, however, the scope and sample were more limited, as it focused specifically on the activities of the assigned demonstration farmers.

[14] The sample at midline included 2,855 unique households in all eight districts.

Table 1: Data Sample

Survey Round		Total	Control	IAPP Treatment
		Baseline - Adoption Year		
Baseline	Households	2855	1373	1482
	Villages	185	91	94
Adoption Year (midline round 2)	Households	2855	1373	1482
	Villages	185	91	94
		Baseline - Endline		
Baseline	Households	1050	220	830
	Villages	60	14	46
Endline	Households	1050	220	830
	Villages	60	14	46
		Baseline - Endline (with extra fishery sample)		
Baseline	Households	1095	252	843
	Villages	77	27	50
Endline + Extra Fishery Sample	Households	1095	252	843
	Villages	77	27	50
		Endline (with extra livestock sample)		
Endline + Extra Livestock Sample	Households	1348	220	1128
	Villages	97	14	83

Interpreting Charts

In the charts that follow, we compare outcomes in the IAPP treatment group to those in the control group. While presented as comparisons of means, the graphs are actually based on the results of regressions. The regression specifications are explained in detail for each regression in the appendix, but in general they are ANCOVA regressions, including the treatment dummy 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 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 at least 95 percent statistical 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.

For each chart there is a corresponding regression table in the appendix section. The number referencing of these tables can be found in the 'Notes' section of each chart. Appendix A and B list the tables for endline and midline round 2 survey years, respectively.[15] The discussion of each chart is supplemented by a comparison of means from endline and adoption survey years provided in relevant tables in Appendix A and B.

The IAPP evaluation was conducted on paddy in Rangpur and Barisal, and for the other IAPP promoted crops (wheat, mung, lentil, mustard and sesame) in Barisal only. Any chart analyzing the IAPP evaluation for paddy includes both Barisal and Rangpur; and for other crops only include Barisal.

[15] Note that results from the midline survey were shared in the 2015 brief. They are recalculated here for exactly the same sample as used in the endline analysis.

Impact Evaluation Findings

Adoption of Crops and Varieties Promoted by IAPP

We examine whether participants were more likely to adopt the crops and varieties promoted by IAPP, focusing on paddy, wheat, mung, lentil, mustard, and sesame. Overall, we find that IAPP caused statistically significant increases in the adoption of promoted varieties of paddy, and cultivation of mung.

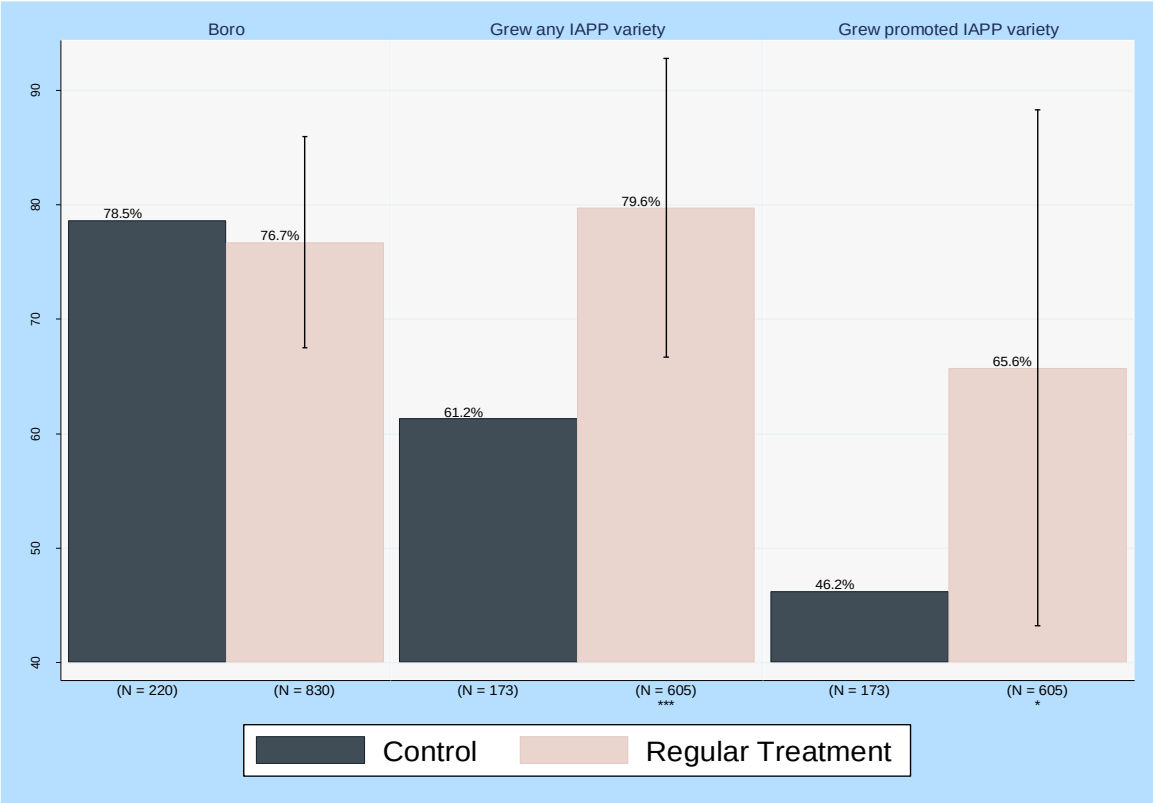
Paddy

In Figure 1 we explore adoption of paddy in across three seasons in endline. The outcome variables are a yes/no indicator for whether farmers adopt any paddy variety promoted by IAPP, and a yes/no indicator for whether farmers adopt the specific variety demonstrated in their village. [16] In all cases, we consider farmers to have adopted a variety if they use any of that variety on any of their plots.[17] First, we explore whether farmers are more likely to grow 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 as this is the primary indicator for the other, less commonly grown, crops. Second, we analyze whether farmers adopt any variety of paddy promoted 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 therefore will contain error, so we interpret the variety-specific results with caution.

Looking at Figure 1 we see that the percentage of farmers growing paddy at all is slightly lower in the IAPP treatment group than in control, approximately 2 p.p. lower.[18] However, **the IAPP treatment group is 19 percentage points (p.p.) more likely to grow one of the specific paddy varieties promoted by IAPP.** The increased rate of adoption was observed at midline; it is positive to note that it persists through to endline.

[16] While farmers were encouraged to demonstrate the exact IAPP variety demonstrated in their village, in practice this variety was sometimes not available or was no longer recommended by IAPP.
[17] Differences in the variety promoted from that demonstrated are detailed in the "IAPP Adoption Distribution Monitoring Report 2014", prepared by DIME.
[18] Please note that there are more households in the IAPP treatment group than in control for paddy growing analysis, i.e., 830 vs. 220, which means about 639 IAPP treatment households grow paddy against 173 control households.

Figure 1: Adoption of Paddy at Endline (Boro, Aus, and Aman)

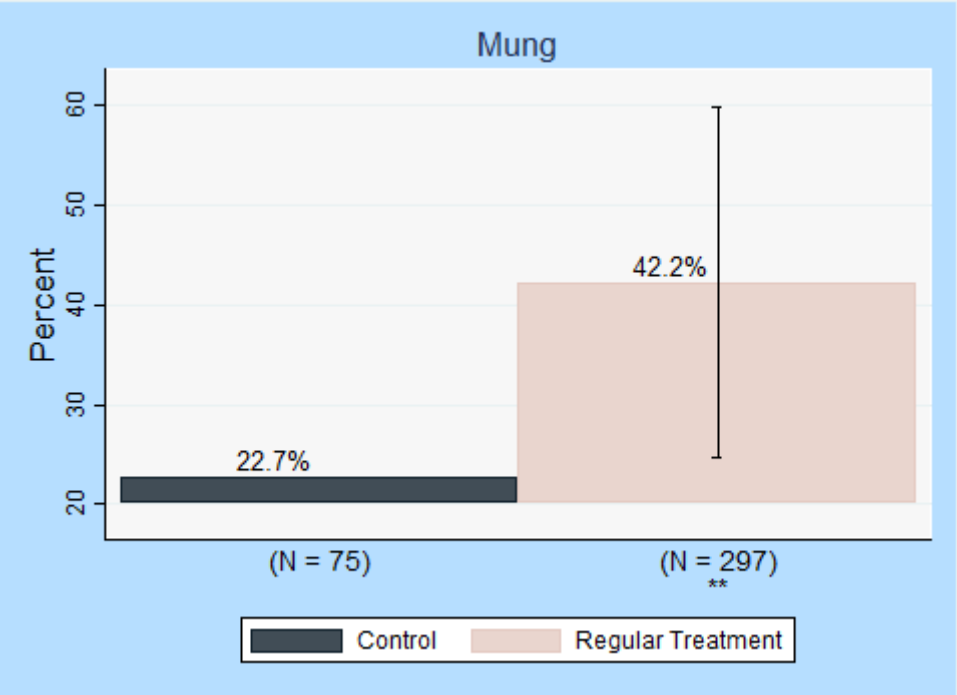


Notes: This figure shows adoption of IAPP varieties of paddy during 3 seasons in 2015-16. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. The leftmost set of columns shows adoption of paddy. The center and rightmost set of columns are restricted to households that actually 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. Only long-term controls are included. This figure corresponds to appendix A - 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.

Mung

In Figure 2 we look at the adoption of mung across three seasons among farmers in the endline, where the **IAPP treatment group shows a higher adoption than the control group, an increase of 20 p.p. with statistical significance.** We had observed a slight, but not significant increase in mung cultivation at midline; gains were cemented by the endline.

Figure 2: Adoption of Mung at Endline (Boro, Aus, and Aman)

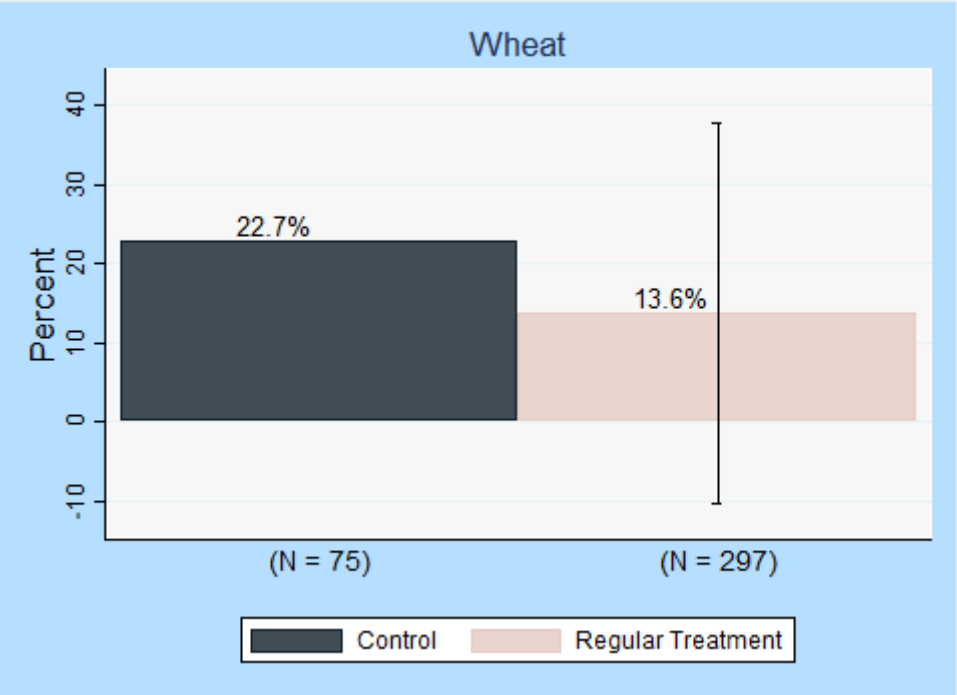


Notes: This figure shows adoption of mung during 3 seasons in 2015-16 season, restricted to Barisal district. Only long-term controls are included. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. This figure corresponds to appendix A - table 5. *,**,*** 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.

Wheat

In Figure 3, we consider wheat adoption for treatment group. **Adoption of wheat decreases by 9 p.p. in IAPP treatment group as opposed to control, however the decrease is not statistically significant**. At midline, we had observed a slight increase in wheat cultivation, but this did not persist.

Figure 3: Adoption of Wheat at Endline (Boro, Aus, and Aman)



Notes: This figure shows adoption of wheat during the Boro 2015-16 season, restricted to Barisal district. Only long-term controls are included. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. This figure corresponds to appendix A - 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.

Mustard

Across three seasons in endline, mustard adoption shows an increase of 6 p.p. in the IAPP treatment compared to control, however the difference is not significant. Results are similar to the trend observed at midline. Adoption statistics are found in Appendix A – Table 5, and Appendix B – Table 1.

Lentil

Lentil growing is more common in all the IAPP treatment villages than the control villages, but the differences are not statistically significant across all seasons at endline. Adoption statistics are found in Appendix A – Table 5.

Agricultural Productivity

As a primary development objective of IAPP is to enhance agricultural productivity for farmers in crop groups, a main focus of the analysis is farm total agricultural yield and earnings. We collected detailed household survey data on agricultural production (self-reported), disaggregated by crop and by plot. The analysis shows that **IAPP treatment group exhibit agricultural yield gains in Boro and Aus season, however the gains are not statistically significant. IAPP did achieve an increase in total crop sale earnings in all seasons, statistically significant during Aus season. Commercialization of crops is significantly higher among treatment households in Boro and Aman seasons as compared to control.**

Agricultural Yield and Earnings – Boro Season

Improving agricultural yields and earnings of IAPP crops are the main focus on IAPP project.[19] Through an increase in individual crops' yields, farmers would be able to see an overall increase in their aggregate farm yields and earnings and have an improvement in their livelihood. We first look whether project activities increased aggregate yields and earnings for IAPP treatment group during Boro season at the time of the endline and adoption year surveys, and then perform similar analysis for Aus and Aman seasons during endline.

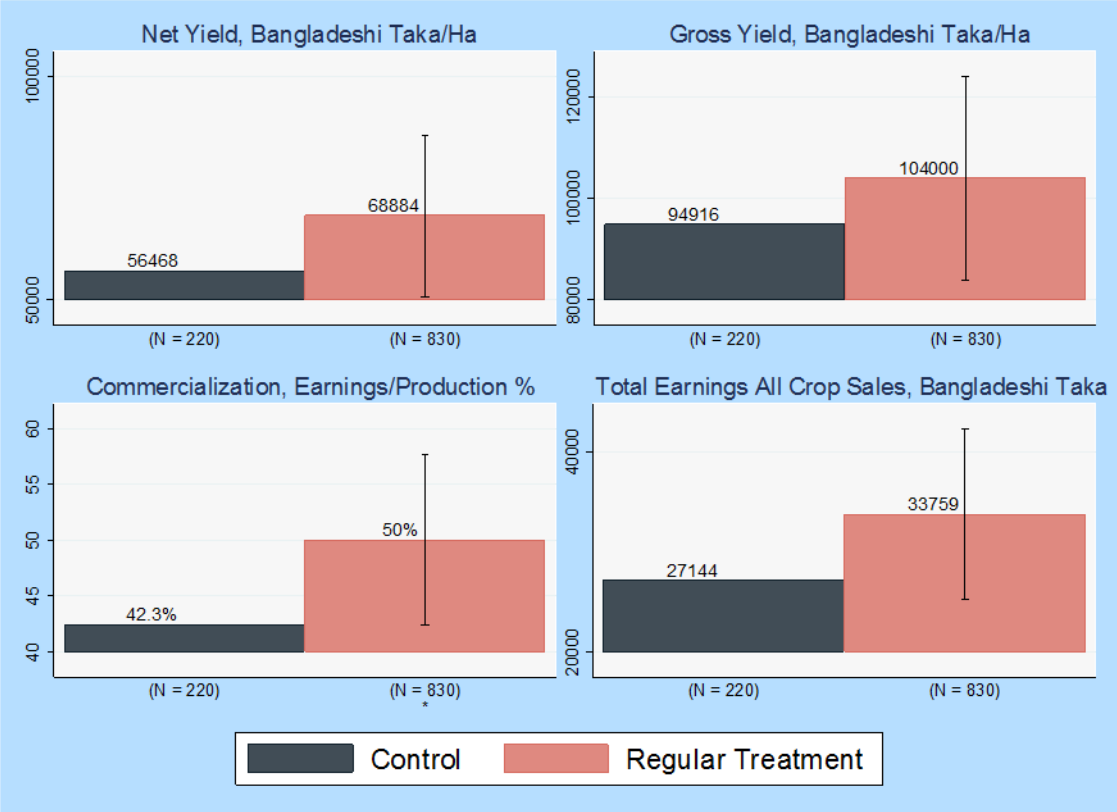
Figure 4 shows the effect of project activities on outcomes: total net and gross yield, earnings from crop sales, and commercialization.[20] We see a positive change in yields and earnings in the treatment arm compared to control, however the estimates are not statistically significant, presumably because of the high levels of variance**. We find a significant increase of 8% in commercialization for the IAPP treatment. This is a notable improvement over the midline, when IAPP households were worse off in terms of each of these indicators compared to the control**.[21] So the endline results show that the **aggregate yield gains are persistent and in fact increasing over time, and earnings have started increasing for the IAPP treatment in Boro season**.

[19] In calculating total crop yields, we restrict to mono-cropped plots. Out of all the crops grown in the endline sample, 53% of the plots in the three seasons are mono-cropped. Appendix A – Table 4 shows the share of mono-cropped plots, by crop, for all seasons. We report share of mono-cropped plots for crops promoted by IAPP, which is higher.

[20] In cases where any of a farmer's crops are not sold, we impute the market value in order to reach at an aggregate value for all crops for all farmers.

[21] Please refer to Appendix B – Table 2. When we restrict the midline analysis to endline sample, yield outcomes in IAPP treatment show an increase but they are smaller in magnitude compared to the endline results as shown in Figure 4, and earning outcomes are still negative. These set of tables, where midline analysis is restricted to endline analysis, are produced on the side for comparison across survey rounds, however they are not provided in the appendix tables.

Figure 4: Farm Total Agricultural Yield and Earning Outcomes, Boro Season - Endline



Notes: This figure shows changes in net and gross yields. Bangladeshi taka is unit of currency; 1 Taka is equal to about .013 USD at the time of writing the report. 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. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A - table 1. All variables are winsorized on the 99% 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 Yield and Earnings – Aus and Aman Seasons

The endline survey also included agricultural indicators for Aus and Aman seasons, in contrast to the midline (which only focused on boro). This section provides results on agricultural yields and earnings during those two seasons in endline. There are 727 households with agricultural yield data during Aus season of endline, among whom 584 are IAPP treatment households and 143 control. During Aman season the number of households with agricultural yield data reduces by a large number, i.e., only 5 IAPP treatment households have agricultural yield numbers. Figure 5 shows that net and gross yields increase in Aus for the IAPP treatment group compared to the control (42% and 4%, respectively). In case of Aman, the data is too sparse to produce reliable estimates.

It is also interesting to not that Aus season are much higher than Boro. We see an increase in net yield in both control and IAPP treatment groups in Aus (3% and 29%, respectively), comparing boro to aus.

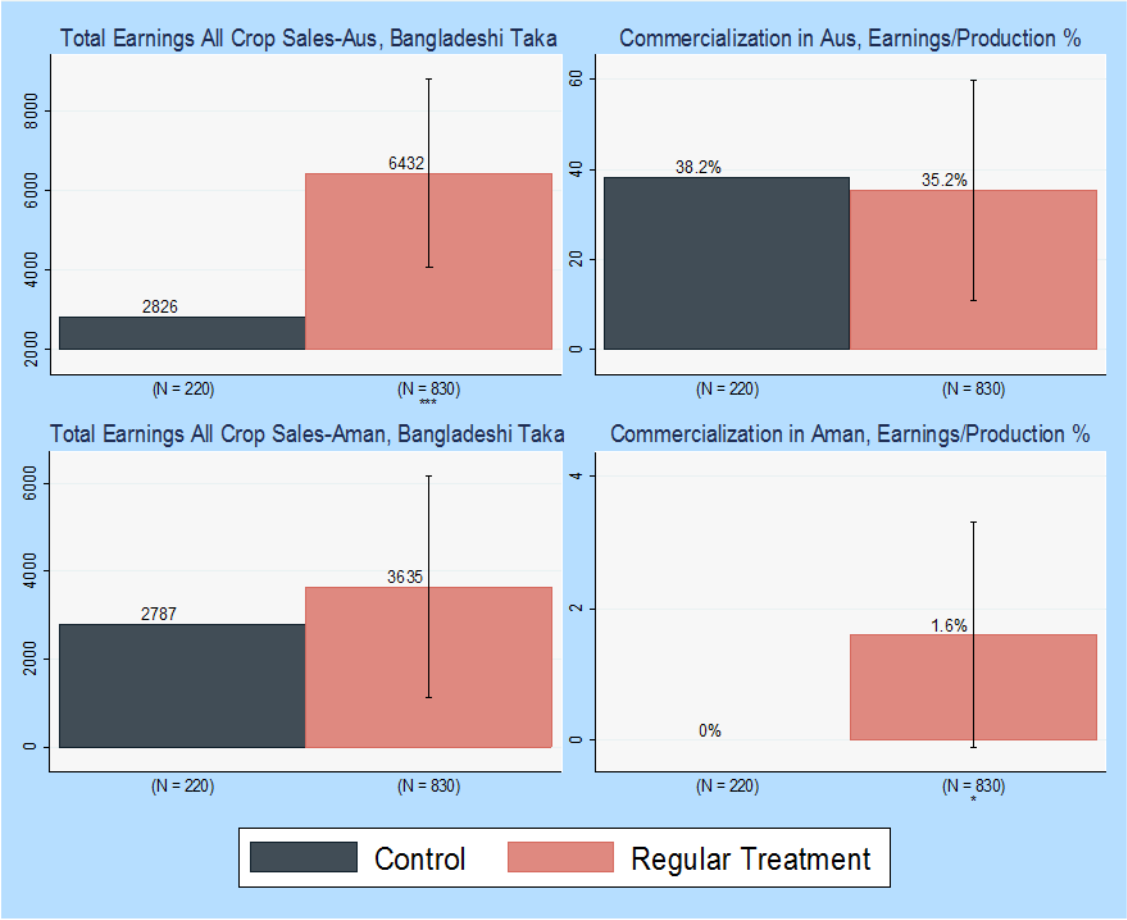
The same is true for gross yield – an increase of 20% and 22% is apparent for control and IAPP treatment groups, respectively.

As we move to Figure 6 which captures the story on total farm earnings and commercialization in Aus and Aman season, **we see a consistent increase in total earnings in the IAPP treatment group as opposed to control in both seasons (128% and 30%, respectively).** The increase of 128% in total earnings for IAPP treatment in Aus is highly significant. In case of commercialization, there is a 3 percentage points (p.p.) decrease in IAPP treatment compared to control in Aus, however, a significant increase of 1.6 p.p. in Aman.

Figure 5: Farm Total Agricultural Yield Outcomes, Aus and Aman Season – Endline

Notes: This figure shows changes in net and gross yields for Aus and Aman seasons. Bangladeshi taka is unit of currency; 1 Taka is equal to about .013 USD at the time of writing the report. 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. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A - table 2 and 3. All variables are winsorized on the 99% 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.

Figure 6: Farm Total Agricultural Earning Outcomes, Aus and Aman Season – Endline



Notes: This figure shows changes in total earnings, and commercialization from all crop sales in Aus and Aman. Bangladeshi taka is unit of currency; 1 Taka is equal to about .013 USD at the time of writing the report. Total earnings (in Bangladeshi taka) is the amount made from selling crops. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A – table 2 and 3. All variables are winsorized on the 99% 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.

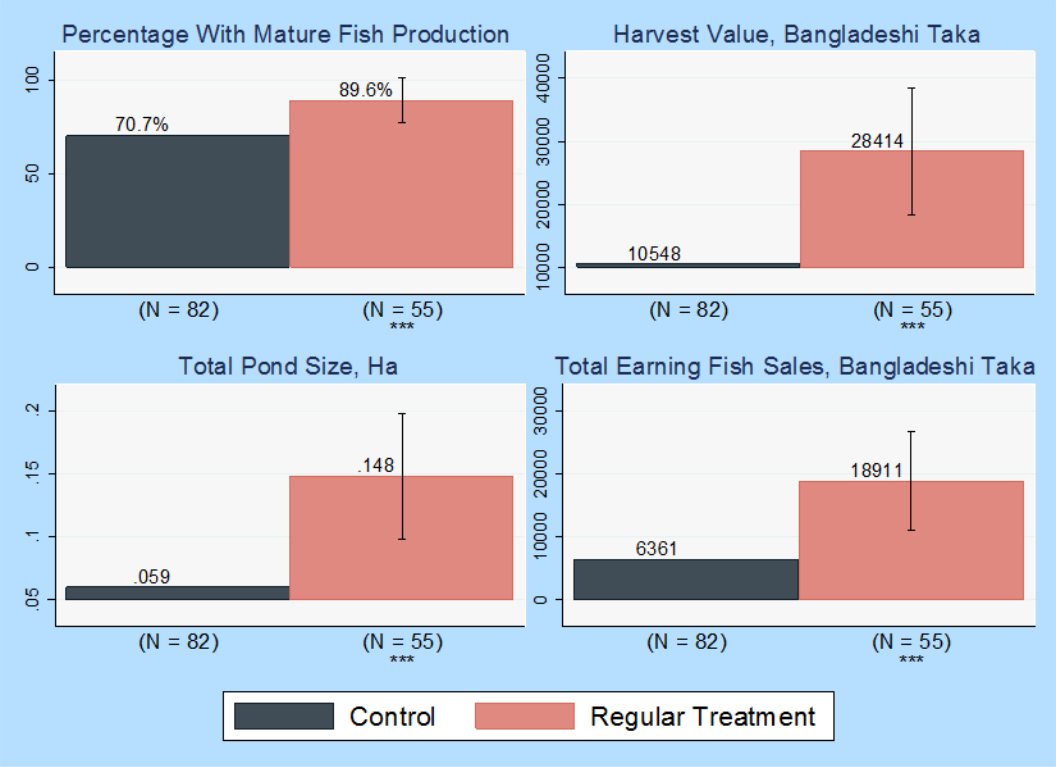
Fisheries

This section presents results on IAPP's fisheries component. Although our midline round 2 and endline surveys 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 in midline round 2 - 257 in treatment and 257 in control; and a total of 318 observations in endline survey – 159 in treatment and 159 in control.

Figure 7 shows the effect of IAPP fisheries group participation on fisheries production and earnings outcomes.[22] The two relevant outcome variables on fish production are (i) the percentage of households with mature fish production, and (ii) total pond size of household. As we can see in the graph**, treatment group has a significantly higher percentage of households with mature fish production than control group, i.e., approximately 19 p.p. more. And the average pond size for treatment group households is 150% greater (statistically significant) than control group. We observe similarly positive and significant results for the treatment group, when looking at fish harvest value and total earnings from fish, around 170% and 197% greater than control group values, respectively.**

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

Figure 7: Fisheries Production and Earnings, Endline Survey Year



Notes: 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 A - table 6. All variables are winsorized on the 99% 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.

In Figure 8 we focus on fisheries yield in endline. **Although we find kilogram yield (Kg/Ha) to decrease by 10% for the treatment group when compared to control, net yield (total harvest value minus input costs per hectare) does increase by 10% in the IAPP treatment as opposed to control. This implies a more efficient use of inputs to fishery ponds for IAPP groups.**

Total mature fish harvest also increase by 60% and 163%, among treatment group households as compared to control, in two other cases (i) when the harvest comes from ponds that are owned by the household, and (ii) harvest coming from own ponds where fingerling was provided by IAPP project, respectively.

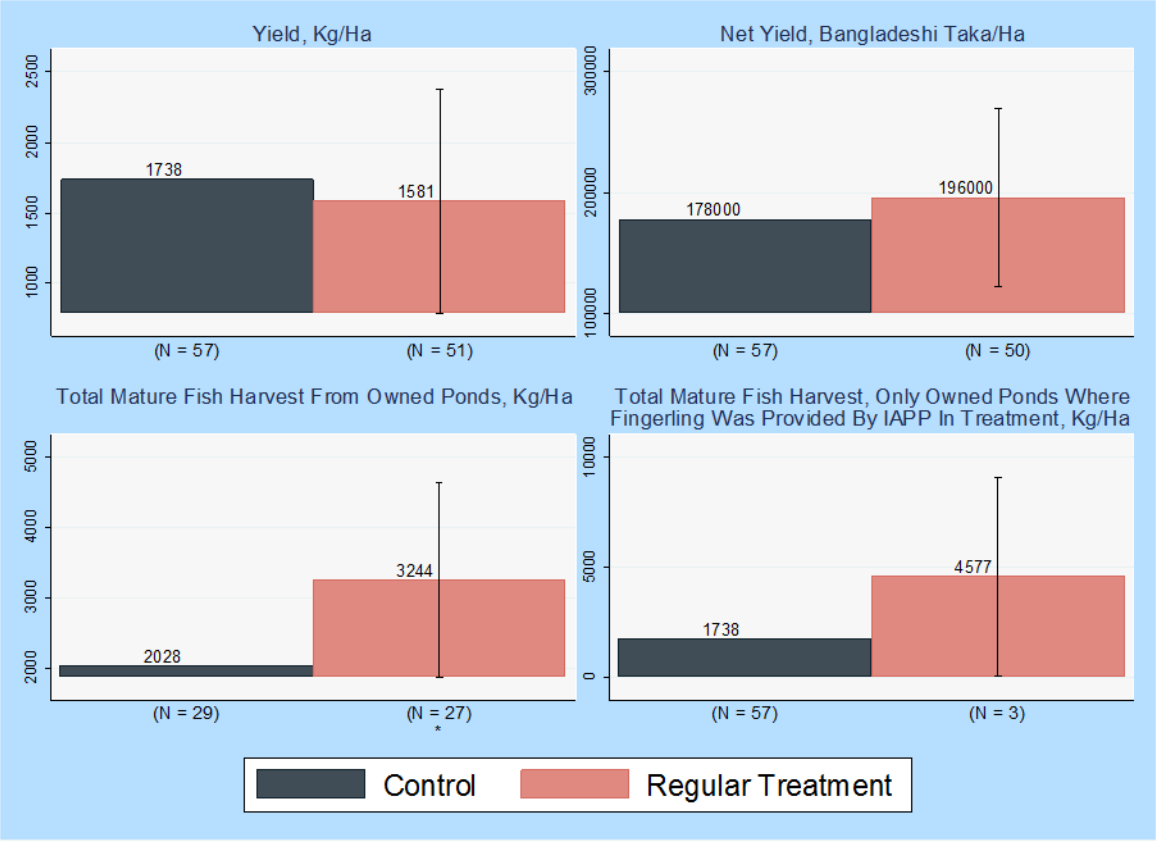
Looking at the overall analysis of fisheries in endline, it is clear that IAPP fisheries activities has helped treatment villages in improving their harvest and earnings.

In midline round 2 analysis of fisheries, outcomes on fisheries production and earnings do show an increase in the treatment group compared to control, however the differences are not significant,

except for the percentage of households with mature fish production where treatment households produce around 6 p.p. more mature fish than control group. When it comes to fisheries yield outcomes, treatment group households exhibit a weaker performance than control, and the overall yield size for treatment households is also smaller than in endline survey.

Even after restricting midline round 2 analysis to endline sample, the overall size of treatment group outcome estimates is smaller than in endline survey, and only significant for percentage households with mature fish production, and total fishery earnings. **Thus we see that fishery outcomes improve over time, from midline round 2 to endline, and farmers receiving IAPP fishery interventions see significant improvements compared to comparable control farmers.**

Figure 8: Fisheries Yield, Endline Survey Year



Notes: 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 A - table 6. All variables are winsorized on the 99% level on the upper tail. All variables are winsorized on the 99% 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.

Livestock

This section presents results on IAPP's livestock component. Like in fisheries, only a small number of sampled households ultimately joined a livestock group, even though many households met the eligibility criteria at baseline. Therefore, comparing eligible households in treatment and control groups yields very low power. To solve this problem, we use groups of households that actually joined livestock groups in our sample, and match them using baseline characteristics to a similar sample in control villages.[23]

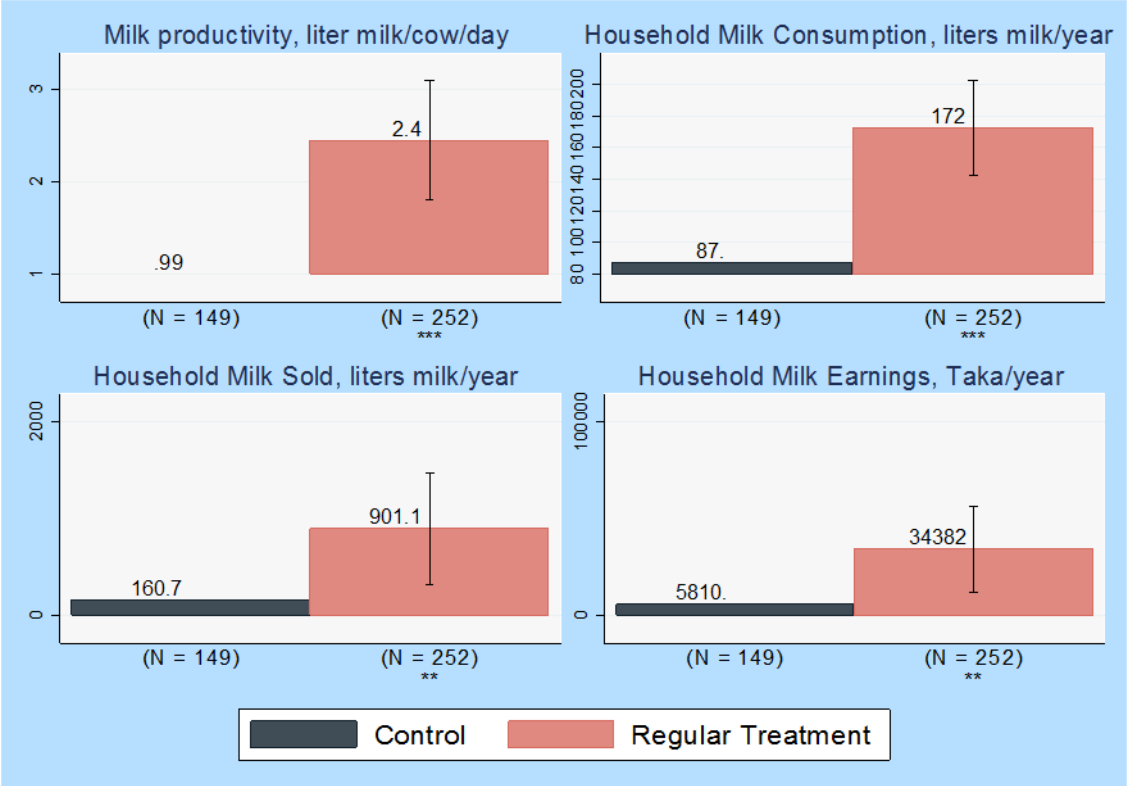
We use a sample of 401 households for our endline livestock (cow) analysis. Everyone in this sample owns at least one milk cow. 86% of control households produced milk from their cows; compared to 60% of control households. Since shifting more potential milk cows into production was an important indicator for the project, we analyze the livestock data unconditionally (e.g. comparing all households with milk cows, whether or not they produced milk). We find that milk productivity of cows in the treatment group households significantly increases, 147% higher in treatment than control. Outcomes on household milk consumption also increase, nearly doubling compared to the control (96% increase). Milk sales and earnings improve greatly: they are 4 to 5-fold higher in treatment than control, respectively. Figure 9 illustrates these significant positive impacts.

In midline round 2, outcomes on livestock productivity, i.e., cow milk and eggs (chicken or duck) productivity, don't show any significant differences between the treatment and control arms.[24] The positive results on cows' productivity by the endline is sign of substantial gains.

[23] In endline, an additional survey of 298 households who are part of livestock group was conducted. This survey mainly focuses on the productivity of cows, in terms of milk. When matching 294 households (4 out of 298 households didn't own a cow) to a similar control sample in endline, we use endline characteristics that are time invariant. After trimming for outliers, we are left with a total of 504 observations in midline round 2 - 252 in treatment and 252 in control; and a total of 508 observations in endline survey – 254 in treatment and 254 in control. The final matched sample that we use for analysis has 411 households, 254 treatment and 157 control households (we don't include long-term controls, which reduced controls from 254 to 157).

[24] Please refer to Appendix B – Table 4.

Figure 9: Livestock Productivity, Endline Survey Year



Notes: This figure shows the productivity of livestock animals. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A - table 7. All outcomes are winsorized on the 99% 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.

Nutrition

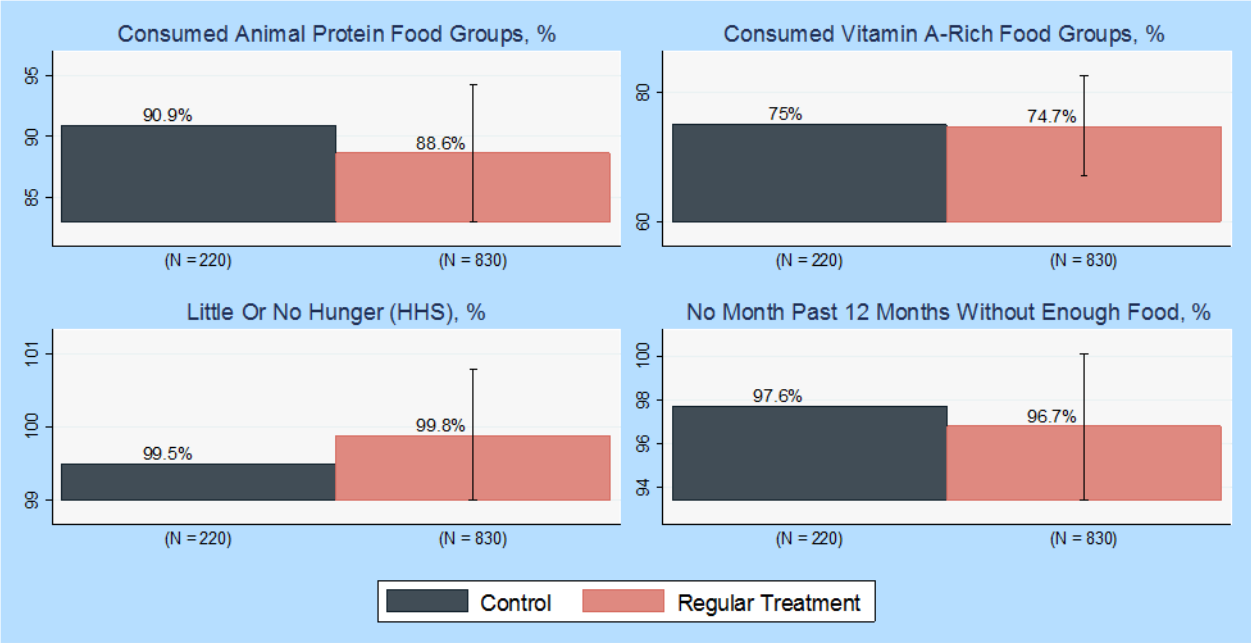
In this section we look into whether being part of a crop or fisheries groups affected nutrition or food security for households.[25] The survey takes three measures of nutrition/food security. The women's dietary diversity module records food consumed by an adult female in the house during the previous day. Based on this, we create dummies for whether the woman consumed foods with vitamin A and foods with animal protein.[26] We also use the household hunger scale (HHS) as a standard measure of hunger. 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.

[25] Other components of IAPP that may affect nutrition, such as livestock promotion, were not included in this analysis because we are missing data on nutrition in endline for livestock group.

[26] Only 115 respondents out of the endline sample of 1,050 households mention their gender as an adult female for "food security" questions, and 16 mention as non-female, thus severely restricting our analysis sample if we restrict to female respondents. We don't restrict women's dietary analysis to female respondents, instead imply that the respondent's dietary answer carry over to female members of the family.

In Figure 10 we look into nutrition outcomes for crop groups in endline survey. Across the main four nutrition and food security outcomes we don't see any significant differences between treatment and control estimates. The same was true at midline. An interesting change from midline round 2 (sample restricted to endline) to endline is the increase in percentage (3 p.p.) of crop-group-households in treatment villages that report not witnessing a month without enough food in the last 12 months, meaning there was enough food to consume in every month.

Figure 10: Nutrition Outcomes for Crop Groups, Endline Survey Year



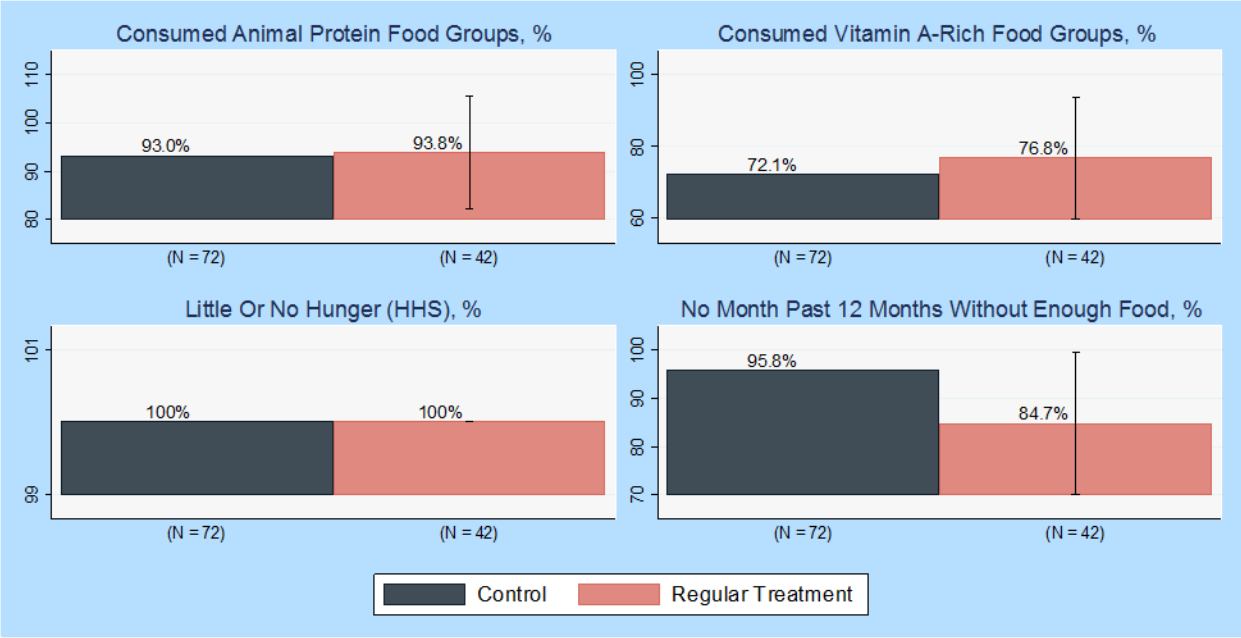
Notes: Districts are Rangpur and Barisal. Only long-term controls are included. This figure shows four nutrition and food security outcomes: consuming animal proteins; consuming vitamin A-rich food; little or no hunger, according to the household hunger score; and households with no month during the 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 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 A - 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.

In Figure 11 we compare nutrition and food security outcomes between treatment and control households among fishery groups in endline. Outcome differences in treatment and control groups are

not significant. Unlike in crop groups, percentage of households in treatment villages who are part of fisheries group and consume animal protein and vitamin A rich foods is higher than percentage of control village households.

We also discover an increase in different food groups' consumption among treatment village households in the midline round 2 analysis, with only the consumption of vitamin A rich foods being significant. When we restrict midline round 2 analysis to endline sample, the estimates on all food groups' consumption in treatment village households become significant.

Figure 11: Nutrition Outcomes for Fisheries Groups, Endline Survey Year



Notes: Districts are Rangpur and Barisal. Only long-term controls are included. This figure shows four nutrition and food security outcomes for households in our sample that joined fisheries groups and matched households in control villages : 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 A - 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.

Household Income

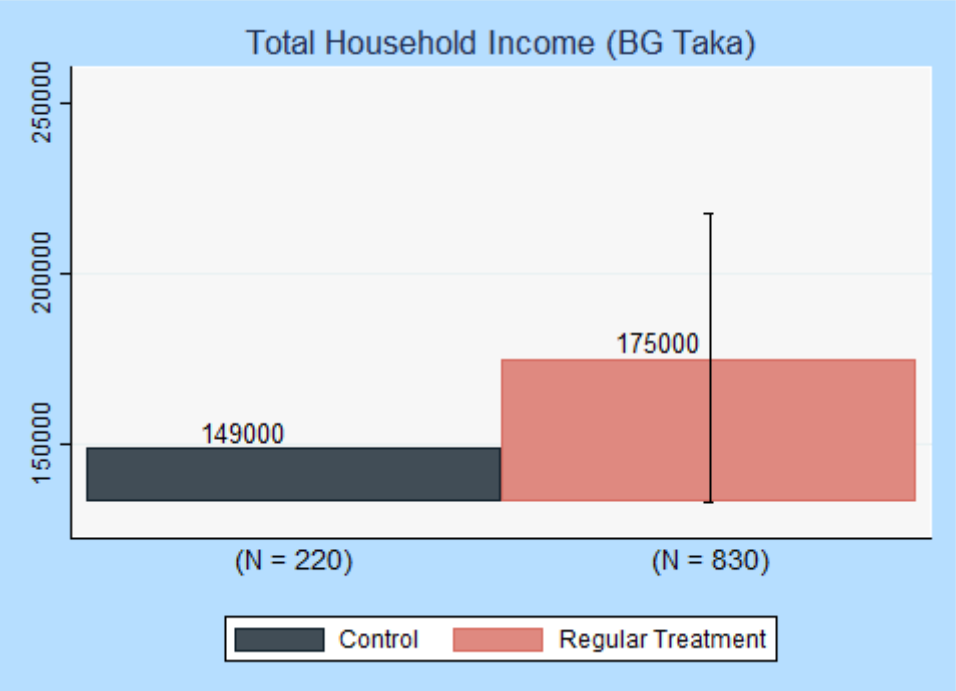
The overall level of households' income is a key indicator of households' well-being. We expect that through IAPP intervention, any positive improvements that take place in households' crops, fisheries and livestock would translate into better household incomes. The household income variables in our

analysis is an aggregate measure of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts.

In Figure 12 we look into household income for crop groups in endline survey. The aggregate level of household income does increase by 17% for treatment group as compared to control, however the difference is not significant.

In midline round 2, we don't see any significant difference between treatment and control group among households in the crop groups. **The average household income in treatment group in endline is 15% higher than average household income in treatment group in midline round 2 survey.** Even when we restrict the midline round 2 to endline sample, we don't see any significant increase in treatment group's income levels compared to control, and the overall income size in treatment group is still much lower than in endline. **Overall, we observe an increase in income levels among crop group households as we move from midline to endline.**

Figure 12: Household Income for Crop Groups, Endline Survey Year



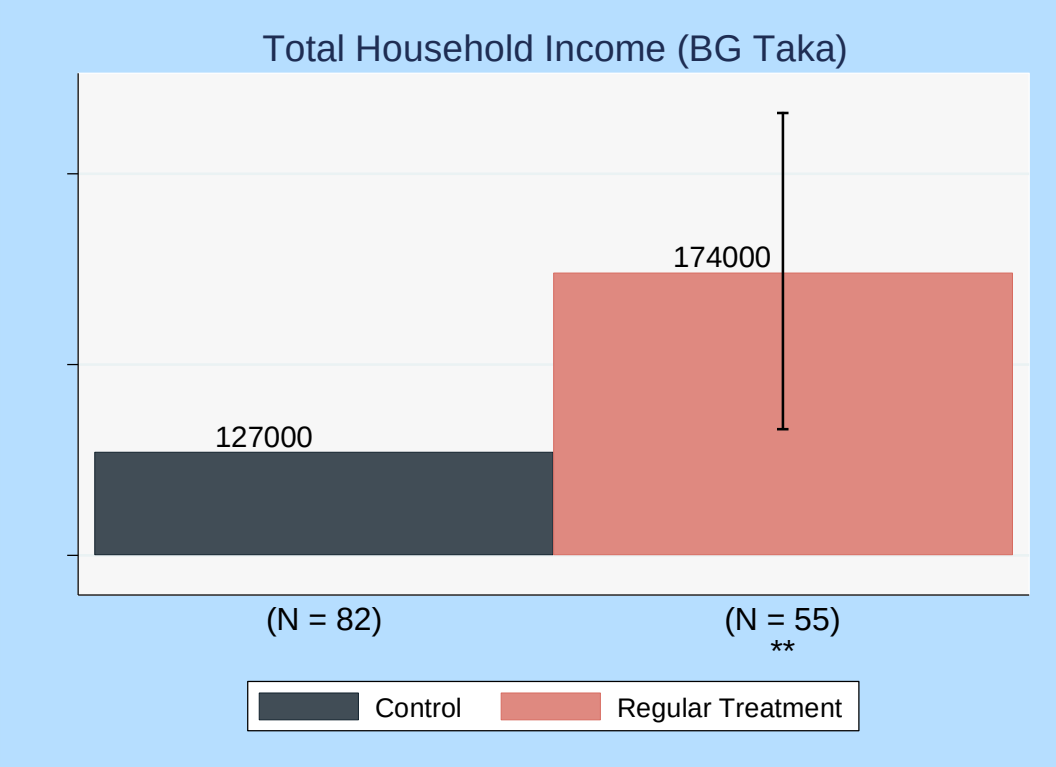
Notes: This figure shows aggregate household income for crops group in 2015-16. Bangladeshi taka is unit of currency; 1 Taka is equal to about .013 USD at the time of writing the report. Household income (in Bangladeshi Taka) is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A - table 10. All variables are winsorized on the 99% 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.

In Figure 13 we measure total household income between treatment and control group for households in fisheries group in endline survey. **There is a significant increase in total income for treatment households compared to control, around 37%.** The average level of total income is almost similar in the treatment group across fisheries and crop groups.

In a similar analysis using midline round 2 survey (with and without endline sample restriction), we observe an increase in household income for treatment group compared to control, however, the difference is only significant when the sample is restricted to endline. Also, household income level drops as we move from midline round 2 to endline.

The two key findings regarding household income in endline are (i) income level increase for crop groups in endline survey compared to midline, and (ii) treatment group's household income is more significant in the endline survey than in midline (with endline restricted sample).

Figure 13: Household Income for Fisheries Groups, Endline Survey Year



Notes: This figure shows aggregate household income for crops group in 2015-16. Bangladeshi taka is unit of currency; 1 Taka is equal to about .013 USD at the time of writing the report. Household income (in Bangladeshi Taka) is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Only villages in the districts of Rangpur and Barisal are included. Only long-term controls are included. This figure corresponds to appendix A - table 11. All variables are winsorized on the 99% 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 A

Specification Details

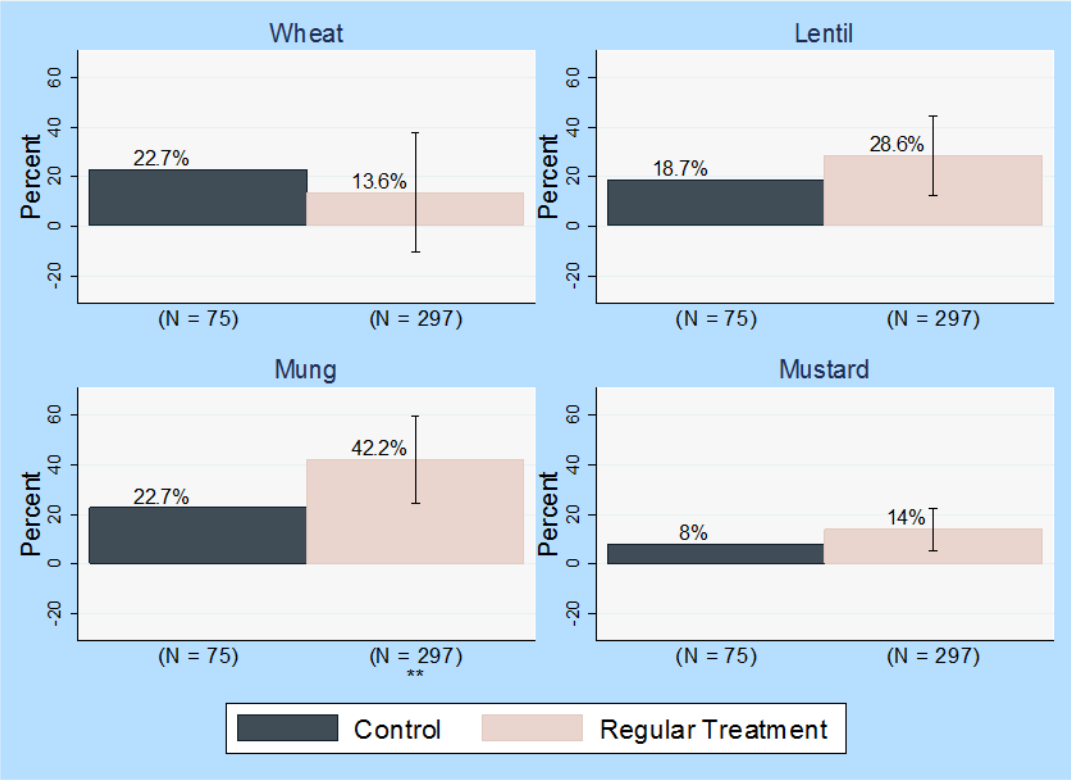
The regression specification used for all results is an ANCOVA specification, described by the following equation:

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

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.

Adoption

Appendix A - Figure 1: Adoption of Other Crops, Aggregate 3 Seasons, Endline Survey Year



Notes: This figure shows adoption of IAPP varieties of wheat, lentil, mung, and mustard during 3 seasons in 2015-16. Households are considered to adopt a specific crop if they grow any of that crop. Villages in Barisal district are included. Only long-term controls are included. Results are for Boro-Aus-Aman seasons combined, 2015-16. This figure corresponds to appendix A- 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.

Farm Total Yield and Earnings

Appendix A - Table 1: Farm Total Yield and Earnings Outcomes, Boro Season, Endline Survey Year

	Net Yield (BG Taka/Ha)	Gross Yield (BG Taka/Ha)	Total Earnings All Crop Sales (BG Taka)	Commercialization (Earnings/Production)
Regular Treatment	12416.4	9092.9	6614.4	0.0766*
	[9227.28]	[10205.03]	[4376.14]	[0.04]
Lag of Dependent Variable	0.204***	0.263***	0.589***	0.212***
	[0.06]	[0.06]	[0.05]	[0.05]
Baseline Mean	73423	86992.3	23386.4	0.405
Baseline Number of Observations	1026	1026	1026	1026
Control Mean	56468.6	94916.7	27144.8	0.424
Control Number of Observations	220	220	220	220
Control Standard Deviation	56492.1	63064.6	34399	0.353
Total Number of Observations	1050	1050	1050	1050

Notes: These results correspond to figure 4 in the main text. All variables are aggregates of all crops on all plots of the household in Boro Season 2015-2016. Districts are Rangpur and Barisal. Only long-term controls are included. 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% 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%, 95%, or 99% respectively.

Appendix A - Table 2: Farm Total Yield and Earnings Outcomes, Aus Season, Endline Survey Year

	Net Yield (BG Taka/Ha)	Gross Yield (BG Taka/Ha)	Total Earnings All Crop Sales (BG Taka)	Commercialization (Earnings/Production)
Regular Treatment	24201.9	5079.5	3606.6***	-0.0304
	[23417.82]	[32297.12]	[1206.02]	[0.12]
Lag of Dependent Variable	0.33	0.236	0.0749***	0.0939
	[0.27]	[0.28]	[0.02]	[0.11]
Baseline Mean	72006.1	84461.5	17551	0.352
Baseline Number of Observations	1026	1026	1026	1026
Control Mean	58255.2	122127	2826	0.383
Control Number of Observations	220	220	220	220
Control Standard Deviation	275572.4	314368.4	6997.4	1.835
Total Number of Observations	1050	1050	1050	1050

Notes: These results correspond to figure 4 and 5 in the main text. All variables are aggregates of all crops on all plots of the household in Aus Season 2015-2016. Districts are Rangpur and Barisal. Only long-term controls are included. 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% 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%, 95%, or 99% respectively.

Appendix A - Table 3: Farm Total Yield and Earnings Outcomes, Aman Season, Endline Survey Year

	Net Yield (BG Taka/Ha)	Gross Yield (BG Taka/Ha)	Total Earnings All Crop Sales (BG Taka)	Commercialization (Earnings/Production)
Regular Treatment	-43.54	115.3	848	0.0158*
	[50.68]	[71.81]	[1283.09]	[0.01]
Lag of Dependent Variable	4.79E-05	-1.9E-07	0.0832	-0.00213
	[0.00]	[0.00]	[0.07]	[0.00]
Baseline Mean	47878.3	52958.3	2227.3	0.301
Baseline Number of Observations	1026	1026	1026	1026
Control Mean	0	0	2787.1	0
Control Number of Observations	220	220	220	220
Control Standard Deviation	0	0	11672.5	0
Total Number of Observations	1050	1050	1050	1050

Notes: These results correspond to figure 4 and 5 in the main text. All variables are aggregates of all crops on all plots of the household in Aman Season 2015-2016. Districts are Rangpur and Barisal. Only long-term controls are included. 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% 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%, 95%, or 99% respectively.

Appendix A - Table 4: Share of mono-cropped plots, by crop, 3 seasons aggregate

Crop	Mean	St. Dev.	Min	Max	N
Paddy	0.998	0.023	0.5	1	778
Wheat	1	0.000	1	1	143
Lentil	0.879	0.316	0	1	113
Mung	0.955	0.204	0	1	141
Mustard	0.873	0.326	0	1	139
Sesame	0.758	0.425656	0	1	31

Appendix A - Table 5: Adoption – Five IAPP Crops (Aggregate Boro, Aus, Aman), Endline Survey Year

	Paddy			Wheat	Lentil	Mung	Mustard
	Grew Crop	Grew Any IAPP Variety	Grew Promoted	Grew Crop	Grew Crop	Grew Crop	Grew Crop
Regular Treatment	-0.0189	0.184***	0.195*	-0.0905	0.0991	0.196**	0.0597
	[0.05]	[0.07]	[0.12]	[0.12]	[0.08]	[0.09]	[0.04]
Lag of Dependent Variable	0.543***	0.185***	0.0205	0.858***	0.421***	0.532***	0.289*
	[0.07]	[0.03]	[0.09]	[0.04]	[0.06]	[0.08]	[0.16]
Control Mean	0.786	0.613	0.462	0.227	0.187	0.227	0.08
Control Number of Observations	220	173	173	75	75	75	75
Control Standard Deviation	0.411	0.489	0.5	0.421	0.392	0.421	0.273
Total Number of Observations	1050	778	778	372	372	372	372

Notes: These results correspond to figure 1, 2, 3 in the main text as well as appendix A - figures 2. Seed variety data was only collected for paddy in baseline. All regressions are ANCOVAs. For 'Grew Any IAPP and Promoted IAPP Variety' regressions, the sample is restricted to households that actually grew the crop. Only long-term controls are included. Villages in districts of Barisal and Rangpur are included for paddy, and only villages of Barisal are included for other crops. Results are the aggregate of 3 seasons in 2015-16. 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.

Appendix A - Table 6: Fish Production, Earnings, and Yield, Endline Survey Year

	Any Mature Fish Harvest b/se	Total Harvest Value b/se	Total Pond Size b/se	Total Fishery Earnings b/se	Kg Yield b/se	Net Value Yield b/se	Kg Yield On Owned Ponds With Only Mature Harvest b/se	Kg Yield Of Ponds Where Fingerling Were Provided By IAPP b/se
Treatment	0.188***	17866.2***	0.0880***	12550.4***	-157.3	18053.1	1216.5*	2839.2
	[0.06]	[5127.18]	[0.03]	[3956.10]	[405.66]	[37793.94]	[703.31]	[2297.29]
Lag of Dependent Variable	0.281	0.888***	0.326*	1.783***	0.083	0.101	0.509	0.203
	[0.20]	[0.17]	[0.19]	[0.24]	[0.21]	[0.18]	[0.42]	[0.25]
Control Mean	0.707	10548.7	0.0603	6361.3	1738.3	178359.6	2028.3	1738.3
Control Number of Observations	82	82	82	82	57	57	29	57
Control Standard Deviation	0.458	23833.5	0.0911	21485.7	1969.7	169785.9	1991.8	1969.7
Total Number of Observations	137	137	137	137	108	107	56	60

Note: This table corresponds to figure 7 and 8 in main text. Instead of only including Rangpur and Barisal, two additional districts of OI sample are also included to increase the fisheries sample size in 2015-16. Treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 2 districts. Only long-term controls are included. First four outcome variables are from all operated ponds. 'Kg Yield' and 'Net Value Yield' column are also from all operated ponds. All yield regressions are restricted to household that harvested mature fish and reported harvest at least once in kg. The last two regression columns are restricted to households that had at least one pond that fits the definition in the title. The last two regressions compare the same constructed variable between treatment and control apart from the last regression which has regular kg yield for all households in control as IAPP only provide fingerling in treatment. All regressions are ANCOVA regressions, contain fixed effect for districts and standard errors are clustered at village level. Only households that joined a fishery group are included in treatment. Controls are selected as being counterfactuals to joining a fishery group 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%, 95%, or 99% respectively.

Livestock

Appendix A - Table 7: Livestock Productivity, Endline Survey Year

	Productivity (litres milk per Cow per Day) b/se	Houshold Milk Consumption (litres/year) b/se	Houshold Milk Sold (litres/year) b/se	Houshold Milk Earnings (Taka/year)	Productivity (eggs per chicken per year) b/se	Productivity (eggs per duck per year) b/se
Treatment	1.461***	84.42***	740.3**	28572.2**	3.154*	19.42**
	[0.33]	[15.14]	[293.79]	[11309.03]	[1.78]	[8.18]
Constant	0.813***	81.86***	44.66	1782.2	40.08***	56.83***
	[0.19]	[9.04]	[109.96]	[4110.40]	[1.49]	[3.92]
Control Mean	0.995	87.91	160.8	5810.5	40.04	57.6
Control Number of Observations	149	149	149	149	137	88
Control Standard Deviation	1.88	105.1	616.4	22204.3	13.1	24.01
Total Number of Observations	401	401	401	401	367	248

Notes: These results correspond to figure 9 in the main text. Variables show the productivity of animals and household milk consumption, sale, and earnings in endline survey year, 2015-2016. This table shows animal produce outcomes for households in our sample that joined livestock groups and matched households in control villages. Districts are Rangpur and Barisal. Only long-term controls are included. All regressions are OLS, contain fixed effect for districts and standard errors are clustered at village level. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.

Appendix A - Table 8: Nutrition and Food Security Outcomes for Crops Group, Endline Survey Year

	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	-0.0229	-0.00223	-0.0226	-0.248	0.00336	-0.00941	0.00512
	[0.03]	[0.04]	[0.03]	[0.18]	[0.00]	[0.02]	[0.02]
Lag of Dependent Variable	0	0	0	0	0	0	0
	[.]	[.]	[.]	[.]	[.]	[.]	[.]
Control Mean	0.895	0.75	0.909	5.205	0.995	0.977	0.982
Control Number of Observations	220	220	220	220	220	220	220
Control Standard Deviation	0.307	0.434	0.288	1.394	0.0674	0.149	0.134
Total Number of Observations	1050	1050	1050	1050	1050	1050	1050

Notes: Districts are Rangpur and Barisal. Only long-term controls are included. Results are for 2015-16. These results correspond to figure 10 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 A - Table 9: Nutrition and Food Security Outcomes for Fisheries Group, Endline Survey Year

	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	0.0225	0.0458	0.00789	-0.0893	0	-0.111	-0.0258
	[0.06]	[0.09]	[0.06]	[0.39]	0	[0.08]	[0.03]
Lag of Dependent Variable	0	0	0	0	0	0	0
	[.]	[.]	[.]	[.]	[.]	[.]	[.]
Control Mean	0.875	0.722	0.931	5.222	1	0.958	0.972
Control Number of Observations	72	72	72	72	72	72	72
Control Standard Deviation	0.333	0.451	0.256	1.436	0	0.201	0.165
Total Number of Observations	114	114	114	114	114	114	114

Notes: Instead of only including Rangpur and Barisal, two additional districts of OI sample are also included to increase the fisheries sample size in 2015-16. Treatment specifically refers to regular treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 2 districts. Results are for Boro season 2015-16 and correspond to figure 11. 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.

Appendix A - Table 10: Household Income for Crops Group, Endline Survey Year

	Aggregate Household Income (BG Taka)
Regular Treatment	26212.8
	[21729.25]
Lag of Dependent Variable	1.602***
	[0.32]
Baseline Mean	28831.9
Baseline Number of Observations	1050
Control Mean	149075.1
Control Number of Observations	220
Control Standard Deviation	226518.5
Total Number of Observations	1050

Notes: These results correspond to figure 12 in the main text. Household income is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Results are for 2015-2016. Districts are Rangpur and Barisal. Only long-term controls are included. All regressions are ANCOVAs, contain fixed effect for districts and standard errors are clustered at village level and have dummy identifying households not surveyed at baseline. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.

Appendix A - Table 11: Household Income for Fisheries Group, Endline Survey Year

	Aggregate Household Income (BG Taka)
Regular Treatment	47610.1**
	[21218.86]
Lag of Dependent Variable	0.917**
	[0.38]
Baseline Mean	36880.2
Baseline Number of Observations	137
Control Mean	126757.9
Control Number of Observations	82
Control Standard Deviation	204903.4
Total Number of Observations	137

Notes: These results correspond to figure 13 in the main text. Household income is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Results are for 2015-2016. Instead of only including Rangpur and Barisal, two additional districts of OI sample are also included to increase the fisheries sample size in Boro season 2015-16. Treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 2 districts. All regressions are ANCOVAs, contain fixed effect for districts and standard errors are clustered at village level and have dummy identifying households not surveyed at baseline. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.

Appendix B

Adoption

This appendix contains similar tables as in appendix A but for the adoption year (midline round 2) sample. The data sample represents 2,855 unique households from all eight evaluation districts in Boro season 2014-15. For further data sample restrictions of each table please refer to the 'Notes' section beneath each chart.

Appendix B - Table 1: Adoption – Five IAPP Crops, Adoption Year

	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	-0.00113	0.109***	0.142***	0.0627***	0.0304	0.0671	0.0319
	[0.02]	[0.03]	[0.04]	[0.02]	[0.05]	[0.05]	[0.03]
Lag of Dependent Variable	0.570***	0.236***	0.317***	0.384	0.370***	0.468***	0.371***
	[0.04]	[0.03]	[0.03]	[0.28]	[0.05]	[0.05]	[0.09]
Control Mean	0.635	0.736	0.491	0.0279	0.202	0.406	0.102
Control Number of Observations	1373	829	829	609	609	609	609
Control Standard Deviation	0.482	0.441	0.5	0.165	0.402	0.491	0.303
Total Number of Observations	2855	1706	1706	1244	1244	1244	1244

Notes: Seed variety data was only collected for paddy in baseline. All regressions are ANCOVAs. For 'Grew Any IAPP and Promoted IAPP Variety' regressions, the sample is restricted to households that actually grew the crop. Villages in all eight districts are included for paddy, and only villages in southern districts are included for other crops. Regular treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. Results are for Boro season, 2014-15. 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.

Appendix B - Table 2: Farm Total Yield and Earning Outcomes, Boro Season, Adoption Year

	Net Yield (BG Taka/Ha)	Gross Yield (BG Taka/Ha)	Total Earnings All Crop Sales (BG Taka)	Commercialization (Earnings/Production)
Regular Treatment	-3452.2	-5081.9	-4306.1***	-0.0287
	[3163.96]	[4163.46]	[1541.98]	[0.02]
Lag of Dependent Variable	0.107***	0.209***	0.487***	0.173***
	[0.03]	[0.04]	[0.04]	[0.06]
Baseline Mean	71699.5	84502.6	25300	0.445
Baseline Number of Observations	2508	2508	2508	2508
Control Mean	62518.5	101240.1	29942	0.471
Control Number of Observations	1373	1373	1373	1373
Control Standard Deviation	66196	76650	39165.1	0.468
Total Number of Observations	2855	2855	2855	2855

Notes: All variables are aggregates of all crops on all plots of the household in Boro Season 2014-2015. All eight evaluation districts are included. Regular treatment specifically refers to regular treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. 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% 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%, 95%, or 99% respectively.

Appendix B - Table 3: Fish Production, Earnings, and Yield, Adoption Year

	Any Mature Fish Harvest b/se	Total Harvest Value b/se	Total Pond Size b/se	Total Fishery Earnings b/se	Kg Yield b/se	Net Value Yield b/se	Kg Yield On Owned Ponds With Only Mature Harvest b/se	Kg Yield Of Ponds Where Fingerling Were Provided By IAPP b/se
Treatment	0.0590*	390.5	0.0101	1375.8	-346.4*	-39802.9*	-366	-706.6***
	[0.04]	[1485.59]	[0.01]	[1040.48]	[183.43]	[23217.08]	[265.19]	[254.36]
Lag of Dependent Variable	0.0628	0.242***	0.502***	0.404***	0.374***	0.0334	0.340**	0.399***
	[0.10]	[0.07]	[0.11]	[0.06]	[0.11]	[0.12]	[0.14]	[0.09]
Control Mean	0.784	11457.6	0.0965	4090.4	1630.6	180131.5	2197.6	1630.6
Control Number of Observations	287	287	287	287	222	222	129	222
Control Standard Deviation	0.412	16904.2	0.124	10297	1841.9	203637.3	2205.6	1841.9
Total Number of Observations	467	467	467	467	378	378	223	248

Notes: All eight districts are included for Boro season 2014-2015. Treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. First four outcome variables are from all operated ponds. 'Kg Yield' and 'Net Value Yield' column are also from all operated ponds. All yield regressions are restricted to household that harvested mature fish and reported harvest at least once in kg. The last two regression columns are restricted to households that had at least one pond that fits the definition in the title. The last two regressions compare the same constructed variable between treatment and control apart from the last regression which has regular kg yield for all households in control as IAPP only provide fingerling in treatment. All regressions are ANCOVA regressions, contain fixed effect for districts and standard errors are clustered at village level. Only households that joined a fishery group are included in treatment. Controls are selected as being counterfactuals to joining a fishery group 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%, 95%, or 99% respectively.

Appendix B - Table 4: Animal Produce, Adoption Year

	Productivity (litre milk per Local Breed Cow per Day) b/se	Productivity (litre milk per Cross Breed Cow per Day) b/se	Productivity (litre milk per Cow per Day) b/se	Productivity (eggs per chicken per year) b/se	Productivity (eggs per duck per year) b/se
Treatment	-0.136	4	-0.102	-1.378	6.276
	[0.13]	[4.67]	[0.14]	[1.79]	[4.54]
Constant	1.410***	2.001	1.473***	43.67***	58.89***
	[0.09]	[1.75]	[0.09]	[1.28]	[2.48]
Control Mean	1.391	6.667	1.51	43.66	60.06
Control Number of Observations	107	3	110	223	141
Control Standard Deviation	0.768	4.163	1.118	15.85	29.81
Total Number of Observations	239	8	246	461	283

Notes: All variables show the productivity of animals in Boro Season 2014-2015. This table shows animal produce outcomes for households in our sample that joined livestock groups and matched households in control villages. Treatment specifically refers to regular treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. All regressions are OLS, contain fixed effect for districts and standard errors are clustered at village level. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.

Appendix B - Table 5: Nutrition and Food Security Outcomes for Crops Group, Adoption Year

	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	0.000221	-0.00508	-0.0126	0.0654	0.000176	-0.00254	-0.00621
	[0.01]	[0.02]	[0.02]	[0.09]	[0.00]	[0.01]	[0.01]
Lag of Dependent Variable	0.116**	0.0291	0.0438	0.184***	0.0168	0.0811***	0.0415**
	[0.05]	[0.05]	[0.05]	[0.06]	[0.01]	[0.02]	[0.02]
Control Mean	0.926	0.857	0.876	5.516	0.996	0.944	0.985
Control Number of Observations	1373	1373	1373	1373	1373	1373	1373
Control Standard Deviation	0.261	0.35	0.329	1.421	0.066	0.23	0.123
Total Number of Observations	2855	2855	2855	2855	2855	2855	2855

Notes: Treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. Results are for Boro season 2014-15. 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 B - Table 6: Nutrition and Food Security Outcome for Fisheries Group, Adoption Year

	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	0.0285	0.0554*	0.0209	0.166	0.0078	-0.0115	-0.00952
	[0.02]	[0.03]	[0.03]	[0.16]	[0.01]	[0.02]	[0.01]
Lag of Dependent Variable	0.135	0.000221	-0.0981**	0.0871	0.0411	0.0561	0.0242
	[0.11]	[0.09]	[0.04]	[0.11]	[0.04]	[0.04]	[0.03]
Control Mean	0.934	0.857	0.892	5.662	0.993	0.965	0.99
Control Number of Observations	287	287	287	287	287	287	287
Control Standard Deviation	0.249	0.351	0.311	1.515	0.0833	0.184	0.102
Total Number of Observations	467	467	467	467	467	467	467

Notes: Treatment specifically refers to regular treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. Results are for Boro season 2014-15. 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.

Aggregate Household Income

Appendix B - Table 7: Household Income for Crops Group, Adoption Year

	Aggregate Household Income (BG Taka)
Regular Treatment	-5991.7
	[9816.24]
Lag of Dependent Variable	0.840***
	[0.12]
Baseline Mean	36118.9
Baseline Number of Observations	2855
Control Mean	158620.4
Control Number of Observations	1373
Control Standard Deviation	192156.9
Total Number of Observations	2855

Notes: Household income is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Results are for Boro Season 2014-2015. Treatment specifically refers to IAPP treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. All regressions are ANCOVAs, contain fixed effect for districts and standard errors are clustered at village level and have dummy identifying households not surveyed at baseline. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.

Appendix B - Table 8: Household Income for Fisheries Group, Adoption Year

	Aggregate Household Income (BG Taka)
Regular Treatment	5426.9
	[21522.34]
Lag of Dependent Variable	0.736***
	[0.24]
Baseline Mean	48462
Baseline Number of Observations	467
Control Mean	186559.6
Control Number of Observations	287
Control Standard Deviation	237067.8
Total Number of Observations	467

Notes: This table shows aggregatre HH income for households in our sample that joined fisheries groups and matched households in control villages. Household income is the aggregate of income from crops, fisheries, animal produce, and other different sources, for instance, non-farm business, agriculture and trees income not reported, renting out land, sale of land, remittances, interests, pensions, casual and salaried labor, and gifts. Results are for Boro Season 2014-2015. Treatment specifically refers to regular treatment group in Rangpur and Barisal, and overall impact (OI) treatments in other 6 districts. Both short- and long-term controls are included. Only households that joined a fishery group are included in treatment. Controls are selected as being counterfactuals to joining a fishery group by propensity score matching. All regressions are ANCOVAs, contain fixed effect for districts and standard errors are clustered at village level and have dummy identifying households not surveyed at baseline. All variables are winsorized on the 99% 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%, 95%, or 99% respectively.