Integrated Agriculture and Productivity Project

Impact Evaluation
Endline Report

DEVELOPMENT IMPACT EVALUATION (DIME)

The World Bank

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Executive Summary

This report presents the endline results of the impact evaluation of the Integrated Agriculture and Productivity Project

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Impact Evaluation Summary

Country Context

Bangladesh has achieved impressive growth and poverty reduction over the last two decades,

Evaluation Questions

The Impact Evaluation (IE) of IAPP contributes to understanding 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 are tested through a randomized control trial to understand what approach to demonstration plots delivers best 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: adoption of new varieties of existing crops and cultivation of less-common crops.

The main evaluation questions are:

1. Does participation in an IAPP crop group lead to increased technology adoption, improved yields, and/or higher income?
2. Does sharing demonstration packages among many farmers (as opposed to a single 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: Yale University and the NGO Innovations for Poverty Action.

Motivation

Bangladesh 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 with farmers 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 will 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 , 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.[9] The theory of change is that by observing and interacting with the demonstration farmer, other group members will learn 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 how 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.[10]

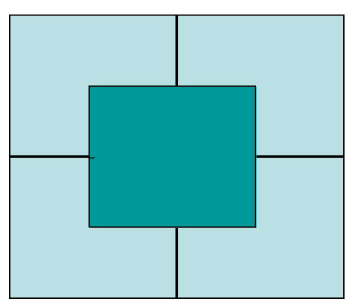
If demonstration plots do not provide a realistic indication of potential yields from new technologies, this is likely to affect technology adoption. Additionally, it might result in a situation where farmers adopt crops ill-suited to their land, resulting in welfare loss. One way to overcome this problem may be to simply have : if farmer group members see more of their neighbors successfully growing a new crop,[11] 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, 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.[12]

At the opposite end of the spectrum from traditional demonstration is . 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'. All group members 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. 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 them. In the second year, all farmers are encouraged to grow the crop. They are offered free seeds, but no inputs or special training.
2. : 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.



3. All members of the farmer field group are offered the opportunity to grow the promoted variety in the first year. Each demonstration 'package' is shared by all farmers who wish to participate. In the first year, farmers are encouraged to grow the new crop on a small parcel to test it out. Farmers who agree to do so receive an additional guarantee: 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).

only long-term controls, as the short-term controls began IAPP activities shortly after the midline was completed.

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 outcomesties shh 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 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

Impact Evaluation Findings

Agricultural productivity

As the primary development objective of IAPP is to enhance agricultural productivity, the first focus of the analysis is on crop yields. We collected detailed household survey data on agricultural production (self-reported)

Yields for other IAPP crops

Appendix A Table 1 includes yields for five other crops promoted by IAPP: wheat, mung, lentil, mustard, and sesame.

lentil yields were more than two-thirds higher than farmers in the control villages, and mung yields were 28% higher The 'shared demo' treatment increased yields for mung as well, and also for wheat: wheat yields were one-quarter higher than in control villages.

Notes: This figure shows the difference in paddy yields between control and the three treatment groups, for the Boro season 2015-16 (the endline survey year). Included in the regressions are all villages in treatment groups where paddy was

Adoption of Crops and Varieties Promoted by IAPP

We next 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 and mustard.

Paddy

In Figure 2 we focus on regular treatment groups, and explore adoption of IAPP-promoted varieties over time. 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. [17] In all cases, we consider farmers to have adopted a variety if they use any of that variety on any of their plots.[18] At baseline, 68% of farmers in control villages cultivated IAPP-promoted varieties

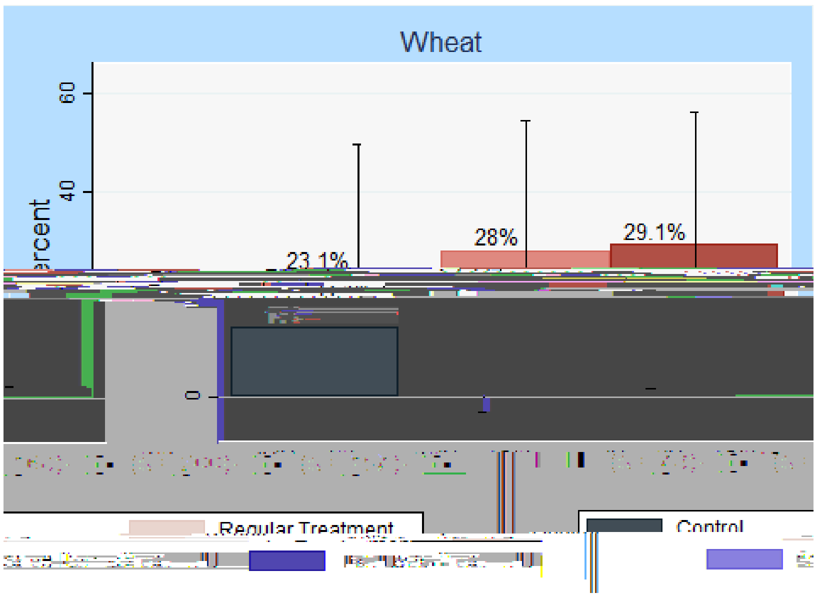
Notes: This figure shows adoption of IAPP-promoted varieties of paddy at baseline, during the adoption year (midline), and during the endline survey year. Results are for Boro season in each period. Households are considered to adopt an IAPP variety if they cultivate any IAPP variety. We include all farmers that grew any paddy, who are either in paddy demonstration villages or in shadow paddy demonstration villages. 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 A - table 2. *,**,*** 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 3, we BT.6TBT4siero at agBT41 0 0 1D0i0i0i0i0i0D0i0i/ redo0 1etio, 95 period57o at agBT489Gat ag

Wheat

In Figure 4, we consider wheat adoption across all three treatment groups.

. Overall, we observe that adoption of wheat has been increasing for all groups, including the control, in every survey round since the baseline. Gains for the treatment group tend to be higher, but improvements in the control do not allow attribution of wheat adoption to IAPP.

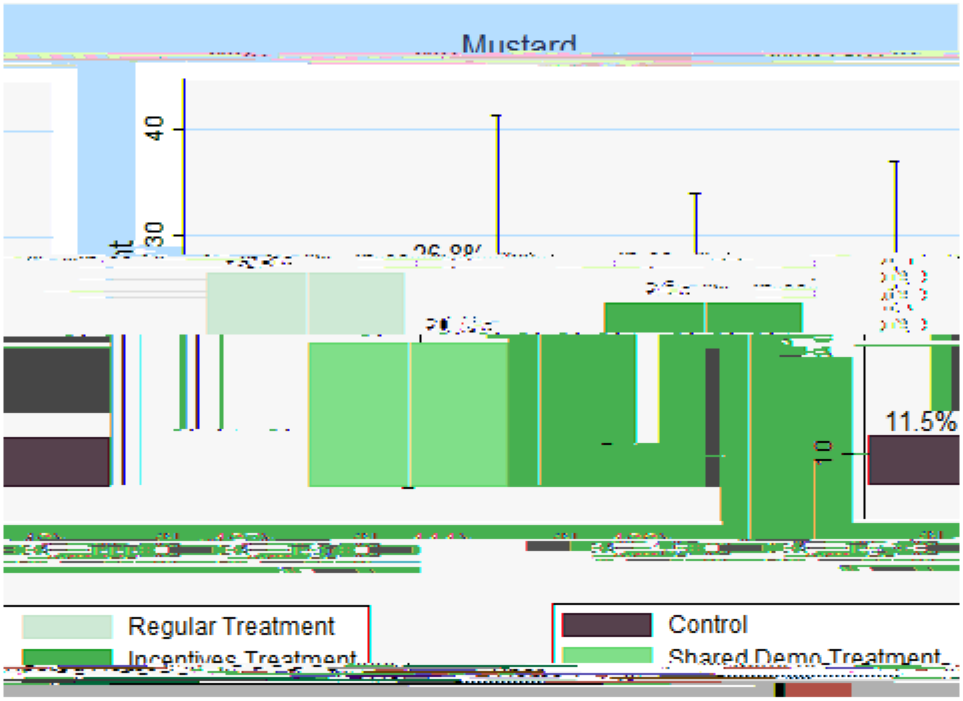


Notes: This figure shows adoption of wheat during the Boro 2015-16 season, restricted to Barisal district. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. The regression is restricted to treatment villages where wheat was demonstrated, as well as control villages where district officials stated wheat would be demonstrated once they begin IAPP. 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.

Mustard

Figure 5 shows adoption for mustard.

The shared plot treatment villages also see large gains, but the sample is small and differences are not statistically significant.

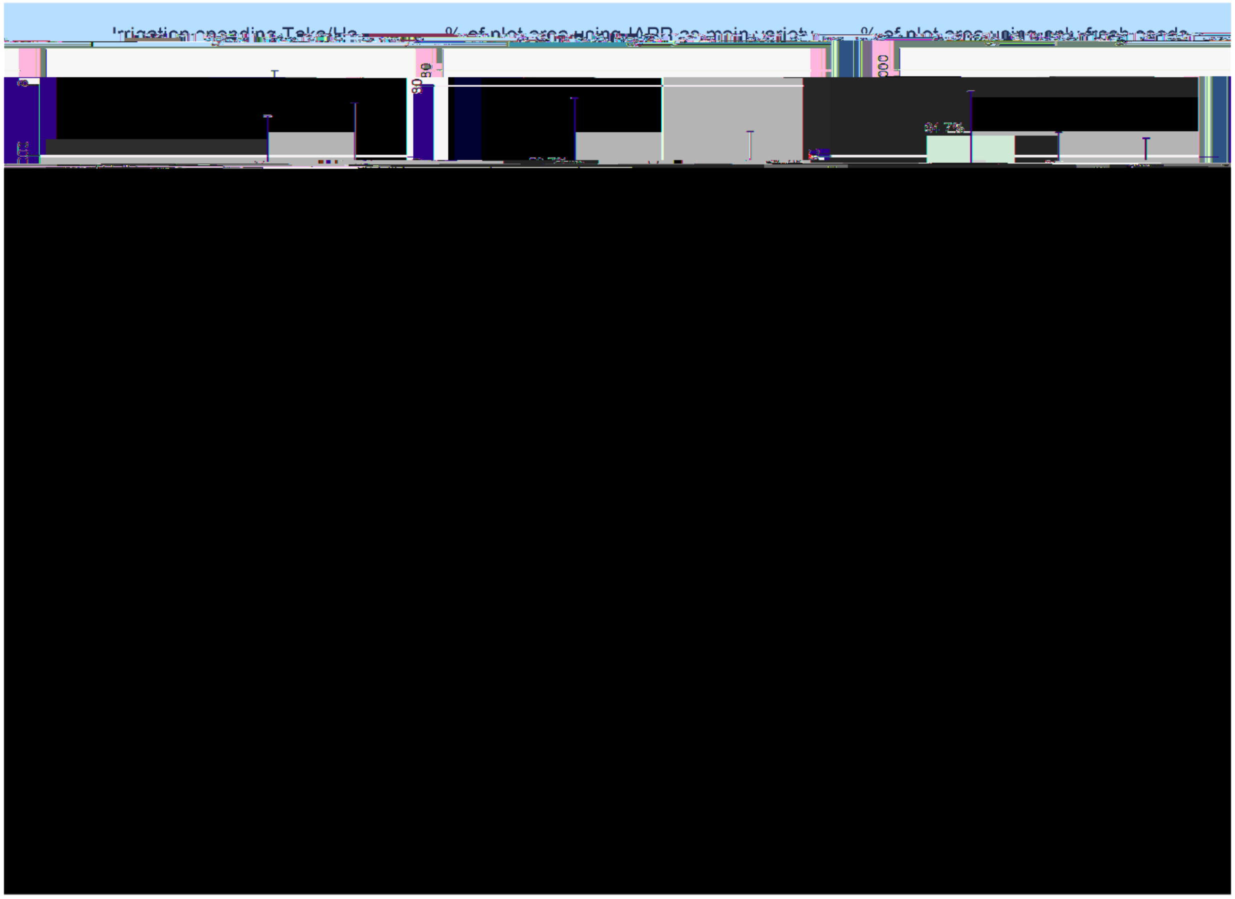


Notes: This figure shows adoption of mustard during the Boro 2015-16 season, restricted to Barisal district. Households are considered to adopt a specific crop/variety if they grow any of that crop/variety. The regression is restricted to treatment villages where wheat was demonstrated, as well as control villages where district officials stated wheat would be demonstrated once they begin IAPP. 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.

Lentil

As with wheat, we see that cultivation of lentils is more common in all the treatment villages than the control villages, but the differences are not statistically significant. Adoption statistics are found in Appendix A Table 3.

Notes:



Notes: This figure details technology use for plots mono-cropped with paddy during the Boro 2015-16 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 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.

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,[20] and the value of harvest is calculated for each household by summing 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.

Figure 8 shows the difference between control and treatment groups for the total harvest value, net yield (in Bangladeshi taka/ha)[21], total earnings from crop sales (in Bangladeshi taka), and commercialization (earnings as a % of total production).

Commercialization increases by 8 p.p. for farmers in the regular treatment, a 20% gain over the control.

Appendix A Table 5 includes the details for these and related outcomes. We see that farmers in the regular treatment groups are earning more from the specific crops promoted by IAPP. The difference is statistically significant and economically meaningful: value of production of these crops is nearly 30% higher compared to the control.

In addition to the gains relative to the control group, we also note that these indicators are improving for the regular treatment group over time. Total value of IAPP harvest, total values of all crop earnings, and commercialization increasing all are higher in the endline compared to the adoption year.

[20] Districts in the north and south of the project area have separate prices.
[21] Net yields in this calculation do not include shadow cost of household labor.

Notes: This figure shows changes in yields, harvest value, and total earnings. 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. Net yield (in Bangladeshi taka/ha) is the total harvest value minus input costs (including labor) per hectare. 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. Total earnings (in Bangladeshi taka) is the amou

Notes: This table presents three measures of diversification in Boro season 2015-2016. The first set of columns shows the percentage of all cultivated land within a household dedicated to the mono crop with the highest percentage of cultivated land. If a household cultivates only one crop, this measure is 100 percent. 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 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.

Next, we analyze changes in crop composition by considering the share of a farmer's field dedicated to each crop. To find the effect of IAPP on crop mix, we look at the differences in the

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The analysis implies that farmers in endline are shifting to mustard, compared to other IAPP crops. When looking at the median prices, mustard is priced around 18 -20 BG Taka/kg higher than wheat, and farmers spend more paid and unpaid labor days on wheat than mustard in adoption year, so the shift towards mustard contributes to the increase in profitability observed in the previous section.[22]

Table 3 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. The table shows that in general paddy provides the most value per hectare, both gross and net.

Notes: This table presents the median harvest value for the main IAPP crops in Boro season 2015-16, for the full sample (all treatment groups and control). The harvest value is calculated by multiplying the yield in Kg/Ha by crop price. Prices are calculated based on median reported sales prices in our survey data when the sample is large enough, while prices from other regions are used if small sample sizes. Prices are reported in Bangladeshi Taka (1 Taka = .013 USD at

Appendix A

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.

Two districts (Rangpur and Barisal) are included in the demonstration plots evaluation. 110 villages were sampled in each district. 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.[23] The sample is representative of farmers who were eligible for participation in IAPP and were part of the initial IAPP group formation.

Specification Details

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

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.

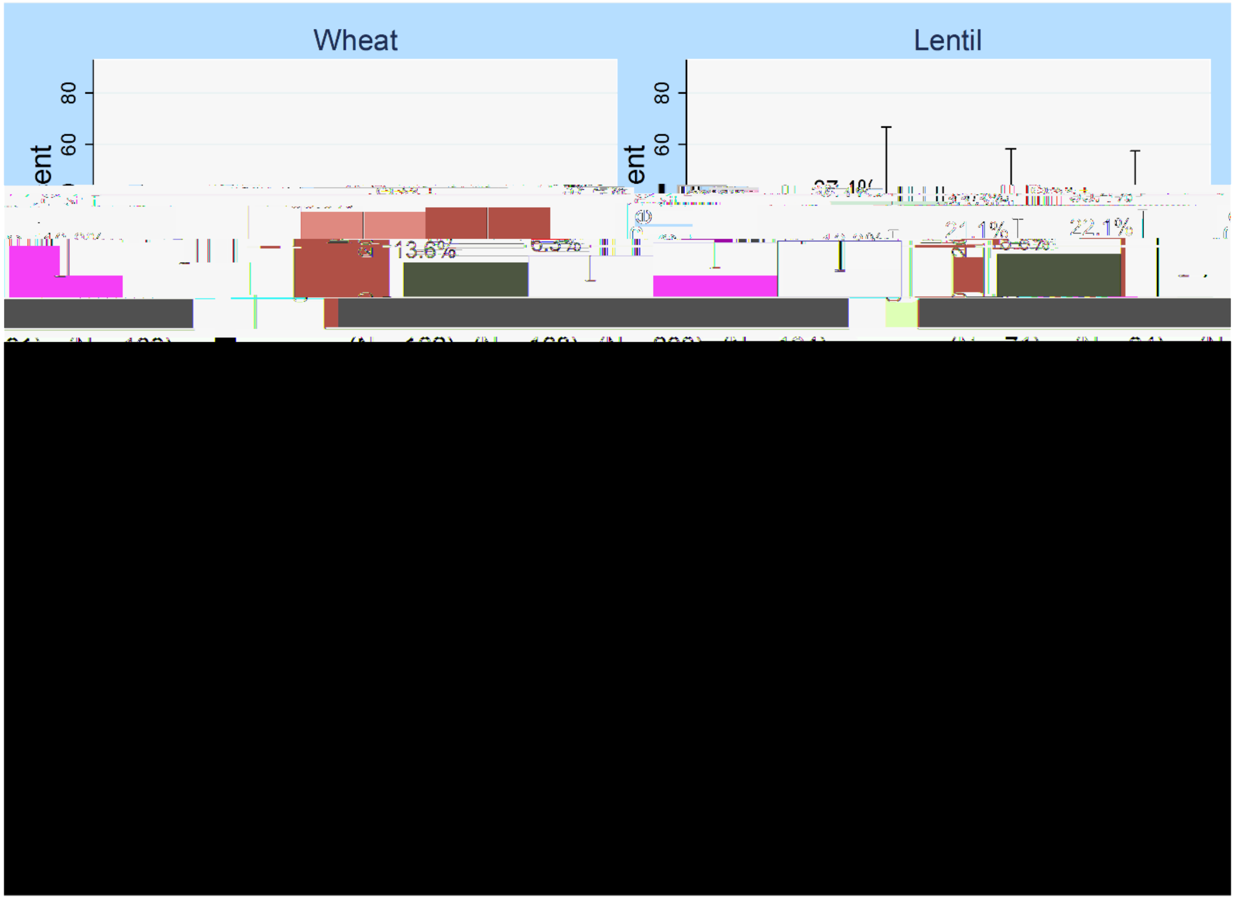
[23] A miscommunication led to sampling the wrong farmer group (a group that had previously existed, not the new group formed by I

KG Yields

Notes: This figure corresponds to appendix table 1 and shows the difference in crop-specific yields between control and the regular treatment group, for the Boro season 2015-16 (endline survey year). All specifications are ANCOVA. Included in the regressions are all villages in regular treatment 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. Villages in Barisal district are included. Only Lentil yield for regular treatment group is significantly different than the control group.

Adoption

Notes: These results correspond to figures 2 and 4 in the main text. The baseline regression is an OLS regression and the other regressions are ANCOVAs. Only households in villages where paddy or mung 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. 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. Results are for Boro season, 2015-16. Villages in districts of Rangpur and Barisal are included for paddy, and only



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. Villages in Barisal district are included. Results are for Boro season, 2015-16. 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.

*Notes:*These results correspond to figure 3 and figure 5 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 (tr

Use of Improved Inputs and Technologies

Note: These results correspond to figure 7 and figure 8 in the main text. All regressions are only on crop instances where paddy was grown. Variables are kg 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 include Barisal and Rangpur districts during Boro season 2015-16. All continuous variables are winsorized on the

Agricultural Outcomes

Notes: These results correspond to figure 8 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. 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

KG Yields

This appendix contains similar tables as in appendix A but for the adoption year (midline round 2) sample. The data sample represents 1,732 households from Barisal and Rangpur districts in Boro season 2014-15. For further data sample restrictions of each table please refer to the 'Notes' section beneath each chart.

Notes: 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. In some cases the lag of the dependent variable is not available due to some farmers not cultivating crops at baseline, or missing cultivation data. In these cases the lag variable is set to zero. The regression also includes dummies that take the value of 1 if the household did not cultivate crops at baseline. Villages in the district of Barisal and Rangpur districts are included for paddy, and only villages of Barisal are included for other crops. Results are for Boro season of 2014-15, adoption year. 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

Midline results included in Appendix A – Table2

Input Usage

Note: Variables are kg 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 include Barisal and Rangpur districts during Boro season 2014-15, adoption year. 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. Fresh Seed varities are those that are acquired from an NGO, IAPP or government project, and not acquired from "bazar retailer", "a seed multiplication village", "recycled seed from another farmer", and recycled seed from own farm." Inputs and Technology Definitions: TSP - Triple SuperPhosphate (a great phosphorous fertilizer); MOP - Muriate of Potash or Potassium Chloride ; FYM - Farmyard manure ; NPKS - Mixed fertilizer of Nitrogen, Potassium and Phosphorous; DAP - Diammonium Phosphate, widely used phosphorous fertilizer ; Green Manure - a fertilizer consisting of growing plants that are plowed back into the soil ; Line Planting - a technique in which weeds around a crop are taken out to allow crop's healthy growth ; IPM - an ecosystem-based strategy that focuses on long-term prevention of pests ; VermiCompost - the process of composting using various worms ; Double Transplant - a small field area is transplanted to let seedlings grow which are then transplanted all over the field ; Dapog - a bed is prepared for seedling to grow which are then transplanted all over fields - no soil is used in the dapog bed hence the seedlings become established early ; Alternative Wet/Dry Method - a water-saving technology tha

Agricultural 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	1093.1	4160.6	5904.3	-3155.8	498.9	0.00313	3190	-0.00633
	[6317.99]	[6585.49]	[9279.60]	[3326.90]	[2233.29]	[0.04]	[4230.98]	[0.03]
Shared Demo Treatment	1080.4	6822.6	7596.6	-1744.3	-648.5	0.00848	1063	0.0109

Notes: All variables are aggregates of all crops on all plots of the household in Boro Season 2014-2015. Districts are Rangpur and Barisal. 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.

Crop's Share of Total Cultivated Area

Notes: Plot share is calculated as the mono plot area dedicated to a certain crop, divided by total cultivated area in Boro season
2014 oy1 Tm[50 TJg(ate)-7(d)5(to)-4(a c)-5(e)5(rt)4(ain)0102]Tt0 0 1 159.86 670.78 Tm03 Tc[(2014 [(at)-12(ar)-11(e)5(is)7(c)-3(alcu)4(l)] TJn5/0 G[(

Notes: This table presents the median harvest value for the main IAPP crops in Boro season 2014-15. The harvest value is calculated by multiplying the yield in Kg/Ha by the price of the crop. Prices are calculated ba014