Technological innovations, downside risk, and the modernization of agriculture
Online Appendix

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A Online Appendix Materials

Appendix A: Theoretical Model

We develop a farm household model of optimal input choice with production uncertainty and technological change. We first set up a general model and then apply it to the specific case of the technology in our experiment. Our model clarifies the three mechanisms discussed in the main text: an expected income effect, a risk effect, and a marginal productivity effect.

Optimal choice of inputs and savings

The model has two periods. Investment and savings decisions are made in the first period and output is realized in the second period.[1] We assume that the farmer holds an exogenously determined amount of rice in the first period denoted as h. The farmer chooses between consuming c, saving an amount s for the next period, and selling the remainder immediately. The farmer can spend on a continuous amount of input x at a cost of r. Non-farm income is denoted as w. The discount factor is δ.

The state of nature θ is revealed in the second period after the crop has been planted. In practice, θ can take several values where each corresponds to a different level of flood severity. Consumption also occurs in the second period and is denoted as c_1.

Introducing a new seed variety results in a change in the production technology. We denote ϕ as the amount of the new seed used. Usage of new seed is exogenous, matching the randomization in our experiment. The production function is $f(x, \phi; \theta)$, with non-negative first derivatives, $f_x \geq 0$ and $f_\phi \geq 0, \forall\theta$.

The farmer's maximization problem is

$$\max_{c,c_1,x,s} U = u(c) + \delta E u(c_1) \tag{1}$$

[1] In reality the decision making process of the farm household occurs in three periods. The savings decision is made after harvest, the input decision is made at or near the time of the next planting, and the harvest is realized at the end of the growing season. We simplify the model by assuming that the first two events occur during the same period.

subject to

$$
\begin{aligned}
c &\leq w - rx + h - s \\
c_1 &\leq w + f(x, \phi; \theta) + s \\
s &\leq h, x \geq 0, s \geq 0.
\end{aligned}
$$

Assuming that the constraints on consumption bind with equality, the two first order conditions for x and s are

$$ru'(c) = \delta E\left[u'(c_1)f_x\right] \tag{2}$$

$$u'(c) = \delta Eu'(c_1), \tag{3}$$

where the expectation is taken over the states of nature θ. Both savings and input use are chosen such that the expected marginal benefits in the future period are equal to the marginal cost in terms of foregone consumption in the present.

The impact of the new techology on input use is equal to

$$\frac{\partial x}{\partial \phi} = \delta \frac{Ef_\phi E\left[u''(c_1)(U_{xs} - U_{ss}f_x)\right] + E\left[u''(c_1)(U_{xs} - U_{ss}f_x)(f_\phi - Ef_\phi)\right] - U_{ss}E\left[u'(c_1)f_{\phi x}\right]}{U_{xx}U_{ss} - U_{xs}^2} \tag{4}$$

where f_ϕ and $f_{\phi x}$ are the marginal effects of using technology ϕ on the level of production and the marginal productivity of input x, respectively, and U_{xs}, U_{ss}, and U_{xx} are the second order derivatives of the objective function with respect to x and s. The second-order conditions for maximization require $U_{ss} < 0$, $U_{xx} < 0$ and $U_{xx}U_{ss} - U_{xs}^2 > 0$. As savings and input use are substitute instruments to transfer rice to the second period, the cross-partial derivative $U_{xs} = ru''(c) + \delta E\left[u''(c_1)f_x\right] < 0$.

Equation (4) shows three effects of the new technology on input use. The first term is the "expected income" effect due to raising expected production by Ef_ϕ. The second term is a pure "risk" effect due to the differential benefit of the technology across states of nature. The third term is a "marginal productivity" effect where the technology directly affects the marginal product of the input. Note that the first two terms represent "insurance effects" in that they only affect the risk averse farmers, while the third term will take place even with risk neutral households.[2]

The expected income effect can be simplified to:

$$Ef_\phi u''(c)E\left[Ru'(c_1)(f_x - r)\right] \tag{5}$$

where R is the coefficient of absolute risk aversion in the second period. From (2) and (3), $E[u'(c_1)f_x] = rEu'(c_1)$, showing that the income effect is null when utility exhibits constant absolute risk aversion, and is positive with decreasing absolute risk aversion. The intuition is that an expected increase in second period income due to the new technology reduces the marginal utility of increased production and of savings in similar orders of magnitude, and hence has either a null or a small positive effect on input use.

[2] Of course, a risk neutral farmer has no incentive to save any output for the second period. In this case the model collapses to a univariate optimization where $s = 0$.

Similarly, the risk effect can be simplified to:

$$U_{ss}E[Ru'(c_1)(f_\phi - Ef_\phi)(f_x - r)] + \delta E[Ru'(c_1)(f_x - r)]E[Ru'(c_1)(f_\phi - Ef_\phi)] \tag{6}$$

Under constant absolute risk aversion, the second term is null, and the first term is proportional to the covariance between increased production (f_ϕ) and the marginal value of an additional unit of input ($u'(c_1)f_x$).

The response of savings to the new technology can be written:

$$\frac{\partial s}{\partial \phi} = -\delta \frac{E[u''(c_1)f_\phi]}{U_{ss}} - \frac{U_{sx}}{U_{ss}}\frac{\partial x}{\partial \phi} \tag{7}$$

The second term shows an effect that is opposite and proportional to the effect on input use, that directly comes from their substitute roles in moving income to the second period. The first term represents a decrease in savings due to the expected increase in income in the second period (even without any increase in input). This term contains an expected income effect $Eu''(c_1)Ef_\phi$ and a risk effect $E[Ru'(c_1)(f_\phi - Ef_\phi)]$. The expected income effect is negative. The risk effect is also negative if the technology increases production more in states with lower consumption, i.e., has any risk-reducing property. The intuition for this effect is that by increasing the expected level of production in the second period, the technology crowds out savings, especially for more risk averse farmers.

In the particular case of the technology we study, results from both experimental plots and the first year of our experiment confirm that Swarna-Sub1 is indistinguishable from Swarna when flooding does not occur. Combining this with the fact that more severe floods lead to lower production and thus lower consumption delivers the prediction that the increase in production from the technology (f_ϕ) occurs in states where the marginal utility of consumption ($u'(c_1)$) is large.[3] Assuming that the marginal product of the input is also lower during more severe flooding, the covariance term in equation (6) is predicted to be negative, making the overall risk effect positive. Thus, an important prediction from the model is that the better technology leads to an increase in the quantity of the input because it reduces the marginal damage — in terms of lost consumption — that resulted from investing in an input that turned out to be unproductive.

Introducing credit

We do not formally model the demand for agricultural credit. Instead, we discuss how introducing the new technology can affect utilization of agricultural credit in a credit environment similar to the one faced by farmers in our sample.

There are two important characteristics of the credit market for farmers in our sample. First, local agricultural cooperative societies are the most popular source of credit. 45% of loans during year one of the experiment came from cooperative societies. Since cooperatives have limited resources, borrowing constraints are likely to be relevant. Second, limited

[3]Implicit in this statement about the correlation between the productivity increase and the marginal utility of consumption is an assumption of imperfect consumption smoothing.

liability is a feature of these loans. In particular, 40% of loans from year one were renegotiated or had liability fully waived.[4]

Credit could therefore be realistically introduced into the model by allowing both borrowing constraints and limited liability. Specifically, the household borrows an amount b, where an exogenous borrowing constraint forces $b \leq \bar{b}$. Assuming that γ is the degree of limited liability, the household must pay back $(1-\gamma)(1+v)b$ during the second period, where v is the interest rate. Since loans are most likely to be forgiven after flooding, it is plausible to assume that $\gamma = 0$ in the event that flooding does not occur.

Under this setup, there are two plausible mechanisms which could explain how introducing the new technology will influence credit usage. First, by increasing production during the flood state, the technology increases consumption, thus decreasing the marginal utility of consumption. This makes it less painful to have liabilities and therefore increases demand for credit. This effect becomes less relevant as limited liability increases because it effectively acts as insurance by further increasing consumption during flooding. Second, making production less risky could induce cooperatives to make more credit available to treatment farmers — an increase in $\bar{b}$. This supply effect would increase credit utilization as long as credit constraints were binding prior to introduction of the technology.

[4] Loans from agricultural cooperative societies in areas where heavy flooding occurred were nearly twice as likely to have their terms changed compared to loans from other sources. The probability of renegotiation is also increasing in the duration of flooding.

Appendix B: Details of Cost Calculation

We explain below the details of the cost calculations referenced in Section III.E of the main text.

Fertilizer use: We rely directly on our estimates in Column 1 of Table 4 to generate an increase in fertilizer cost of 397 Rs. Given that farmers cultivate an average of one hectare, we also use this value as the increase in fertilizer costs per hectare.

Labor for fertilizer: Our first follow-up survey included information on total labor use — including family labor — for physically applying fertilizers. We calculate that on average, for each 100 kg of fertilizer applied, a total of 6 person days are required. Applying this number to the increase in fertilizer usage in kilograms rather than expenditures, we obtain an increase in labor demand of 1.48 days. Valuing all labor at the average wage of 161 Rs per day, this amounts to an increase in labor costs of 238 Rs per hectare.

Labor for planting: Our first follow-up survey also included information on labor used for sowing for a single plot of each respondent. We simply compare average labor costs per hectare between plots that were planted using the broadcasting and transplanting methods. A caveat of this exercise is that the comparison is clearly non-experimental.[5] We find that labor costs for transplanting are larger by 5,670 Rs per hectare — an approximate three fold increase relative to the broadcasting method. Multiplying this value by the decrease in the probability of broadcasting of .063, we obtain an increase in average planting costs per hectare of 357 Rs.

Loan interest: Our second follow-up survey asked the annual interest rate for each loan. We combine this with the value of the loan to estimate annual interest costs for each farmer in the sample.[6] We simply regress this value on the same set of regressors used in our main specifications. Doing this delivers an increase in annual interest costs of 82 Rs.

Seed cost: Treatment farmers in our sample had no choice but to use Swarna-Sub1 from their previous harvest. The effective price of seeds in this case is their opportunity cost, which is the price that would have been obtained had the output been sold as rice instead. As we show below, farmers report an average increase in output price for Swarna-Sub1 of 0.46 Rs per kilogram. Combining this with an approximate seed rate of 62 kilograms per hectare, the additional cost of Swarna-Sub1 seeds is around 29 Rs per hectare.

[5] It is most likely that this simple comparison of means *overstates* the effect of transplanting on planting costs. Farmers would be more likely to use transplanting with higher-yielding varieties that may induce more labor use at planting independently of choice of planting technique. The estimate is also conservative because one of the benefits of transplanting is reduced weed populations. Consequently, a portion of the increase in planting costs that results from transplanting is offset by reduced costs of weeding.

[6] This is only an estimate because our survey was carried out immediately after harvest and thus we do not measure the timing of repayment.

Appendix C: Additional Tables and Figures

Table A.1: Knowledge and adoption of Swarna-Sub1 by control farmers

	Knowledge		Adoption	
	(1)	(2)	(3)	(4)
Treatment village	0.293***	0.299***	0.100***	0.094***
	(0.044)	(0.045)	(0.023)	(0.023)
Block Fixed Effects	Yes	Yes	Yes	Yes
Household controls	No	Yes	No	Yes
Mean of Dep Variable	0.62	0.62	0.10	0.10
Number of Observations	928	921	928	921
R squared	0.118	0.126	0.104	0.116

All observations are from year 2 follow-up survey. Dependent variable in columns 1 and 2 is an indicator variable for ever hearing of Swarna-Sub1 at the time of the second year follow-up. Dependent variable in columns 3 and 4 is an indicator variable for adoption of Swarna-Sub1 during year 2. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Figure A.1: Stated reasons for choosing rice varieties during year 2

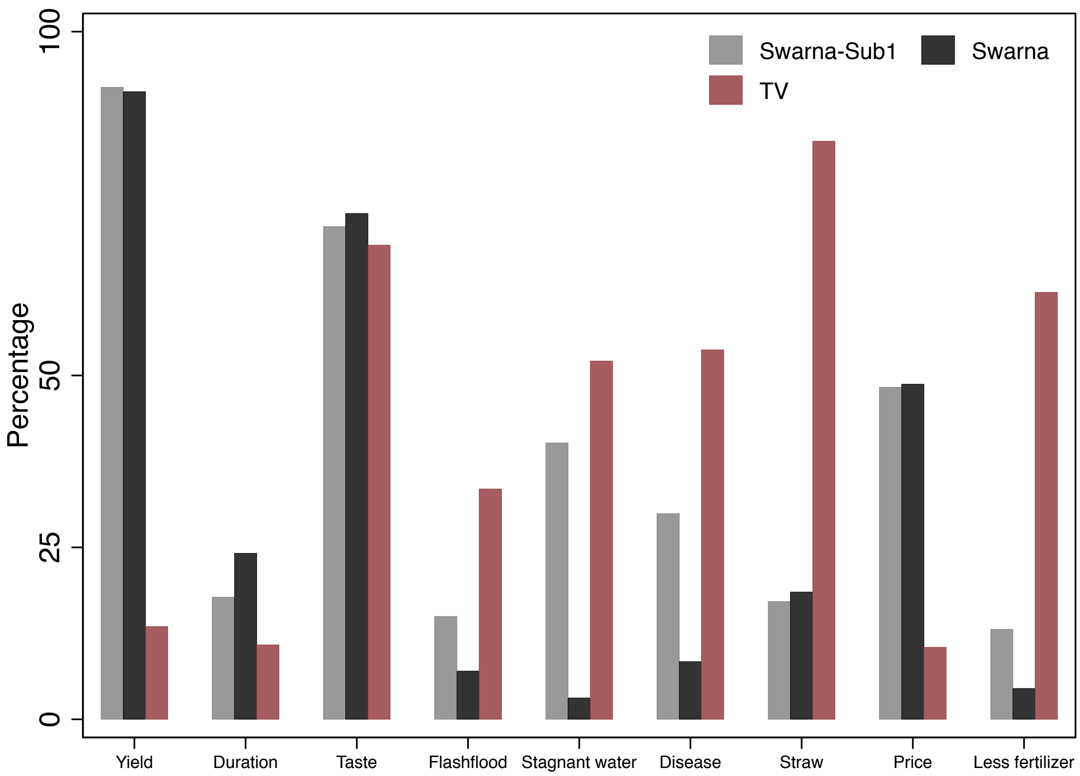
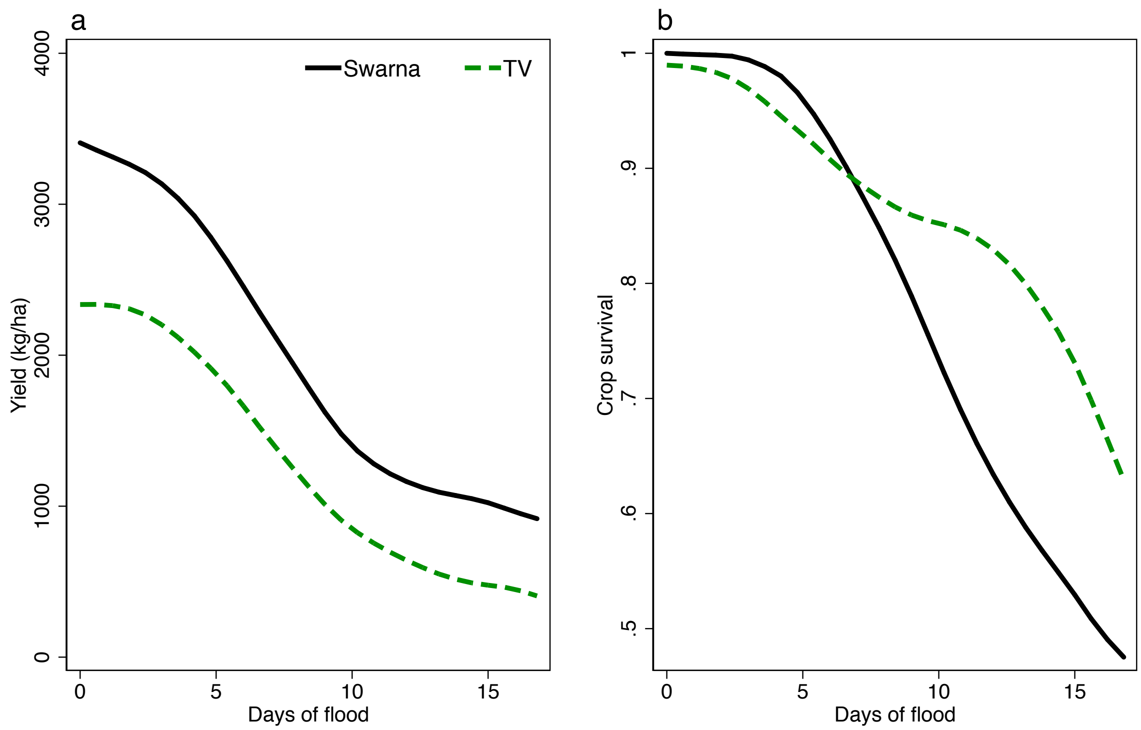


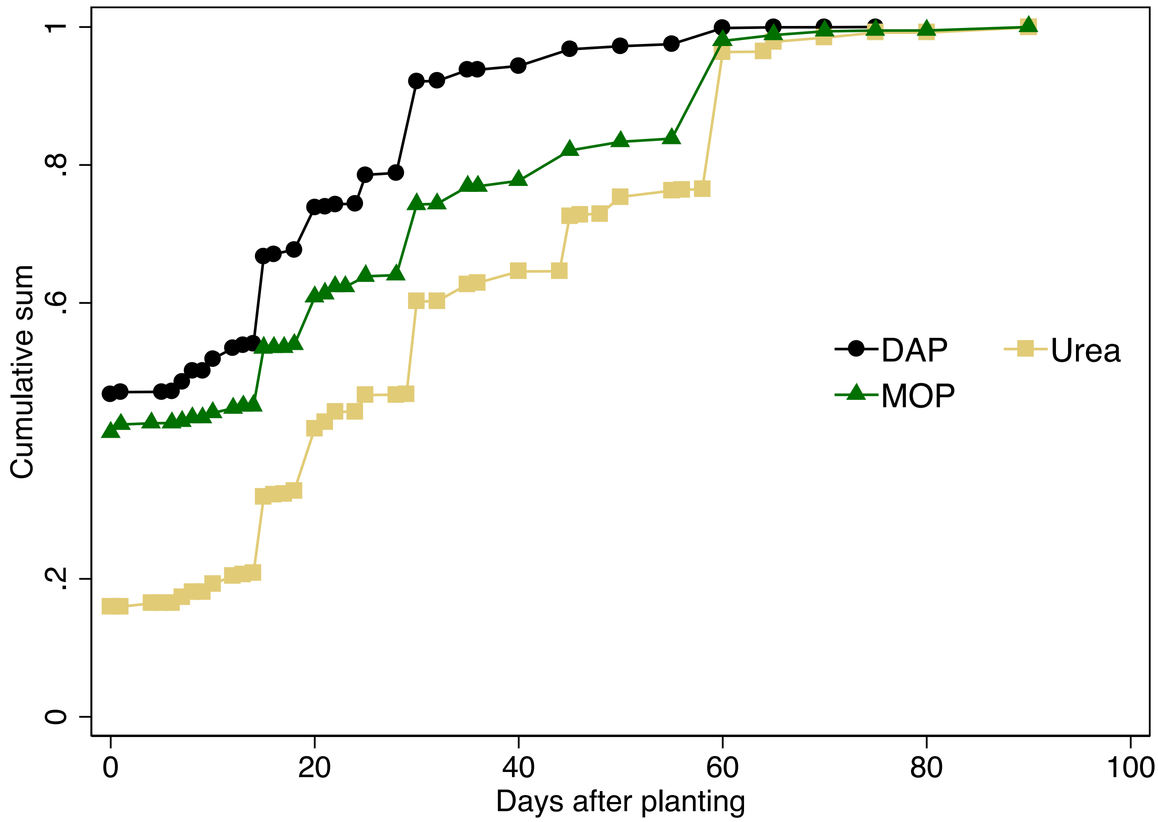
Figure displays percentage of farmers (Swarna and Swarna-Sub1) and percentage of farmer-variety pairs (TV) for which the characteristic on the horizontal axis is a reason the variety was chosen during year 2. For example, over 90% of farmers cultivating Swarna stated that high yield was one of the reasons for this choice (first grey bar above yield).

Figure A.2: Nonparametric regressions of yield and crop survival on duration of flooding during year one



Notes: Figure displays fan regressions of yield and crop survival (0/1) on duration of submergence. Estimates are for year one when flooding occurred in part of the sample area.

Figure A.3: Timing of fertilizer applications during first year of study



Notes: Figure displays cumulative share of each fertilizer applied by each day in the growing season, where timing is measured in days after planting. Data are for farmers surveyed during the follow-up after year one. Urea is source of nitrogen (N), DAP is primary source of phosphorous (P) and MOP is the source of potassium (K).

Table A.2: Effects on cultivation practices with household controls

	Panel A: Year 1				
	(1)	(2)	(3)	(4)	(5)
	Area planted	Log area	Use Swarna	Use TV	Broadcast
Original minikit	0.025	0.049	-0.155***	-0.030*	-0.027**
recipient	(0.031)	(0.037)	(0.018)	(0.015)	(0.013)
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	0.92	-0.36	0.47	0.21	0.11
Number of Observations	1238	1228	4182	4181	4188
R squared	0.652	0.602	0.137	0.168	0.122
	Panel B: Year 2				
	(1)	(2)	(3)	(4)	(5)
	Area planted	Log area	Use Swarna	Use TV	Broadcast
Original minikit	0.079*	0.076**	-0.103***	-0.040**	-0.062***
recipient	(0.045)	(0.035)	(0.018)	(0.016)	(0.017)
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	1.00	-0.20	0.36	0.28	0.19
Number of Observations	1227	1165	4477	4476	4470
R squared	0.387	0.409	0.121	0.280	0.253

Dependent variable is total rice area planted in hectares (column 1), log of total rice area (column 2), an indicator for using Swarna on the plot (column 3), an indicator for using a traditional seed variety on the plot (column 4) and an indicator for planting the plot using the broadcasting technique (column 5). The observations are at the farmer level in columns 1 and 2 and at the plot level in columns 3 and 4. Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.3: Effects on fertilizer usage during year two with household controls

	(1) All	(2) Urea	(3) DAP	(4) MOP	(5) Gromor
Original minikit recipient	397.425**	12.748	395.939***	94.914*	-106.178
	(170.766)	(32.999)	(133.021)	(56.425)	(70.838)
Rice area (hectares)	3986.428***	777.545***	2344.337***	633.036***	231.510***
	(382.500)	(136.847)	(307.059)	(176.412)	(87.886)
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	3786.37	665.80	2020.46	702.86	397.25
Number of Observations	1227	1227	1227	1227	1227
R squared	0.629	0.522	0.532	0.295	0.072

Dependent variable is fertilizer expenditure in Rupees. The column labels indicate the type of fertilizer. All observations are from year two of the experiment and are at the farmer level. Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.4: Effects on rice storage and credit uptake with household controls

	Panel A: Year 1				
	(1) Storage Rate	(2) Storage Rate	(3) Credit	(4) Coop Loan	(5) Other Loan
Original minikit recipient	-0.026*	-0.012	0.059	0.033	0.026
	(0.014)	(0.024)	(0.039)	(0.029)	(0.032)
Original minikit recipient*HH has BPL card		-0.024			
		(0.032)			
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	0.73	0.73	0.43	0.24	0.19
Number of Observations	1175	1175	1238	1238	1238
R squared	0.172	0.172	0.147	0.163	0.078
	Panel B: Year 2				
	(1) Storage Rate	(2) Storage Rate	(3) Credit	(4) Coop Loan	(5) Other Loan
Original minikit recipient	-0.047***	-0.081***	0.064**	0.049**	0.018
	(0.018)	(0.024)	(0.027)	(0.024)	(0.020)
Original minikit recipient*HH has BPL card		0.061**			
		(0.030)			
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	0.69	0.69	0.19	0.12	0.08
Number of Observations	1157	1157	1227	1220	1227
R squared	0.094	0.097	0.077	0.076	0.031

Dependent variable is the share of the total rice harvest that was stored for future consumption (columns 1 and 2), an indicator for having a loan (column 3), an indicator for having a loan from an agricultural cooperative (column 4), and an indicator for having a loan from another source (column 5). Other sources are banks, input sellers, Self-Help groups (SHG's), MFI's, friends/relatives, or money lenders. Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.5: Effects on productivity with household controls

	Year 1	Year 2			
	(1)	(2)	(3)	(4)	(5)
Original minikit recipient	316.75***	299.92***	248.70***	215.41***	187.07***
	(89.62)	(76.68)	(73.51)	(68.24)	(65.69)
Broadcast planting			-786.57***	-657.66***	-388.22***
			(127.03)	(115.31)	(104.70)
Tons fertilizer per hectare				4386.63***	3339.31***
				(980.85)	(815.51)
Tons fertilizer per hectare^2				-3924.83**	-2939.92**
				(1592.65)	(1251.44)
Traditional variety					-460.26***
					(70.36)
Irrigated					712.93***
					(93.73)
Has credit					136.09**
					(68.06)
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	2220.76	2809.62	2811.20	2811.20	2810.69
Number of Observations	4151	4461	4456	4456	4402
R squared	0.421	0.179	0.218	0.254	0.320

Dependent variable in all regressions is yield in kg/hectare. Estimation data are at the plot level. All independent variables are measured at the plot level, except for fertilizer per hectare, which is measured at the farmer level. Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.6: Effects estimated for sample of fields not cultivated with Swarna-Sub1 with household controls

					Fertilizers				
	(1) Yield	(2) Use Swarna	(3) Use TV	(4) Broadcast	(5) All	(6) Urea	(7) DAP	(8) MOP	(9) Gromor
Original minikit recipient	177.213**	-0.004	0.020	-0.040**	39.172	-1.446	80.795*	5.553	-45.729**
	(77.851)	(0.021)	(0.018)	(0.019)	(51.775)	(8.785)	(41.389)	(15.892)	(18.716)
Area of field	-226.757*	0.091**	-0.033	-0.014	3376.056***		1906.778***	514.372***	307.905***
	(122.361)	(0.043)	(0.034)	(0.039)	(362.017)		(226.677)	(90.406)	(81.011)
Owned land	-16.947	0.107***	-0.052***	0.035*	95.301*	12.714	51.504	14.400	16.683
	(69.821)	(0.022)	(0.020)	(0.021)	(56.389)	(9.351)	(35.283)	(15.158)	(20.130)
Area of field						261.832***			
						(39.700)			
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land quality indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land slope indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	2747.44	0.40	0.32	0.20	1094.46	190.74	587.23	200.66	115.83
Number of Observations	3987	3987	3986	3982	3987	3987	3987	3987	3987
R squared	0.20	0.16	0.32	0.28	0.52	0.50	0.44	0.26	0.08

Data consist of entire sample of plots not cultivated with Swarna-Sub1 during the second year of the study. The dependent variables are rice yield in kg/hectare (column 1), an indicator for planting using the broadcasting technique (column 2), and total kilograms of DAP and MOP fertilizers used (column 3). Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.7: Effects on fallowing of plots cultivated in year 1 during year 2

	(1)	(2)	(3)
Original minikit recipient	-0.023*	-0.018	-0.018*
	(0.012)	(0.013)	(0.010)
Minikit*Low land		-0.030	
		(0.020)	
Low land		0.015	
		(0.016)	
Minikit*Low quality land			-0.071**
			(0.036)
Low quality land			0.119***
			(0.025)
Block Fixed Effects	Yes	Yes	Yes
Mean of Dep Variable	0.08	0.07	0.07
Number of Observations	5068	5047	5012
R squared	0.019	0.021	0.038

Dependent variable in all regressions is an indicator for whether the plot was fallowed during year 2 of the study. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.8: Decomposition of area effects

	(1) Number plots	(2) Plot size
Original minikit recipient	0.68***	-0.02*
	(0.13)	(0.01)
Block Fixed Effects	Yes	Yes
Mean of Dep Variable	3.57	0.27
Number of Observations	1237	4589
R squared	0.100	0.040

The unit of observation is the farmer in column 1 and the plot in column 2. The dependent variable in column 1 is the total number of rice plots cultivated in year two. The dependent variable in column 2 is the size of the plot, measured in hectares. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.9: Estimation of main results during year 2 with a separate indicator for control farmers in treatment villages

	(1) Area	(2) Use Swarna	(3) Use TV	(4) Broadcast	(5) Fertilizer	(6) Storage Rate	(7) Credit	(8) Yield
Original minikit recipient	0.147*	-0.127***	-0.011	-0.050*	188.109	-0.057**	0.098***	373.057***
	(0.076)	(0.028)	(0.032)	(0.028)	(241.238)	(0.022)	(0.036)	(133.487)
Nonrecipient in treatment village	0.058	-0.038	0.043	0.019	-309.419	-0.010	0.044	130.169
	(0.065)	(0.030)	(0.032)	(0.034)	(199.263)	(0.021)	(0.030)	(131.720)
Rice area (hectares)					3840.532***			
					(314.390)			
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	1.00	0.36	0.28	0.19	3781.48	0.70	0.19	2817.97
Number of Observations	1237	4589	4588	4582	1237	1167	1237	4573
R squared	0.113	0.116	0.272	0.242	0.620	0.070	0.060	0.161

Dependent variables are total rice area in ha (column 1), an indicator for sowing the plot with Swarna (column 2), an indicator for sowing plot with a traditional rice variety (column 3), an indicator for planting using the broadcasting technique (column 4), total fertilizer expenditures (column 5), share of harvest consumed or saved for consumption (column 6), and indicator for having a loan (column 7), and rice yield in kg per ha (column 8). Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.10: Adjustment of p-values for multiple hypothesis testing

Outcome	Mean outcome	Point estimate	Unadj. p-value	FDR adj. p-value
Broadcasting	0.186	-0.063	0.000	0.003
Use TV	0.284	-0.041	0.011	0.031
Use Swarna	0.359	-0.101	0.000	0.001
Plot yield	2,817.971	283.449	0.000	0.003
Irrigated	0.737	0.033	0.267	0.315
Log seed rate	4.158	-0.041	0.037	0.068
Plot sharecropped in	0.155	-0.021	0.169	0.226
Rice area, ha	1.002	0.109	0.063	0.105
Storage rate	0.696	-0.050	0.004	0.019
Has credit	0.187	0.068	0.012	0.031
Use pesticide	0.776	0.060	0.024	0.053
Has dry season crop	0.228	-0.003	0.900	0.900
Has ag. labor income	0.483	-0.036	0.267	0.315
Sold rice seeds	0.052	0.016	0.337	0.375
Has livestock income	0.369	-0.076	0.010	0.031
Extension contact	0.213	0.069	0.027	0.054
Urea expenditure	664.704	13.428	0.697	0.734
DAP expenditure	2,016.799	393.768	0.005	0.019
MOP expenditure	702.823	90.579	0.122	0.188
Gromor expenditure	397.154	-101.073	0.138	0.198

The data consists of the agricultural outcome variables from our year 2 follow-up survey. The first column displays the mean value of the outcome variable across the entire sample. The second column gives the point estimate from a regression of the outcome on the farmer-level treatment indicator and block fixed effects. The third column displays p-values that are not adjusted for multiple hypothesis testing. The fourth column shows p-values that are adjusted to control the false discovery rate, i.e. the share of rejections of the null that are false. All p-values are based on standard errors that are clustered at the village level.

Table A.11: Effects on non-Swarna-Sub1 fields when conditioning on variety fixed effects

			Fertilizers				
	(1) Yield	(2) Broadcast	(3) All	(4) Urea	(5) DAP	(6) MOP	(7) Gromor
Original minikit recipient	157.724**	-0.048**	72.084	1.789	108.623**	9.422	-47.750**
	(73.489)	(0.020)	(53.498)	(7.832)	(45.822)	(16.264)	(19.157)
Area of field	-224.831**	0.027	3553.724***	665.104***	2096.437***	535.004***	257.179***
	(109.670)	(0.025)	(350.550)	(94.225)	(238.493)	(95.815)	(68.536)
Owned land	22.661	0.049***	86.297	8.008	66.364*	8.432	3.493
	(68.776)	(0.018)	(58.529)	(11.244)	(39.804)	(16.203)	(20.802)
Variety Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land quality indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land slope indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	2757.37	0.20	1098.14	191.28	590.57	200.88	115.41
Number of Observations	4087	4082	4087	4087	4087	4087	4087
R squared	0.32	0.50	0.58	0.56	0.49	0.33	0.11

Data consist of the sub-sample of plots not cultivated with Swarna-Sub1 during the second year of the study. The dependent variables are rice yield in kg/hectare (column 1), an indicator for planting using the broadcasting technique (column 2), and total fertilizer expenditures in rupees (columns 3-7). Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.12: Relationship between planting of Swarna-Sub1 and plot-level characteristics

	Farmers:		
	(1) All	(2) Treatment	(3) Control
Area of field	-0.079***	-0.189***	-0.016
	(0.023)	(0.067)	(0.015)
Owned land	0.043***	0.113***	0.012
	(0.012)	(0.042)	(0.008)
Low land	-0.020*	-0.071**	-0.002
	(0.011)	(0.031)	(0.007)
Bad quality land	-0.005	0.018	-0.018*
	(0.015)	(0.038)	(0.010)
Field has tubewell irrigation	0.021	-0.006	0.015
	(0.019)	(0.041)	(0.012)
Block Fixed Effects	Yes	Yes	Yes
Mean of Dep Variable	0.10	0.26	0.04
Number of Observations	4575	1312	3263
R squared	0.02	0.05	0.03

The dependent variable in all regressions is an indicator for fields that were planted with Swarna-Sub1. Low land is land that farmers reported was lowest in elevation in the village (on a scale from 1-3). Bad quality land is land that farmers reported to have below-average land quality. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.13: Correlates of plot characteristics with minikit treatment for sample of plots not cultivated with Swarna-Sub1

	Sample:	
	(1)	(2)
	All	Non-Sub1 trimmed
Low land	0.018	0.022
	(0.022)	(0.022)
Area of field	-0.033	-0.027
	(0.043)	(0.044)
Bad quality land	0.027	0.026
	(0.032)	(0.033)
Owned land	0.011	0.015
	(0.025)	(0.025)
Field has tubewell irrigation	0.068	0.065
	(0.041)	(0.042)
Block Fixed Effects	Yes	Yes
Mean of Dep Variable	0.24	0.25
Number of Observations	4087	3903
R squared	0.01	0.01

The dependent variable in both regressions is an indicator for plots cultivated by treatment farmers. Column 1 contains all plots that were not cultivated with Swarna-Sub1. Column 2 contains all of these plots, but then drops the lowest-productivity plot of each control farmer with a probability of 0.2354. Low land is land that farmers reported was lowest in elevation in the village (on a scale from 1-3). Bad quality land is land that farmers reported to have below-average land quality. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.14: Effects on non-Swarna-Sub1 fields when conservatively trimming the sample by dropping a subset of the lowest productivity plots of control farmers

					Fertilizers				
	(1) Yield	(2) Use Swarna	(3) Use TV	(4) Broadcast	(5) All	(6) Urea	(7) DAP	(8) MOP	(9) Gromor
Original minikit recipient	134.760*	-0.010	0.028	-0.039**	55.964	0.243	92.796*	8.153	-45.229**
	(76.890)	(0.021)	(0.018)	(0.019)	(57.732)	(8.603)	(48.063)	(16.659)	(17.943)
Area of plot	-206.927*	0.007	0.018	0.021	3615.375***	687.718***	2161.306***	530.727***	235.624***
	(122.864)	(0.041)	(0.038)	(0.035)	(352.274)	(117.836)	(259.745)	(105.278)	(67.128)
Owned land	48.502	0.066***	-0.031	0.056***	118.905*	13.354	89.448**	13.299	2.804
	(67.347)	(0.021)	(0.019)	(0.018)	(65.304)	(12.580)	(44.569)	(17.356)	(19.963)
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land quality indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land slope indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	2790.84	0.40	0.31	0.20	1099.88	191.39	595.56	201.03	111.91
Number of Observations	3904	3904	3903	3899	3904	3904	3904	3904	3904
R squared	0.18	0.15	0.30	0.27	0.53	0.51	0.44	0.26	0.07

Data consist of the sub-sample of plots not cultivated with Swarna-Sub1 during the second year of the study. In order to ease selection concerns, this sub-sample of plots is further trimmed for the control group by dropping each control farmer's lowest yielding plot with a probability of 0.2354. This probability was calculated to balance the total number of plots in this sub-sample across treatment and control farmers. After trimming there is no statistically significant difference in the number of plots between treatment and control farmers. The dependent variables are rice yield in kg/hectare (column 1), an indicator for planting the field with Swarna (column 2), an indicator for planting the field with a traditional rice variety (column 3), an indicator for planting using the broadcasting technique (column 4), and total fertilizer expenditures in rupees (columns 5-9). Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.15: Relationship between total rice output and flood exposure during year one for control farmers

	(1)	(2)
Flood exposure in days	-90.305***	-90.352***
	(28.715)	(26.765)
Block Fixed Effects	Yes	Yes
Household controls	No	Yes
Mean of Dep Variable	1738.91	1740.38
Number of Observations	928	921
R squared	0.123	0.364

The data include observations for control farmers only. The dependent variable in both columns is the total rice harvest during year one. Flood exposure in days is the area-weighted average number of days the farmer's fields were flooded. Household controls are all covariates in Panel A of Table **??** of the main text. Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.16: Comparison of effects of Swarna-Sub1 treatment with effects of a flood shock with the same expected increase in rice production

Outcome	Sub1 treatment	Equivalent flood shock
Rice area	0.109*	0.008
	(0.056)	(0.013)
Log rice area	0.098**	0.016
	(0.044)	(0.011)
Use Swarna	-0.101***	-0.002
	(0.017)	(0.004)
Use TV	-0.041**	0.007
	(0.016)	(0.005)
Broadcast planting	-0.063***	0.004
	(0.017)	(0.007)
All fertilizer	396.703**	-81.134*
	(179.631)	(44.627)
Urea	13.428	-21.017*
	(34.372)	(11.149)
DAP	393.768***	-52.922
	(136.410)	(34.474)
MOP	90.579	-1.992
	(58.170)	(14.587)
Gromor	-101.073	-5.202
	(67.759)	(20.772)
Share saved	-0.050***	-0.002
	(0.017)	(0.004)
Has credit	0.068**	-0.008
	(0.027)	(0.006)
Yield	283.449***	-7.548
	(77.484)	(21.127)

Each entry in the table is from a separate regression. Entries in the first column are the effects of the Swarna-Sub1 treatment as reported in Tables 3 to 6 of the main text. Each regression in column 2 shows the coefficient from a regression of the listed outcome variable on the number of flood days the farmer was exposed to in year 1 divided by 1.4, controlling for block fixed effects. This "equivalent shock" variable is constructed so that a one unit decrease is equivalent to 126.67 kilograms of rice, which is the expected output gain that treatment farmers could expect from planting 0.33 hectares of area with Swarna-Sub1. The regressions in column 2 use observations from the control group only. Standard errors in parentheses are clustered at the village level for all regressions. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.17: Estimation of main results conditioning on the year 1 rice harvest

	Plot level			Farmer level		
	(1) Yield	(2) Use TV	(3) Broadcast	(4) Fertilizer	(5) Share saved	(6) Credit
Original minikit recipient	275.834***	-0.039**	-0.062***	350.188*	-0.043**	0.065**
	(77.658)	(0.016)	(0.017)	(182.558)	(0.017)	(0.027)
2011 rice harvest (tons)	21.122	-0.005	-0.004	216.455**	-0.022***	0.009
	(16.863)	(0.004)	(0.003)	(95.097)	(0.004)	(0.006)
Rice area (hectares)				3540.807***		
				(375.751)		
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	2817.97	0.28	0.19	3781.48	0.70	0.19
Number of Observations	4573	4588	4582	1237	1167	1237
R squared	0.161	0.271	0.243	0.627	0.102	0.060

Estimation data are at the plot level in columns 1-4 and the farmer level in columns 5-8. Dependent variables are rice yield in kg/ha (column 1), an indicator for sowing plot with a traditional rice variety (column 2), an indicator for planting using the broadcasting technique (column 3), an indicator for plot not being cultivated (column 4), total fertilizer use (column 5), number of plots cultivated with rice (column 6), share of harvest consumed or saved for consumption (column 7), and indicator for access to credit (column 8). Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.

Table A.18: Estimation of main results for sample that did not sell rice following year 2 harvest

	Plot level				Farmer level		
	(1) Use Swarna	(2) Use TV	(3) Broadcast	(4) Yield	(5) Fertilizer	(6) Area	(7) Credit
Original minikit recipient	-0.117***	-0.031	-0.071**	465.781***	136.074	0.053	0.069**
	(0.024)	(0.020)	(0.032)	(102.602)	(152.201)	(0.043)	(0.030)
Rice area (hectares)					2339.055***		
					(334.648)		
Block Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dep Variable	0.38	0.30	0.22	2362.44	2384.25	0.70	0.13
Number of Observations	2303	2302	2297	2297	747	747	747
R squared	0.132	0.326	0.297	0.138	0.414	0.140	0.053

Data are limited to 747 farmers that did not sell any rice after the harvest from year 2 of the experiment. Estimation data are at the plot level in columns 1-4 and the farmer level in columns 5-7. Dependent variables are an indicator for sowing plot with Swarna (column 1), an indicator for sowing plot with a traditional rice variety (column 2), an indicator for planting using the broadcasting technique (column 3), rice yield in kg per ha (column 4), total fertilizer use (column 5), total rice area (column 6), an indicator for having a loan (column 7). Standard errors that are clustered at the village level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels.