BRIEFCASE

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DELIVERING RESILIENCE: A DECADE OF EXPERIMENTAL RESEARCH ON FLOOD-TOLERANT SEEDS IN INDIA

This J-PAL Briefcase was updated in collaboration with the Center for Effective Global Action (CEGA).

Small-scale farmers, who adopted flood-tolerant rice, reduced their vulnerability to seasonal flooding, increased investment in their farms, increased productivity, and subsequently increased their profits, whether or not flooding occurred. Targeting agro-dealers with information, holding farmer field days, and spreading information through farmers' social networks led to the improvements in adoption.

Featuring evaluations by Manzoor Dar, Alain de Janvry, Kyle Emerick, Manaswini Rao, Elisabeth Sadoulet, and Eleanor Wiseman

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KEY RESULTS

Flood-tolerant rice helped small-scale farmers in Odisha, India, reduce yield losses during floods and encouraged them to invest more in their farms. Access to the new rice seed variety avoided losses in yields by an average of 10.5 percent (64 kilograms [kg] per hectare) during flooding the first year. Yields increased more among farms that experienced more days of flooding. Farmers who received flood-tolerant rice seeds cultivated more land, used more fertilizer, and followed better planting techniques.

Targeted information and training about flood-tolerant rice increased farmers' demand and adoption of improved seeds. Village-based field days that allowed farmers to learn about the benefits and qualities of flood-tolerant seeds and observe their performance increased the adoption of flood-tolerant rice by 40 percent.

Providing private seed suppliers with targeted information about flood-tolerant rice also encouraged adoption. When private seed suppliers learned about the new rice seed variety, they were more likely to stock the seeds in their stores and encourage farmers to buy them.

Social relationships influenced how flood-tolerant rice spread. In villages where people were more closely connected and shared similar backgrounds, the flood-tolerant rice variety spread more quickly through peer-to-peer information sharing than in villages with more divided social structures.

OVERVIEW AND POLICY ISSUE

Extreme weather events threaten people living in poverty. In India, 66 million people are both flood-exposed and living on less than US$1.90 per day.[1] For households reliant on agriculture, floods can destroy crops and discourage long-term farm investments.

To manage weather shocks, farmers often self-insure against losses by cultivating crops that have stable but low yields instead of more profitable options, such as weather-sensitive cash crops. They may also forgo complementary productive investments, like buying fertilizer, for fear that these purchases will not pay off in the event of a flood or drought. While seemingly safe, these choices result in lower yields and profits during years with typical weather. Stress-tolerant crop varieties, like flood-tolerant rice, can strengthen agricultural resilience by protecting yields during extreme weather while maintaining productivity in typical years. However, evidence-based approaches are critical to ensure that these improved seeds are effectively delivered to and adopted by farmers who need them most.

This Briefcase features five randomized evaluations of the adoption of Swarna-Sub1 seeds in Odisha, India, from 2011 to 2019. In Odisha, rice cultivation is central to livelihoods, and flooding is a common seasonal challenge. Swarna-Sub1 rice is genetically similar to the widely cultivated Swarna variety except for the presence of the SUB1 gene increasing flood tolerance. In partnership with the International Rice Research Institute, researchers Manzoor Dar, Kyle Emerick, Alain de Janvry, Manaswini Rao, Elisabeth Sadoulet, and Eleanor Wiseman conducted randomized evaluations of different interventions to reduce barriers to adopting Swarna-Sub1 seeds, build farmers' resilience to flooding, and improve rice yields. Table 1 provides details of each evaluation.

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[1] Rentschler, Jun, Melda Salhab, and Bramka Arga Jafino. 2022. "Flood Exposure and Poverty in 188 Countries." *Nature Communications* 13, no. 1 (June). https://doi.org/10.1038/s41467-022-30727-4.

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CONTEXT AND DETAILS OF THE EVALUATIONS

Table 1

Evaluation[2]	Years	Sample	Intervention Description
Reducing Farmers' Risk Through Flood-Tolerant Rice	2011-2013	128 villages in Bhadrak and Balasore districts	Researchers conducted a randomized evaluation to test the effect of Swarna-Sub1 (SS1) on yields and farmer behavior. Eligible farmers were offered *minikits*, which contained information about SS1 and a 5 kg bag of seeds, before the 2011 wet season. In each of the 64 participant villages, five farmers were offered a *minikit*. The researchers then compared outcomes between farmers offered *minikits* in participant villages and farmers in villages where SS1 was not distributed.
Long-Term Diffusion and Impact of Flood-Tolerant Rice	2011-2015	126 villages in Bhadrak and Balasore districts	Three years after the initial evaluation, researchers returned to the farming communities to assess how SS1 spread within villages and social groups. They tracked the use of various rice varieties between 2011 and 2015, farmers' production decisions, and basic demographic details, including subcaste (*jati*), among those who did not receive *minikits* in the 2011 evaluation. To measure shared connections (or lack thereof) within villages, researchers quantified the number of distinct jati groups in each village.
Diffusing New Seeds Through Social Networks in Indian Village Economies	2012-2015	82 villages in Bhadrak district	The researcher conducted a randomized evaluation to assess rates of SS1 seed trading between farmers relative to direct door-to-door sales. Farmers were invited to a village meeting about the benefits of SS1. At the end of the meeting, five attendees were randomly assigned by public lottery to receive a *minikit*. The researcher then compared adoption rates between farmers in villages where farmers traded seeds among themselves and farmers in villages where seeds were sold door-to-door.
Farmer Field Days and Demonstrator Selection	2014-2015	100 villages in Balasore district	Researchers conducted a randomized evaluation to assess the impact of farmer field days on the adoption of SS1. They first allocated 25 kg of seed packages using one of three methods: local leader selection (status quo), participatory selection during village meetings, or participatory selection by women's self-help groups. Half of the farmers were invited to field days on the plots of demonstrators where they learned about the crop and heard from demonstrator farmers about their experiences with the seed. The researchers compared adoption rates from direct sales across all groups to assess which was more effective at spurring adoption.
Private Input Suppliers as Information Agents	2016-2019	72 blocks[3] in 10 flood-prone districts	Researchers conducted a randomized evaluation to assess the impact of targeting extension services to agro-dealers on the adoption of SS1. Agro-dealers in participant blocks received extension services, including *minikits* and an informational pamphlet. The researchers used an active comparison group where traditional agricultural extension services to farmers were carried out. These services included the usual government extension activities, such as *minikit* distribution and farmer field days. The researchers then compared adoption rates between farmers in the participant agro-dealer blocks with those in the blocks receiving traditional extension activities.

[2] For more details on the individual evaluation designs, contexts, and results, please review the evaluation summaries linked in the column.

[3] Blocks are the relevant administrative unit for agricultural extension in Odisha, India. In the context of the evaluation, each block included an average of 136 villages and had its own local agricultural extension office.

CONTEXT AND DETAILS OF THE EVALUATIONS

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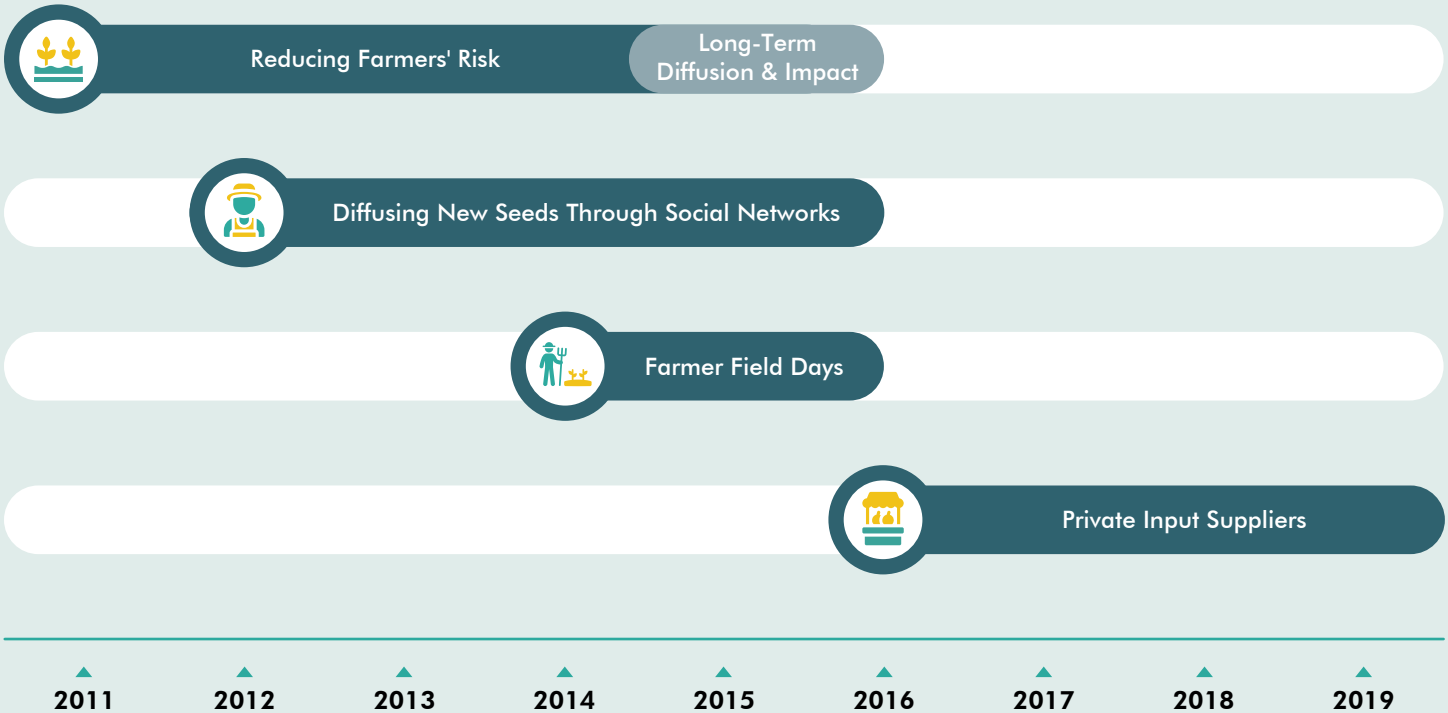
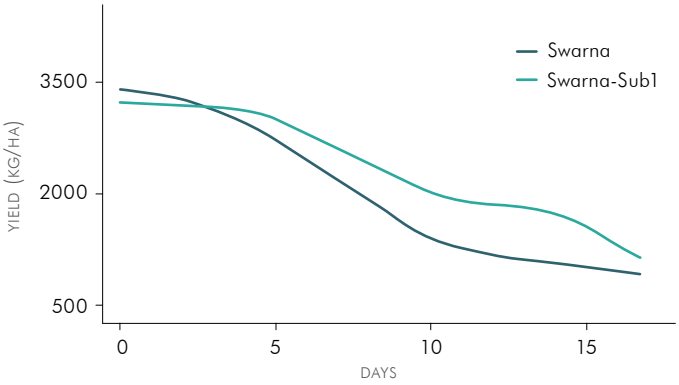
Figure 1. Timeline of the Evaluations



RESULTS

Swarna-Sub1 mitigated risk of crop damage by floods. Relative to Swarna, Swarna-Sub1 increased yields by approximately 64 kg per hectare for each additional day of flooding in the first year of the study which was a flood year. For floods lasting ten days, the avoided yield loss was 628 kg per hectare, representing a 45 percent yield advantage over Swarna. In non-flooded areas, there was no meaningful difference in yield between the two varieties, indicating there was no disadvantage to planting Swarna-Sub1 in non-flood years.

Figure 2. The yield advantage of Swarna-Sub1 increases with more days of flooding



Access to Swarna-Sub1 led farmers to invest more in their farms, benefiting the most marginalized. Being offered a *minikit* of Swarna-Sub1 gave farmers confidence to take higher-reward risks, such as using more land, fertilizer, and better farming methods. These changes boosted rice yields and profits, even without flooding. Specifically, farmers who were offered *minikits* increased yields on their plots by 10 percent over the course of both years of the study even though 2012 was not a flood year. Farmers belonging to Scheduled Castes or Scheduled Tribes, which are historically marginalized groups, benefited most as their fields tend to be located in the most flood-prone areas.

Targeted information and training encouraged farmers to adopt Swarna-Sub1 seeds. Farmers in villages where farmer field days took place were 12 percentage points more likely to adopt Swarna-Sub1 in the following season compared to those who did not participate (42 percent increase in adoption compared to 30 percent). Varying the selection method for farmers receiving *minikits* did not affect adoption rates.

Informing private input suppliers about the benefits of Swarna-Sub1 seeds increased farmers' adoption and cultivation. Farmers in blocks where agro-dealers received extension services were 56 percentage points more likely to adopt Swarna-Sub1 compared to those receiving traditional agricultural extension services (9.8 percent increase in adoption compared to 6.3 percent). These farmers also cultivated more land using Swarna-Sub1.

The result is driven primarily by farmers most exposed to floods, showing that agro-dealers directed the technology to farmers with higher returns. Informed input suppliers became more proactive in carrying Swarna-Sub1 and informing potential customers about its benefits for at least four years after the intervention.

Farmers shared Swarna-Sub1 in their social networks, but the impact of network-based sharing is limited in the short run. One year after introducing the seeds, adoption of Swarna-Sub1 was over five times higher when sold door-to-door compared to adoption rates achieved through informal peer-to-peer sharing (40 percent compared to 7 percent, respectively). Informal sharing between farmers tended to be limited to within caste-based networks. However, social connections only partially explained the adoption gap, suggesting that other factors limited the effectiveness of farmer-to-farmer seed diffusion.

Peer-to-peer sharing facilitated the adoption of Swarna-Sub1 seeds, but limited sharing between caste groups continued to be a barrier in the long run. Four years after the introduction of Swarna-Sub1 seeds, adoption increased overall, particularly in villages where people were more closely connected and shared similar backgrounds. Farmers in more homogeneous villages adopted at a rate of 8 to 9 percentage points higher (an increase of over 370 percent) relative to 1.7 percent in more socially divided villages. However, the rate of adoption still fell far below the estimated demand.

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POLICY LESSONS

Stress-tolerant crops can reduce weather-based risk for farmers, strengthening farmers' resilience to shocks while maintaining productivity in normal years. Moreover, mitigating agricultural risk through stress-tolerant crops could be an important step in encouraging farmers to invest in productive agricultural inputs and practices. To the extent that marginalized groups around the world tend to farm less desirable pieces of land—and to the extent that climate change will make this land increasingly more difficult to farm—access to (and use of) these varieties can also address inequities, as marginalized groups face higher exposure to environmental risk.

Strengthening programs that help farmers learn about the use and benefits of stress-tolerant crops increases their adoption, but the availability of seeds on the supply side is often a barrier. Farmer field days encouraged adoption of Swarna-Sub1 more quickly than peer-to-peer sharing or social learning. Over time, social learning did facilitate adoption of Swarna-Sub1; however, local social structures limited diffusion. Swarna-Sub1 diffused more rapidly and extensively in villages where people were more closely connected and shared similar backgrounds compared to villages with more divided social structures. In the effort to deliver stress-tolerant crops, policymakers should carefully design information dissemination strategies that proactively consider underlying social structures.

When designed carefully, leveraging profit incentives of the private sector spurs adoption of stress-tolerant crops. When agro-dealers were informed of the benefits of Swarna-Sub1 and given seeds to try, farmers with the most flood-prone land purchased and cultivated more Swarna-Sub1. In return, dealers profited and were more likely to keep seed in stock, which increased adoption of the seed. Engaging the private sector offers the chance to stimulate farmer demand and supply simultaneously.

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Featured evaluations: Emerick, Kyle, Alain de Janvry, Elisabeth Sadoulet, and Manzoor H. Dar. 2016. "Technological Innovations, Downside Risk, and the Modernization of Agriculture." *American Economic Review* 106, no. 6 (June): 1537–1561. http://dx.doi.org/10.1257/aer.20150474.

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Briefcase Author: Nisha Giridhar | **Editor:** Anna Schickele
2025 Update Author: Jenna Fahle, CEGA Agricultural Program Manager
Editor: Emily Sylvia

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ABOUT ATAI

The Agricultural Technology Adoption Initiative (ATAI) is a joint effort between J-PAL and CEGA to fund randomized evaluations that rigorously test programs to improve the adoption and profitable use of agricultural technology. The initiative receives support from the Gates Foundation, UK International Development from the UK government, and an anonymous donor.

atai-research.org

ABOUT J-PAL

The Abdul Latif Jameel Poverty Action Lab (J-PAL) is a network of affiliated researchers around the world who are united by their use of randomized evaluations to answer questions critical to poverty alleviation. J-PAL's mission is to reduce poverty by ensuring that policy is informed by scientific evidence.

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ABOUT CEGA

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