Impact of Stress-Tolerant Rice on Farmer Welfare in India

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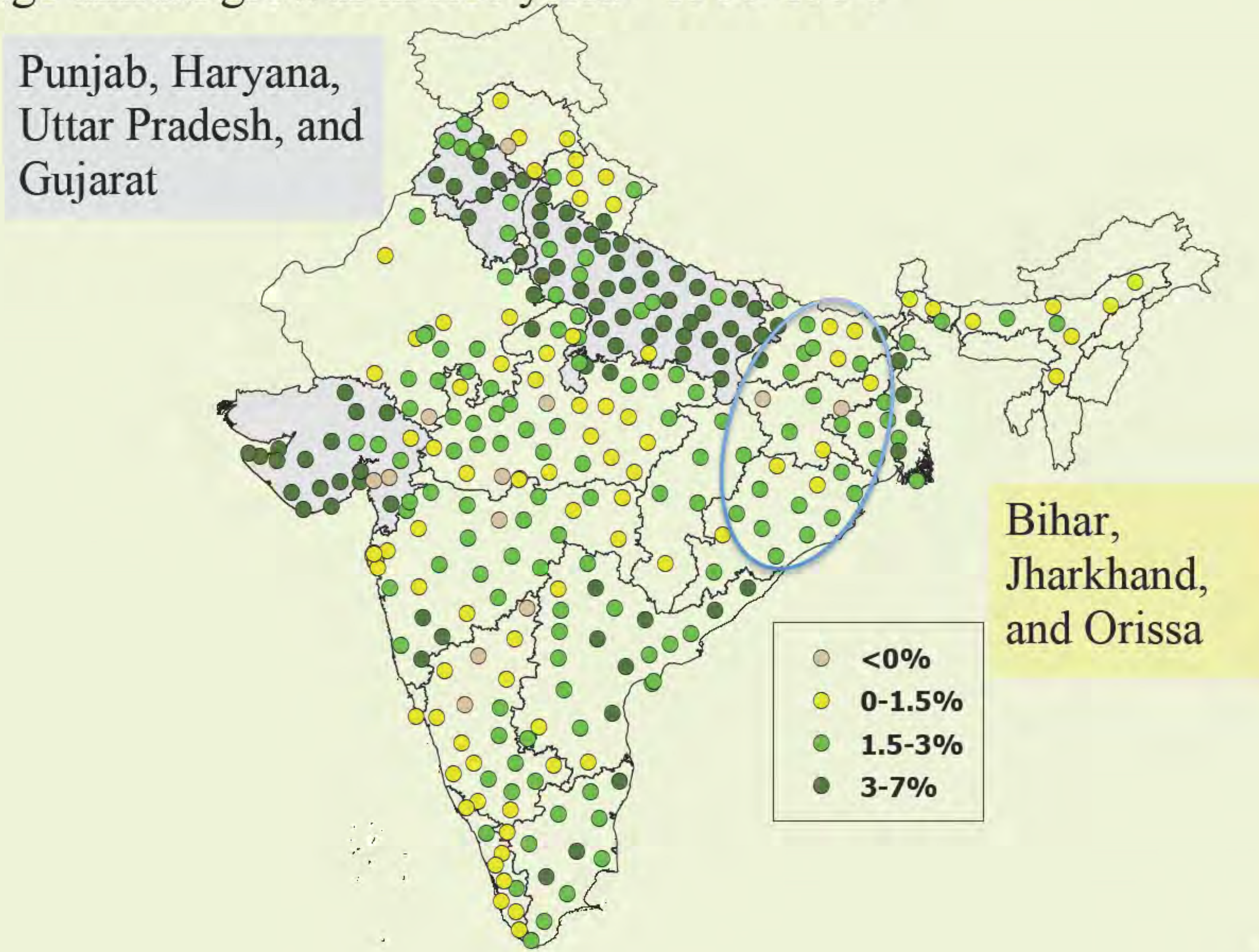
The food problem, ...

- Urgent need to increase food production to feed the world. Need increase by 70% in 2050 (FAO). Main world staples: maize, rice, wheat
- Rice is the major staple food for Asia
- Green Revolution in the 1970s in the best lands with irrigation: huge increase in yield, reaching 11-12 tons/ha, but relatively stagnant yield for the past 10 years.
- 43% of area planted in rice is rainfed, with yield levels on average 44% of what is achieved under irrigated conditions. No Green Revolution for rainfed lands

Average annual growth in rice yield - 1966-1994



agricultural research, ...

- Relative under-investment in research for rice in rainfed areas.
- Return from investment in yield-increasing research is now estimated to be higher for the good rainfed than for the irrigated areas.
- Yield gains could be greatest in addressing losses under extreme events, flood and drought.

Life in rainfed areas: From normal year to flood and drought

flood, drought, and climate change, ...

- Currently, flooding affects some 12 million hectares in South Asia and as much as 1/3 of the rainfed lowland areas in Sub-Saharan Africa.
- Drought regularly affects 13 million hectares of rainfed rice in South Asia. In Orissa, where we work, severe droughts hit about one year in five with losses about 40% of total rice production. Drought is similarly considered to be a major constraint to both upland and rainfed lowland rice production in SSA.
- With the progress of climate change, farmers' exposure to extreme flood and drought events is expected to rise, making resilient yields for these conditions increasingly important.

with a focus on poor farmers

- Most rice in the world is produced in Asia (90%) and Sub-Saharan Africa (3%) in small farms of 0.5 to 3 ha.
- Hence, rice production is closely associated with rural poverty and vulnerability to poverty and hunger.

- Raising the technological frontier for rice research is in part led by the Gates-IRRI STRASA initiative

- New flood-tolerant (Swarna-Sub1) and drought-tolerant (Sahbhagi Dhan) varieties have recently been released by IRRI and the Indian National Agricultural Institute.

- The ATAI research results we report here are part of this initiative.

New varieties and their potential expansion

A flood tolerant rice: Swarna-Sub1

Identification of a single gene Sub1 that can be inserted in the popular varieties

Potential for India: approximately 12-14 million hectares, or 30 percent of the cultivated rice area

Swarna is cultivated on an estimated 30-40% of the area in rainfed lowlands. Swarna-Sub1 maintains all the properties of Swarna while acquiring improved submergence tolerance.

A drought tolerant rice: Sahbhagi Dhan

An early maturing crop, Sahbhagi Dhan (SD) is designed to withstand up to two weeks of drought exposure

Potential for Asia, 20 percent of the total rice cultivation.

For India: Large potential in many of the poorest states.

Potential for Africa? Certainly very large. IRRI and Africa Rice working on inserting gene in African varieties

This project:

1. Field experiment to establish the yield profile of new seeds

Extensive trials in experimental station settings. Useful to establish the agronomic potential. But cannot predict what farmers will obtain.

Results for Swarna-Sub1.

2. Beyond the direct effect, establish the behavioral response of farmers to lower risk exposure

Preliminary (and incomplete results for Swarna-Sub1)

Work on drought tolerant Sahbhagi Dhan still in the field

Overview of Results

Efficiency impact

Swarna-Sub1 has a significant advantage over Swarna for flood of 6-14 days, with a 45% yield advantage for 10 days of submergence. Swarna-Sub1 is as good as Swarna when there is no flood.

Equity impact

Because of the location of their lands, low caste farmers are predicted to have a 15.2 percentage point larger yield gain than the general farming population in heavy flooding years.

Behavioral response

Strong response from farmers increasing investment in rice (area and inputs)

Experimental Design - RCT

Random selection of 64 treatment villages and 64 control villages in flood-prone districts of Orissa

May-June 2011, visit and identification with local leaders of 25 farmers that cultivate Swarna and have land that is prone to flooding.

5 farmers in each of the 64 treatment villages randomly selected to receive a 5 kgs minikit of Swarna-Sub1 seed

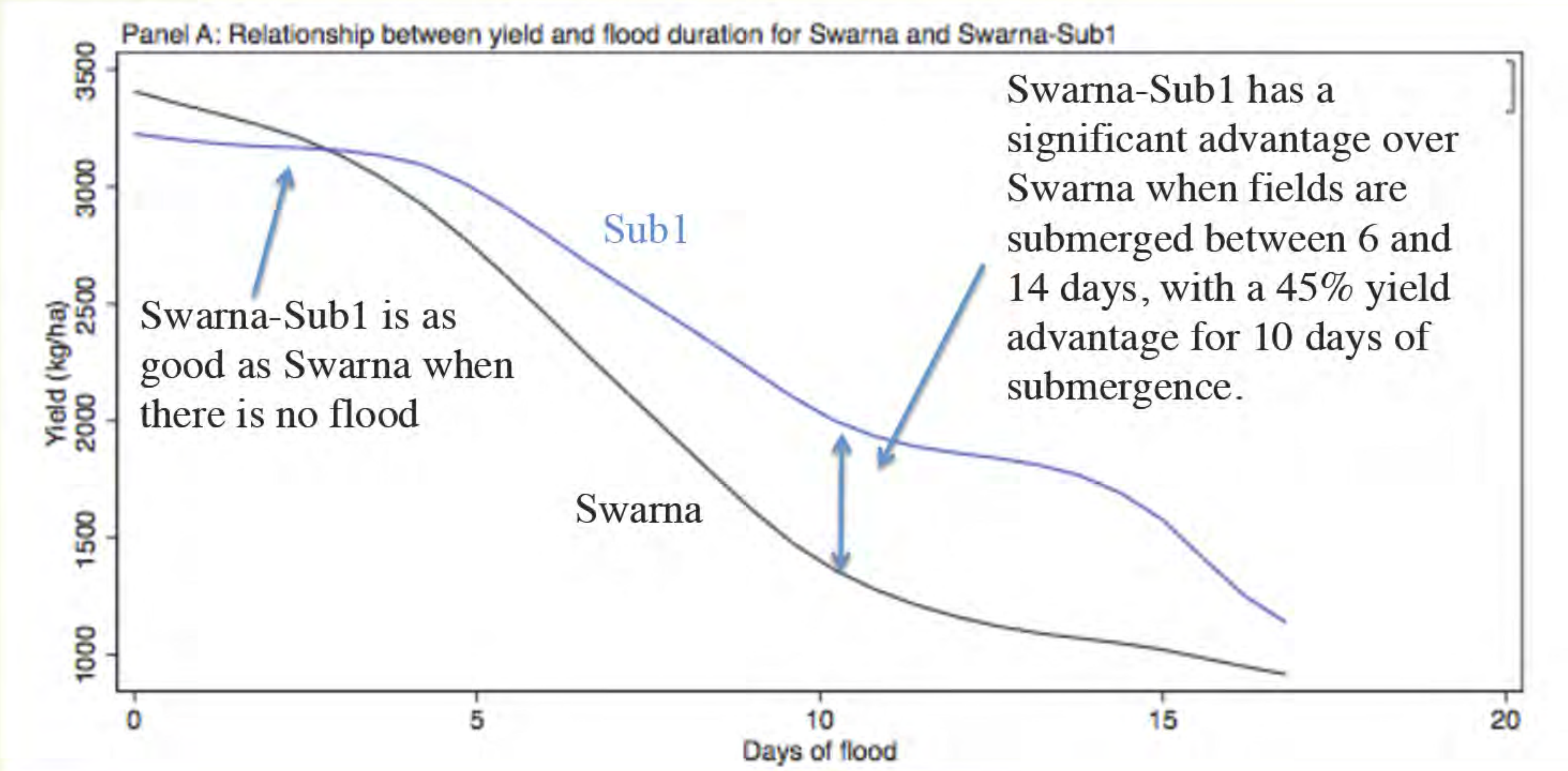
The minikits were delivered prior to sowing time in mid June.

Feb-March 2012, survey of 1248 farmers: 5 minikit recipients + 10 randomly chosen farmers in T villages + 5 randomly chosen farmers in C villages

Kharif 2011 – Important flooding in Orissa. Flooding very localized, hence varies a lot across plots, from 0 to 15 days, in any single year.

Farmer in our project inspecting his flooded rice field

Efficiency result: Impact of flood-tolerant rice (Swarna-Sub1) on yield during 2011 wet season



Equity result (agronomy and geography)

”Schedule Castes (SC)” and ”Schedule Tribes (ST)” are lowest socio-economic groups in India

Over years of discrimination and marginalization, they are more likely to be on worst land:

- Mountainous very dry areas (ST)
- Areas/fields with more flooding in flood prone area (SC)

In our sample:

Plots cultivated by SC had 1.8 more days of flood (21%) than others

For Orissa:

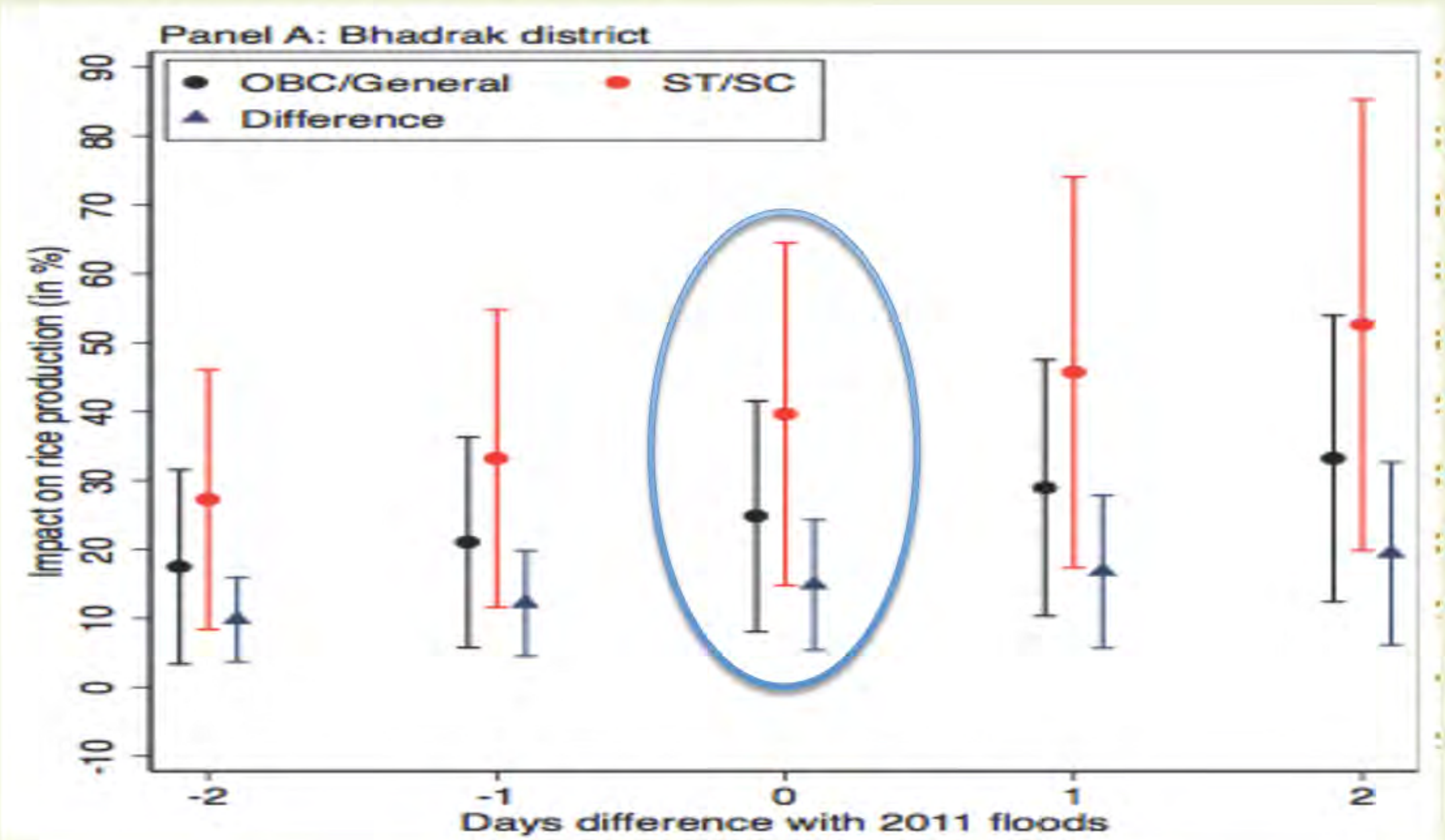
During the 2008 major flood, using RADARSAT images overlayed on 4,200 geo-coded villages with census information, villages with entirely SC were twice as likely to be flooded for 8-12 days as other villages

Simulation results:

Predicted increase in total rice production (with flood of 2011) of

25.4% for OBC/General caste farmers

40.6% for SC/ST farmers



Behavioral response to lower risk

Year 2012: No flood at all, in fact somewhat drought conditions

What should we expect to see?

No difference between Sub1 and Swarna?

No difference between minikit recipients and control farmers?

Economic behavior (preliminary, 65% of data):

Facing less downward risk, minikits recipients:

- Obtained a 14.4% higher yield, even with no flood
- Changed their management practices
    * less likely to fallow low land plots
    * 13% less plots planted with traditional varieties
    * less broadcast (cheaper technique)
    * lower seed rate (insurance technique)
    * more fertilizer (10-20% depending on which fertilizer)
- Cultivated more rice (9.1% larger area)

(on average over all plots, not only Sub1)

Conclusion

Need yield gains to address future world food security problem:

- Technological saturation in irrigated areas
- Potential yield gains in marginal areas
- Drought and flood tolerance, crucial with climate change

First round efficiency: Flood-tolerant rice successful for 6-14 days:

- 45% yield advantage with 10 days

Equity gains due to discriminatory access to land by quality:

- Concentration of SC in flood prone areas

Second round efficiency effect through behavioral response:

- Farmers improve their management practice and obtain *higher* yields, even when no flood.

Flood tolerance technological innovation is win-win for efficiency and equity gains. A very promising instrument of adaptation to climate change.

Future steps:

Confirm behavioral response of farmers with Sub1

Drought-tolerant variety: minikits distributed, survey in progress.