Productivity Effects of Farmers Field Schools: Evidence from Rice Producers in the Senegal River Valley

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Introduction

- Data are sourced from a FFS intervention implemented by FAO on rice producers in the Senegal River Valley (SRV)
- Sample selected around Farmer Field Schools (FFS) participants
- Interest on further validating the methodology for possible use in future impact assessments of relevant IFAD projects
- Quasi-experimental approach

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Objectives and Contribution

- Assess the impact of FFS participation on rice technology (frontier shift) and management (technical efficiency change) accounting for selectivity bias on observables and unobservables
- Evaluate possible spillovers from FFS participants to neighbouring farmers
- We combine Impact Evaluation and Stochastic Production Frontier (SPF) methods
- Similar applications: González-Flores *et al*. (2014), Villano *et al*. (2015), Abdulai and Abdulai (2017), De los Santos and Bravo-Ureta (2017), Lawin and Tamini (2018)

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Study Area

- Rice core staple in Senegal though about 80% is imported
- The Government launched a number of programs aimed at achieving self-sufficiency in rice production
- Rice produced mainly in the SRV, primarily by smallholder farmers with an avg. yield of about 5 tons/ha
- FFS has been promoted by FAO as a way of increasing adoption of sustainable rice intensification (SRI) practices to increase productivity → **Shift the frontier**
- This was done through provision of training and technical assistance to support adoption and implementation → **Increase technical efficiency**
- FFS relies on spillovers from FFS graduates to control farmers living nearby

Data and Samples for Analysis

- Cross-sectional parcel level data for (i) FFS participants, (ii) neighbors (spillovers), and (iii) non-neighbors located in Dagana and Podor depts.
- Fundamental differences between the two depts, suggests separate analysis → We focus on Podor due to very small sample size for Dagana
- Participants of other types of FFS are also excluded from the sample → We focus on rice FFS

Methodology

- The methodology applied includes the following steps:
  1. Use Propensity Score Matching (PSM) to define a sample of treated and control parcels that are as similar as possible based on **observable** attributes;
  2. Estimate separate SPF models for treated and control parcels to deal with possible **difference in technology** across the two groups and biases from **unobservables** (Greene, 2010; Bravo-Ureta *et al.*, 2012);
  3. Estimate a stochastic **meta-frontier** model to obtain a benchmark technology to compare directly the performance of treated and control groups (Battese and Rao, 2002; Battese, 2004; O'Donnell *et al.*, 2008; Huang *et al.*, 2014).

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Definition of Treated and Control Groups

- We estimate a probit model on FFS participation to generate PS
- We use radius matching of PS to improve the balance of the treated-control sub-samples enforcing common support condition
- We drop further controls with a score below the next lowest treated score and above the highest treated score
- Three alternative matched sub-samples are created based on alternative control groups:
  1) Non-participants living in treated communities (neighbors);
  2) Non-participants living in non-treated communities (non-neighbors);
  3) The combination of 1) and 2).

Reduction of Bias (Rubin's B)		**Rubin's R**		**Final sample size**	
Before	After	Before	After	Participants	Neighbors
85.5%	32.8%	0.88	1.31	156 (9)	188 (7)

Reduction of Bias (Rubin's B)		**Rubin's R**		**Final sample size**	
Before	After	Before	After	Participants	Non-neighbors
99.5%	21.3%	1.28	0.83	152 (13)	296 (40)

Estimation of SPF models

- Once treated-control sub-samples are defined we estimate the following CD SPF using all observations:

$$(1)\quad ln(Y_i) = \beta_0 + \sum_{j=1}^{n} \beta_j \, ln(X_{ij}) + \delta_l D_l + v_i - u_i$$

- We then use (1) except that we drop D_l and estimate separate SPF models for treated and controls
- We perform a LR test (Greene, 2007) to compare separate vs pooled model and check whether treated and controls display different technologies
- We estimate the Sample Selection corrected SPF (SPF-SS) using again (1) separately for treated and controls along with the following selection equation:

$$(2)\quad PART_i = \alpha_0 + \sum_{k=1}^{n} \alpha_{ik} Z_{ik} + w_i$$

- SPF-SS model is estimated twice: first for treated ($PART_i$=1 for treated) and then for controls ($PART_i$=1 for controls)

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Results: **Neighbors** Control Group

Y = Log rice production (kg)	(2): Neighbors				
	Conventional SPF			SPF-SS	
	(1A) Pooled Coeff	(1B) Participants Coeff	(1C) Neighbors Coeff	(1D) Participants Coeff	(1E) Neighbors Coeff
Dummy participant to FFS	.09013***				
Log land (ha)	.54272***	.60805***	.41358***	.60092***	.40715***
Log seeds (kg)	.23074***	.24119***	.12180***	.24437***	.11380***
Log exp.on purchased inputs & irrigation (LCU)	.09375***	.05968***	.41205***	0.05748	.43194***
Log labor (person days)	-0.11133	-0.12234	-.14778***	-0.11653	-.14188***
Dummy hired labor	0.03274	.15014***	-0.08987	.14560*	-0.15148
Dummy PIV/PIP irrigation scheme	0.01252	-.11135**	.12828**	-.10660**	.12905***
Constant	6.82690***	7.32060***	3.78563***	7.32613***	3.44726***
Observations	**344**	**156**	**188**	**156**	**188**
lambda [sigma(u)/sigma(v)]	**1.768*** **	**1.641*** **	**2.158*** **	**-**	-
LR test for pooled vs. separate frontiers					
Chi-sq Computed =	21.230	**cannot reject**			
Degrees of freedom =	9	**H0**			
Chi-sq C* 99% =	21.666				
ρ(w,v)	-	**-**	-	**-0.19735**	**.80588*** **

*** p<0.01, ** p<0.05, * p<0.1

Results: **Non-neighbors** Control Group

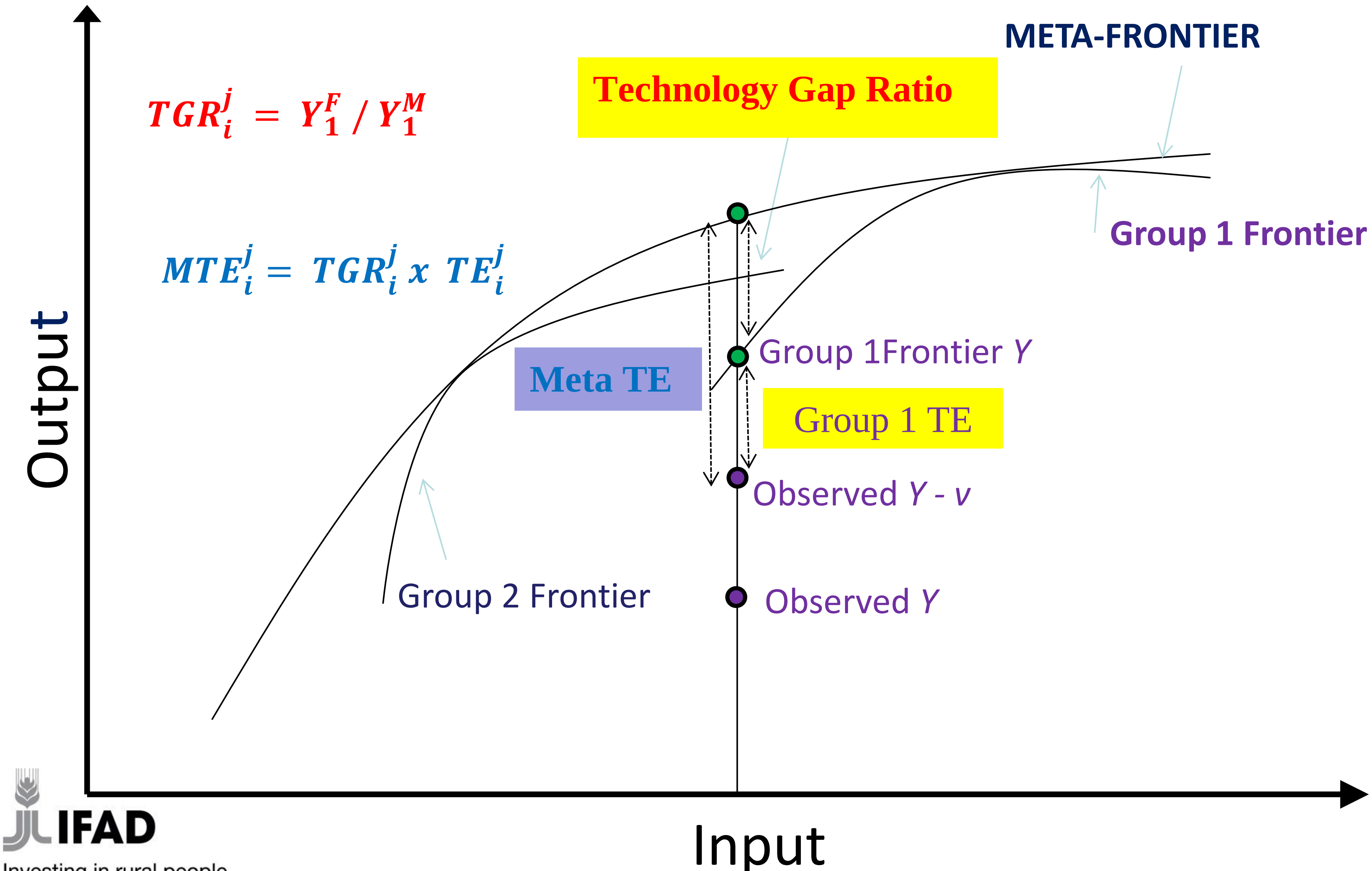
Y = Log rice production (kg)	(2): Non-neighbors				
	Conventional SPF			SPF-SS	
	(2A) Pooled Coeff	(2B) Participants Coeff	(2C) Non-neighbors Coeff	(2D) Participants Coeff	(2E) Non-neighbors Coeff
Dummy participant to FFS vs all controls	.08765**				
Log land (ha)	.52759***	.60528***	.33816**	.60092***	.40715***
Log seeds (kg)	.21311***	.24227***	.17953***	.24437***	.11380***
Log exp. on purchased inputs & irrigation (LCU)	.11036***	.06172***	.32143**	0.05748	.43194***
Log labor (person days)	-0.01914	-0.11905	0.00857	-0.11653	-.14188***
Dummy hired labor	0.10152	.11687***	0.08232	.14560*	-0.15148
Dummy PIV/PIP irrigation scheme	.06512**	-.10213*	.10813***	-.10660**	.12905***
Constant	6.22209***	7.28236***	3.73540**	7.32613***	3.44726***
Observations	**448**	**152**	**296**	**156**	**188**
lambda [sigma(u)/sigma(v)]	**1.509*** **	**1.636*** **	**1.539*** **		
LR test for pooled vs. separate frontiers					
Chi-sq Computed =	22.374	reject H0			
Degrees of freedom =	9				
Chi-sq C* 99% =	21.666				
ρ(w,v)	-	-	-	**-0.07602**	**-0.09085**

*** p<0.01, ** p<0.05, * p<0.1

Estimation of the Meta-Frontier

- Results indicate that:
  - Participants and Non-neighbors display different technologies, whereas Participants and Neighbors share the same technology;
  - As expected, there is evidence of selection bias for Neighbors, whereas there is not for Non-neighbors.
- The final step of the analysis implies estimating a stochastic meta-frontier (SMF) to be able to compare output and technical efficiency (TE) across treated and control groups
- Finally for each group, we compute and compare the following:
  - Predicted group frontier output and predicted meta-frontier output;
  - TE level in the group frontier and in the meta-frontier;
  - Technology Gap Ratio (TGR) – defined as the distance between the group frontier and the meta-frontier.

Group Frontiers and Meta-Frontier



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FFS Impact on Frontier Output and TE

	Participants (N=156)	Neighbors (N=188)	Diff.	Test of means
Predicted group frontier output	2 718	1 995	**36%**	***
TE group frontier	0.666	0.600	**11%**	***
Predicted meta frontier output	2 930	2 683	9%	
TE meta-frontier	0.612	0.454	**35%**	***
MTR	0.918	0.756	**22%**	***

	Participants (N=152)	Non-neighbors (N=296)	Diff.	Test of means
Predicted group frontier output	2 692	2 356	**14%**	**
TE group frontier	0.650	0.644	1%	
Predicted meta frontier output	2 716	2 652	2%	
TE meta-frontier	0.634	0.579	**10%**	***
MTR	0.974	0.898	**9%**	***

Conclusions and the Way Forward

- Overall positive impact of FFS participation on productivity (technology shift + positive change in TE level)
- Larger relative gains for participants *vis-à-vis* neighbors *vs* participants *vis-à-vis* non-neighbors
- Neighbors don’t seem to have benefited from spillover effects
- Results suggest that more productive farmers self-selected into the project but did not pass on their knowledge
- Try alternative matching methods to improve balance of treated and control groups
- Heterogeneity analysis (length of participation, frequency of meeting attendance, etc.)
- Closer look at changes in input usage and adoption of SRI practices

THANK YOU!

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