From Learning to Doing: Diffusion of Agricultural Innovations in Guinea-Bissau

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1 Introduction

➢ Agriculture represents the main source of livelihood for Africa's low-income population

➢ Productivity improvements can be an effective means to reduce poverty

➢ Adopting modern agricultural practices/technologies could boost productivity

➢ …but adoption in the region has been low and slow

1 Introduction

➤ **Information barriers** (e.g. low access to extension services and to reliable information) can prevent the uptake of agricultural technologies

➤ **Social interactions** may play a key role in mitigating information constraints and disseminating improved technologies

1 Introduction

In this paper:

➢ This paper analyzes the **role of social networks in the diffusion** of cultivation techniques introduced by an agricultural project in Guinea-Bissau.

➢ We take advantage of this intervention to study the diffusion of knowledge and adoption of cultivation techniques from project participants to the wider community.

  ▪ Does the knowledge gained by project participants have spillover effects to the rest of the community?

  ▪ And does it translate into practices adoption?

  ▪ How do the different information channels affect the diffusion of information and adoption?

2 Related Literature

➤ **Positive diffusion effects along social networks have been documented in a variety of settings:**

- health prevention (Oster and Thornton, 2012; Godlonton and Thornton, 2012)
- educational outcomes (Bobonis and Finan, 2009; Fafchamps and Mo, 2017)
- financial decisions (Cai, Janvry and Sadoulet, 2015; Banerjee et al., 2013)
- agricultural practices (Foster and Rosenzweig, 1995; Munshi, 2004; Bandiera and Rasul, 2006; Conley and Udry, 2010; Van den Broeck and Dercon, 2011)

➤ **…but results have not always been as encouraging:**

- limited diffusion (Fafchamps and Quinn, 2016; Fafchamps and Söderbom, 2014)
- no diffusion (Duflo, Kremer and Robinson, 2011)
- delay adoption and free-riding behavior (Foster and Rosenzweig, 1995; Bandiera and Rasul, 2006; Maertens, 2017)
- negative effects (Kremer and Miguel, 2007)

3 Study Design

➢ Suzana village: 354 households and 8 neighbourhoods

4 Project

Horticultural project implemented by NGO 'VIDA'

- 3 sessions of **horticultural production**
  - <u>Improved horticultural production practices </u>(Land preparation, staking, pruning, pest and disease management, organic pesticides…)

Project participants

- Participants selection: Village leaders provided a list of female farmers interested in participating in the intervention
- List of potential participants: sample of a randomized impact evaluation conducted on the project
- Randomly allocated to either the control or treatment group
- 35 treated farmers in Suzana

5 Measurement and data

1st Household survey:

- Village census
- Photo of the respondent for the **village photo album**, which included one photo per household

2nd Household survey:

- Network links
- Improved horticultural production practices and knowledge

➢ All the households in the village
➢ Both data collection activities took place after the horticultural training intervention

5.1 Network measures

➢ Complete network map

Four network dimensions:

i.   **kinship**: individuals with whom the respondent has a kinship tie;

ii. **regular chatting**: individuals the respondent regularly chats with;

iii. **agricultural advice**: individuals the respondent would go to for agricultural advice;

iv. **borrowing money**: individuals the respondent could ask for money in time of need.

5.1 Network measures

The main network variables were collected through survey questions in a **two step procedure**:

- **1st step:** Elicit link from **"memory"**
  - E.g. "Who are your family members that live in the neighbourhood of «Catama» but outside of your household residence?"

5.1 Network measures

- **2nd step**: Elicit extra links not mentioned yet using the **photo album**.
  - E.g. "Do you have any other familiy member living in the neighbourhood of «Catama»?"
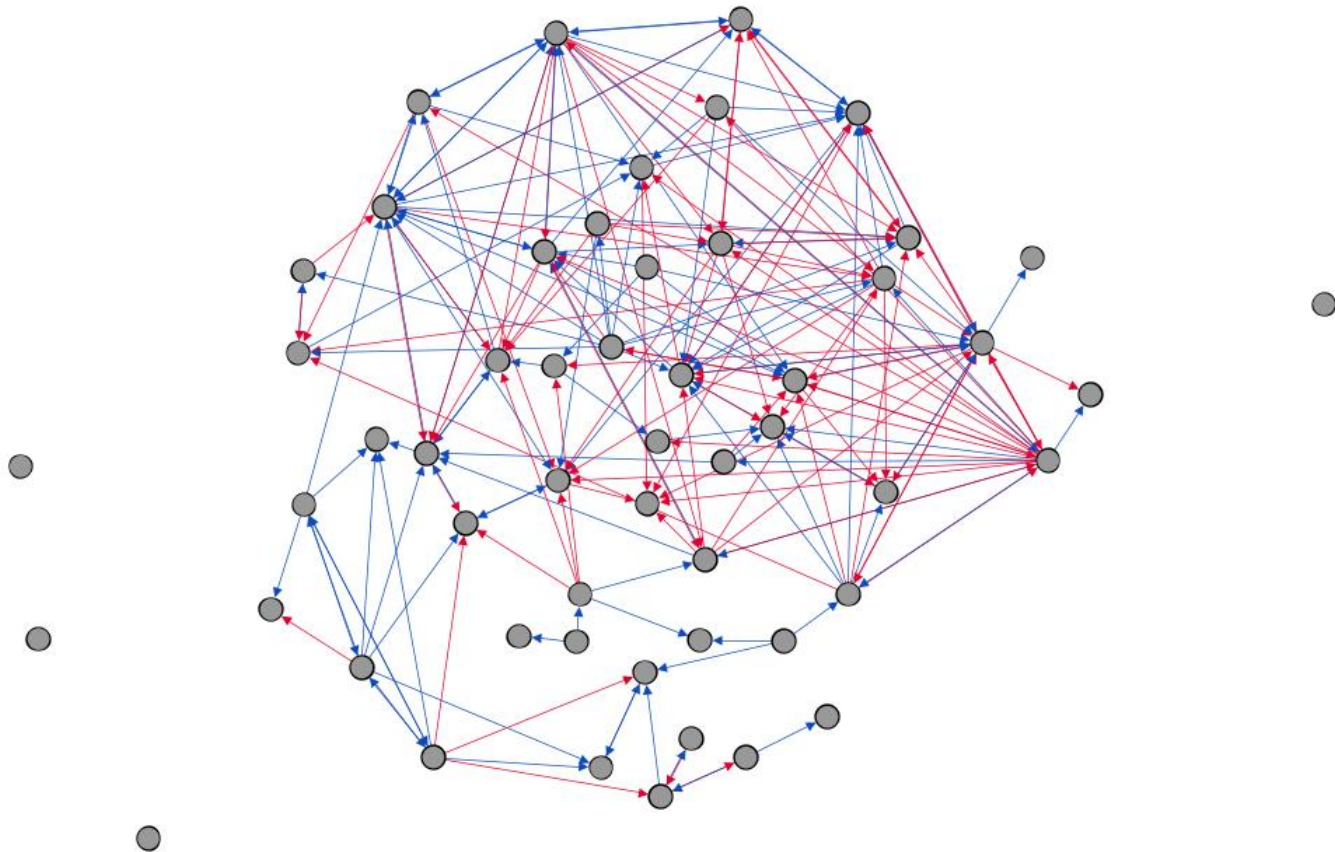
5.1 Network measures

Strength of the ties:

- links that were elicited from **memory** are more likely to capture **strong ties**;

- links elicited with **village photo** album would more likely capture the **weak ties**.

➤ Robustness check: Positive correlation between our tie strength measure and the tie strength proxies used in the literature.

❖Table

5.1 Network measures

Kinship network

5.1 Network measures

Table 1: Summary statistics

		Obs	Mean	Std. Dev.	Min	Max
kinship network	**strong**	355	19.30	13.47	0	102
	weak	355	17.15	14.58	0	96
chatting network	**strong**	355	14.52	9.81	0	52
	weak	355	7.10	10.84	0	94
agricultural advice network	**strong**	355	4.43	5.83	0	37
	weak	355	1.26	2.51	0	16
borrowing money network	**strong**	355	6.15	5.22	0	27
	weak	355	1.43	2.70	0	20

5.2 Outcome measures

➤ **practices knowledge**

 • Index of 10 improved practices knowledge

 • Based on survey questions

➤ **practices adoption**

 • Index of 10 improved practices adoption

 • Based on survey questions

❖ Table

6.1 Results: Impact evaluation

➢ RCT

Table 3: Adoption and knowledge of production practices

dependent variable ------>		practices knowledge		practices adoption	
		(1)	(2)	(3)	(4)
Treatment	coefficient	0.200*	0.197*	0.254***	0.252***
	standard error	(0.116)	(0.111)	(0.095)	(0.096)
mean dep. variable (control)		0.000	0.000	0.000	0.000
r-squared adjusted		0.022	-0.001	0.069	0.053
number of observations		75	75	75	75
controls		no	yes	no	yes

Note: All regressions are OLS. The unit of observation is the individual. Only observations from the impact evaluation sample are included. The dependent variables are an average of z-scores. 'treatment' is a binary variable, which takes the value of one if the individual was assigned to the treatment group and zero otherwise. Controls are individual and household characteristics, which include age, years of education, religion dummies, marital status, whether the households produced horticultural crops in the previous year and household assets. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

6 Results: Network effects

$$Y_i = \alpha + \beta_T \boldsymbol{N_i^T} + \beta_{nT} N_i^{nT} + \gamma X_i + \theta \bar{X}_{-i} + \varepsilon_i,$$

- Y_i : outcome of interest for **non-treated individuals**
- $\boldsymbol{N_i^T}$: number of **links with treated** individuals in i social network
- N_i^{nT}: number of **links with non-treated** individuals in i social network

- X_i: vector of individual and household characteristics
- $\bar{X}_{-i}$: vector of average individuals and household characteristics in i network

6 Results: Network effects

$$Y_i = \alpha + \beta_{sT} N_i^{sT} + \beta_{wT} N_i^{wT} + \beta_{nT} N_i^{nT} + \gamma X_i + \theta \bar{X}_{-i} + \varepsilon_i$$

- N_i^{sT}: number of **strong links with treated** individuals in i social network;

- N_i^{wT}: number of **weak links with treated** individuals in i social network.

6 Results: Short run network effects

Table 8: Knowledge of production practices

dependent variable ------>		practices knowledge							
network variable ------>		kinship		regular chatting		agricultural advice		borrowing money	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
number of links with treated (β_T)	Coeficiente	0.040*		0.057***		0.059**		0.059	
	standard error	(0.020)		(0.022)		(0.024)		(0.039)	
number of strong links with treated (β_{sT})	Coeficiente		-0.009		0.052*		0.070**		0.049
	standard error		(0.029)		(0.031)		(0.027)		(0.044)
number of weak links with treated (β_{wT})	Coeficiente		0.079***		0.062**		0.029		0.094
	standard error		(0.025)		(0.024)		(0.054)		(0.073)
number of links with non-treated (β_{nT})	Coeficiente	-0.004	-0.004	-0.009*	-0.009*	-0.014	-0.015*	-0.018*	-0.019*
	standard error	(0.004)	(0.004)	(0.005)	(0.005)	(0.009)	(0.009)	(0.011)	(0.011)
mean dep. Variable		-0.910	-0.930	-0.664	-0.656	-1.046	-1.042	-1.083	-1.094
$\beta_T = \beta_{nT}$	F-stat p-value	0.063		0.011		0.017		0.091	
$\beta_{sT} = \beta_{wT}$	F-stat p-value		0.021		0.770		0.512		0.590
r-squared adjusted		0.334	0.344	0.354	0.352	0.456	0.454	0.337	0.335
number of observations		308	308	308	308	308	308	308	308
Controls		yes	yes	yes	yes	yes	yes	yes	yes

Note: All regressions are OLS. The unit of observation is the household. Treated households are excluded from the observations. The dependent variable is an average of z-scores. 'number of links with treated' is the number of links with treated individuals in individual i's social network. 'number of links with non-treated' is the number of links with non-treated individuals in individual i's social network. 'number of strong links with treated' and 'number of weak links with treated' refer to the number of strong and weak links with treated individuals in i's social network, respectively. Controls are demographic characteristics and average demographic characteristics in the network. Demographic characteristics include gender, years of education, marital status, religion, ethnic group, whether the household produced horticultural crops in the previous year, and household assets. Average demographic characteristics in the network include proportion of female respondents, average years of education, proportion of married respondents, proportion of animists, proportion of respondents from the main ethnic group, proportion of households that produced horticultural crops in the previous year and household assets in the network. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

6 Results: Short run network effects

Table 9: Adoption of production practices

dependent variable ------>		practices adoption							
network variable ------>		Kinship		regular chatting		agricultural advice		borrowing money	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
number of links with treated (β_T)	coefficient	0.017		-0.008		0.033		0.022	
	standard error	(0.016)		(0.018)		(0.034)		(0.027)	
number of strong links with treated (β_{sT})	coefficient		0.009		0.024		0.051		0.023
	standard error		(0.022)		(0.026)		(0.043)		(0.029)
number of weak links with treated (β_{wT})	coefficient		0.023		-0.038*		-0.019		0.018
	standard error		(0.020)		(0.022)		(0.051)		(0.059)
number of links with non-treated (β_{nT})	coefficient	0.000	0.000	-0.001	-0.001	0.004	0.003	-0.000	0.000
	standard error	(0.003)	(0.003)	(0.004)	(0.004)	(0.008)	(0.009)	(0.008)	(0.008)
mean dep. Variable		-2.284	-2.288	-1.282	-1.329	-1.824	-1.817	-1.908	-1.907
$\beta_T = \beta_{nT}$	F-stat p-value	0.373		0.761		0.467		0.491	
$\beta_{sT} = \beta_{wT}$	F-stat p-value		0.592		0.048		0.275		0.931
r-squared adjusted		0.574	0.573	0.562	0.567	0.626	0.627	0.567	0.565
number of observations		311	311	311	311	311	311	311	311
Controls		yes	yes	yes	yes	yes	yes	yes	yes

Note: All regressions are OLS. The unit of observation is the household. Treated households are excluded from the observations. The dependent variable is an average of z-scores. 'number of links with treated' is the number of links with treated individuals in individual i's social network. 'number of links with non-treated' is the number of links with non-treated individuals in individual i's social network. 'number of strong links with treated' and 'number of weak links with treated' refer to the number of strong and weak links with treated individuals in i's social network, respectively. Controls are demographic characteristics and average demographic characteristics in the network. Demographic characteristics include gender, years of education, marital status, religion, ethnic group, whether the household produced horticultural crops in the previous year, and household assets. Average demographic characteristics in the network include proportion of female respondents, average years of education, proportion of married respondents, proportion of animists, proportion of respondents from the main ethnic group, proportion of households that produced horticultural crops in the previous year and household assets in the network. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

7 Conclusion

➢ We take advantage of a rich data set based on village census and detailed network data to study social learning effects on agricultural practices knowledge and adoption

➢ Impact evaluation:

- positive effect in practices knowledge
- positive effect in practices adoption

7 Conclusion

➢ Network effects:

- positive knowledge externalities

- different information channels at work

- weak social network links seem to be as important as strong links in the diffusion of knowledge

- no effects in adoption

➢ Open question: non-adoption or delayed adoption?

➢ Future work: Long run network effects

4.1 Network measures

Table A1a: Kinship link strength

dependent variable ------>		link reciprocity	mutual ties
		(1)	(2)
strong kinship link	coefficient	0.037***	0.028***
	standard error	(0.012)	(0.004)
mean dep. Variable		0.011	0.276
r-squared adjusted		0.021	0.055
number of observations		12 571	12 571
controls		yes	yes

Note: All regressions are OLS. The unit of observation is the directed dyad. The dependent variables link reciprocity is binary. It takes the value of one if there is a reciprocal relationship between nodes i and j, and zero otherwise. The dependent variable proportion of mutual ties is the number ties common to nodes i and j divided by the total number of ties in both i and j. 'strong kinship link' is a dummy variable. It takes the value of one if nodes i and j have a strong kinship link and zero if the link is weak. Controls include characteristics of the dyad and of both nodes. Dyad controls include whether the respondents have the same religion, belong to the same ethnic group, have the same gender and the geographical distance between them. Node controls are individual and household characteristics, which include years of education, household assets, marital status and whether the household produced horticultural crops in the previous year. Two-way cluster-robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

4.1 Network measures

Table A1b: Regular chatting link strength

dependent variable ------>		link reciprocity	mutual ties
		(1)	(2)
strong regular chatting link	coefficient	0.100***	0.041***
	standard error	(0.011)	(0.005)
mean dep. Variable		-0.118	0.226
r-squared adjusted		0.040	0.105
number of observations		7 604	7 604
controls		yes	yes

Note: All regressions are OLS. The unit of observation is the directed dyad. The dependent variables link reciprocity is binary. It takes the value of one if there is a reciprocal relationship between nodes i and j, and zero otherwise. The dependent variable proportion of mutual ties is the number ties common to nodes i and j divided by the total number of ties in both i and j. 'strong regular chatting link' is a dummy variable. It takes the value of one if nodes i and j have a strong regular chatting link and zero if the link is weak. Controls include characteristics of the dyad and of both nodes. Dyad controls include whether the respondents have the same religion, belong to the same ethnic group, have the same gender and the geographical distance between them. Node controls are individual and household characteristics, which include years of education, household assets, marital status and whether the household produced horticultural crops in the previous year. Two-way cluster-robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

4.1 Network measures

Table A1c: Agricultural advice link strength

dependent variable ------>		link reciprocity	mutual ties
		(1)	(2)
strong agricultural advice link	coefficient	0.045***	0.006
	standard error	(0.016)	(0.011)
mean dep. Variable		-0.195	0.576
r-squared adjusted		0.029	0.129
number of observations		2 010	2 010
controls		yes	yes

Note: All regressions are OLS. The unit of observation is the directed dyad. The dependent variables link reciprocity is binary. It takes the value of one if there is a reciprocal relationship between nodes i and j, and zero otherwise. The dependent variable proportion of mutual ties is the number ties common to nodes i and j divided by the total number of ties in both i and j. 'strong agricultural advice link' is a dummy variable. It takes the value of one if nodes i and j have a strong agricultural advice link and zero if the link is weak. Controls include characteristics of the dyad and of both nodes. Dyad controls include whether the respondents have the same religion, belong to the same ethnic group, have the same gender and the geographical distance between them. Node controls are individual and household characteristics, which include years of education, household assets, marital status and whether the household produced horticultural crops in the previous year. Two-way cluster-robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

4.1 Network measures

Table A1d: Borrowing money link strength

dependent variable ------>		link reciprocity	mutual ties
		(1)	(2)
strong borrowing money link	coefficient	0.039***	0.034***
	standard error	(0.015)	(0.011)
mean dep. Variable		-0.042	0.466
r-squared adjusted		0.030	0.132
number of observations		2 665	2 665
controls		yes	yes

Note: All regressions are OLS. The unit of observation is the directed dyad. The dependent variables link reciprocity is binary. It takes the value of one if there is a reciprocal relationship between nodes i and j, and zero otherwise. The dependent variable proportion of mutual ties is the number ties common to nodes i and j divided by the total number of ties in both i and j. 'strong borrowing money link' is a dummy variable. It takes the value of one if nodes i and j have a strong borrowing money link and zero if the link is weak. Controls include characteristics of the dyad and of both nodes. Dyad controls include whether the respondents have the same religion, belong to the same ethnic group, have the same gender and the geographical distance between them. Node controls are individual and household characteristics, which include years of education, household assets, marital status and whether the household produced horticultural crops in the previous year. Two-way cluster-robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

4.2 Outcome measures

➤ Index of production **practices knowledge**

Improved horticultural production knowledge	
1) Land preparation	Best use for the stover and straws after land preparation
2) Irrigation	Advantages of early morning or late afternoon watering
3) Nursery Management	Best way to protect the nursery from sunlight
4) Spacing	Ideal spacing between onions
5) Mulch	Advantages of mulch
6) Soil enrichment	Awareness of different soil fertilizers
7) Pruning	Advantages of pruning
8) Staking	Crops that need staking
9) Pest and disease management	Awareness of organic pesticides
10) Crop rotation	Awareness of crop rotation

4.2 Outcome measures

➤ Index of production **practices adoption**

Improved horticultural production adoption	
1) Land preparation	Use of stover and straws after land preparation
2) Irrigation	Time of irrigation
3) Nursery Management	Sunlight protection
4) Spacing	Spacing between onion plants
5) Mulch	Practice of mulch
6) Soil enrichment	Use of organic soil fertilizers
7) Pruning	Practice of pruning
8) Staking	Practice of staking
9) Pest and disease management	Use of organic pesticides
10) Crop rotation	Practice of crop rotation

4.3 Descriptive statistics

Table 3a: Individual characteristics - differences across treatment and non-treatment groups

		non-treatment	treatment
basic demographics	**age**	51.652	-9.258*** (2.128)
	female	0.875	0.095*** (0.034)
	years of education	1.969	0.266 (0.522)
	married	0.523	0.271*** (0.075)
religion and ethnicity	**catholic**	0.255	0.186** (0.089)
	animist	0.632	-0.132 (0.090)
	felupe	0.882	0.089*** (0.034)
occupation	**farmer**	0.749	0.104 (0.066)
	stays at home	0.167	-0.020 (0.065)
	vendor	0.019	-0.019** (0.008)

Note: Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

4.3 Descriptive statistics

Table 3b: Individual characteristics - differences across treatment and non-treatment groups

		non-treatment	treatment
network	**number kinship links**	35.184	10.228**
			(4.006)
	number of chatting links	20.885	7.674*
			(4.115)
	number of agricultural advice links	5.243	4.728***
			(1.680)
	number of borrowing money links	7.542	0.399
			(1.187)

Note: Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.