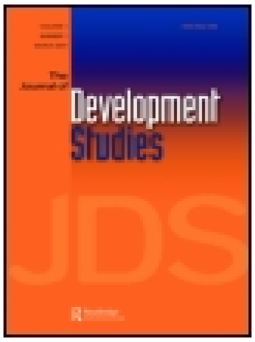

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Junior Farmer Field Schools, Agricultural Knowledge and Spillover Effects: Quasi-Experimental Evidence from Northern Uganda

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ABSTRACT *We analyse the impact of a junior farmer field school project in Northern Uganda on students' agricultural knowledge and practices. We also test for the presence of intergenerational learning spillover within households. We use differences-in-differences estimators with ex-ante matching and find evidence that the programme had positive effects on students' agricultural knowledge and adoption of good practices. The project also produced spillover effects in terms of improvements of household agricultural knowledge and food security. Overall, our results point to the importance of adapting the basic principles of farmer field schools to children.*

1. Introduction

Low agricultural productivity and rural poverty in developing countries may be caused by market incompleteness such as credit constraints, imperfect financial and insurance markets, weak property rights or lack of agricultural knowledge regarding new technologies, products and methods (among others, Conning & Udry, 2007; Croppenstedt, Demeke, & Meschi, 2003; Goldstein & Udry, 2008; Kazianga & Udry, 2006; Rosenzweig & Wolpin, 1993; Van der Ban & Hawkins, 1996).

Several countries have tried to tackle informational constraints through agricultural extension services, with the goal of helping farmers to improve their agricultural productivity. Such initiatives generally provide knowledge in agronomic techniques and skills to rural communities in a participatory manner.

One of the most widespread capacity building approaches within agricultural extension programmes is Farmer Field School (FFS). FFS is a participatory method of learning, technology adaptation and dissemination. In practice, FFSs are community-based adult-education practices aimed at transferring agricultural knowledge, improving skills and empowering farmers through learning-by-doing. FFSs were implemented first in Indonesia in 1989, and they are now applied in many sub-Saharan countries (Braun, Jiggins, Röling, van den Berg, & Snijders, 2006).

Given the large popularity of FFSs, a number of studies have tried to assess their impact on different outcomes such as agricultural knowledge, technology adoption, agricultural production, food security

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and poverty alleviation. Although randomised controlled trials on the effect of FFSs have not been conducted so far, some studies have tried to account for selection into programme participation through non-experimental methods. The findings of this literature are mixed, with some studies showing no significant programme impacts, and other papers finding positive effects in terms of improved agricultural knowledge, technology, production and food security.[1]

The same principles of FFSs can be adapted to different specific topics or groups of beneficiaries, for instance to children through junior farmer field schools (JFFSs).[2] JFFSs aim to improve short- and long-term livelihood, food security and wellbeing of both children and their households. Expected benefits include increased agricultural knowledge and skills and improved food security. In addition, a process of inter-generational knowledge transmission from children to their household's adults may occur. The transfer of agricultural knowledge can change the agricultural practices of the recipients' units, while agricultural production and household food security can develop. In view of this spillover from children to their households, the potential beneficial effects of JFFS programmes are enhanced.

JFFSs have been developed and implemented in Mozambique, Zimbabwe, Kenya, Swaziland and Namibia since November 2003 (FAO, 2007). However, contrary to FFSs for adults, the literature on the effect of JFFSs is still very scarce and, to the best of our knowledge, a quantitative evaluation of their impact has never been performed.[3]

In this paper, we analyse the impact of a JFFS project implemented in Northern Uganda by the international NGO Associazione Volontari Servizio Internazionale (AVSI) in 2011–2013. Using a quasi-experimental approach, we measure the direct effects of JFFS on students' agricultural knowledge and practices. We also look at the extent to which the project spills over to students' households' agricultural knowledge and practices. As far as we know, this is the first paper analysing the direct and spillover effects of a JFFS project using a quasi-experimental methodology.[4]

Northern Uganda was afflicted by nearly 20 years of continuous conflict in the 1987–2007 period. At the end of the conflict, in 2007, the Government of the Republic of Uganda formulated and launched the Peace, Recovery and Development Plan (PRDP), a comprehensive development framework. Since then, the overall situation in Northern Uganda improved substantially. However, much still remained to be done to restore the disrupted economic and social fabric and to ensure food security, particularly in some districts.

Smallholder farmers account for 96 per cent of farmers and 75 per cent of agricultural produce. However, they underperform substantially, contributing to food insecurity among smallholder farming families. Agricultural knowledge is still quite poor, and the production techniques are those of subsistence farming (World Food Porgramme, 2015).

In Uganda, the universal primary education curriculum includes agriculture, but it has important gaps, like the lack of proper agriculture training for teachers, adequate agricultural teaching materials for primary schools and the lack of integration between practical and academic education. Moreover, as a consequence of living in the internally displaced camps for a couple of decades, children and their families were forced to eat a diet that did not necessarily correspond to their traditional one, because local food could not be produced during the insurgency and food products were mainly imported or provided by the donor community. This heavily affected food consumption patterns in favour of products that were not grown locally. Hence, children and their families often lack proper knowledge of food preparation and conservation and they are often unaware of the importance of a diet containing good and varied nutrients. Thus, re-gaining agricultural education is crucial for the development of the area.

In view of this, drawing from FAO's experience and lessons on JFFSs, in 2011 the NGO AVSI adopted the JFFS approach within the project *Agriculture for all* (AFA). The primary objective of the project was to increase agricultural knowledge and food security in primary school children, teachers, local leaders and district officials, and to advocate for the inclusion of practical agricultural education in the existing primary school curriculum. According to the project, agricultural knowledge had to be fostered through the active involvement of the children in the school gardens through JFFSs.

In this paper, we analyse the impact of AFA using quantitative counterfactual analysis. More specifically, we try to assess its impact on students' agricultural knowledge and practices.

Moreover, we assume that children are induced to transmit their newly acquired knowledge to their parents and guardians, for the new knowledge to be applied at household level (inter-generational spillover effects). Although the transmission of information from one subject to another is not necessarily automatic and may require costly efforts, children and their household members are related by strong ties and physical proximity. Therefore, a process of information exchange is likely to occur. In view of this, we analyse the spillover effects of the project at household level investigating its impact on agricultural knowledge, practices and production and on household food security and nutrition.

The empirical analysis is mainly based on household-level panel data. The data were collected before and after programme implementation in 10 treated and 10 control schools in two districts of Northern Uganda (Gulu and Kitgum). We also use a second source of data containing results of a test on agricultural knowledge administered to treated and control students before and after the programme by the project's staff. Our estimation strategy combines two approaches: propensity score matching (PSM) and differences-in-differences (DID). As robustness checks, we use different matching algorithms.

Using data on students' performance in the test on agricultural knowledge, we find suggestive evidence that the programme had positive effects on the students' level of agricultural knowledge and practices. This evidence is corroborated by results obtained using information on guardians' perceptions on students' agricultural knowledge contained in the household-level dataset. Moreover, we find that this knowledge is spilling over to other members of the household in terms of more agricultural knowledge and improvements of food security and nutrition. However, we find no impact on the propensity to introduce new agricultural good practices and on crop diversification. We use a number of placebo tests and correction for multiple hypothesis to validate our results.

The remainder of the paper is organised as follows: the next section presents a description of the project under evaluation; Section 3 describes the sampling procedure and the data; Section 4 explains the empirical strategy; econometric results are discussed in Section 5 while concluding remarks are provided in the last section.

2. The project

At the end of October 2011, within the framework of the Peace, Recovery and Development Plan (PRDP), the international NGO AVSI[5] launched the project *Agriculture for all* (AFA) using funding from a group of Italian Foundations (*Fondazioni 4 Africa*).

The AFA project is based on three pillars: (i) experimental learning field, (ii) teaching of special agriculture topics and good agricultural practices, (iii) life skills. According to the first pillar, the school gardens should be realised and used as a place for experimental learning where children are exposed to the complexity of proper gardening and where they can learn the basics of food security and nutrition. The second pillar of the project requires that field learning goes along with the teaching of special topics and good agricultural practices, such as integrated pest management and intercropping. It includes traditional and modern practices for the entire cycle of agricultural activities (preparation, sowing, transplanting, weeding, irrigation, pest control and so forth). Finally, each module includes a life skills component (third pillar), for children to make the 'magic link' between how they take care of their fields and how they take care of themselves.[6]

The project was implemented in 10 primary schools in the Northern Uganda districts of Kitgum and Gulu. In each of the selected schools, children attended weekly learning sessions, including practical and theoretical classes, which were given by AVSI staff together with the school agriculture teachers. These latter benefitted from refresher courses on agricultural techniques and on life skills to better accompany the children's learning process.

A general work plan for each school was defined upon opening of the school garden. It detailed the activities, resources and the responsible people for the whole duration of the programme. The plan, detailed by week, provided children and teachers with a clear schedule of the work to do in the garden.

Moreover, children and their teachers could select some crops to be grown in the school gardens among those cultivated in the area throughout the year. The project provided some equipment and tools to each JFFS.

Training courses based on the AVSI and FAO JFFS manuals (FAO, 2010b) for the head teachers, the agriculture teachers and the local chiefs were organised upon opening of the school gardens. Allowances were provided to agricultural teachers, district officials, head teachers, local authorities and community animators to facilitate the training of children.

In order to ensure the involvement and participation of local authorities and communities in the JFFS approach, the project also planned other specific activities, like open days, community events and JFFS days. During these initiatives, which had very limited duration, no technical information potentially influencing participants' agricultural knowledge have been provided.

The schools' selection was made in the last months of 2011, while the selection of students within schools, the mobilisation of schools and of other local institutions was made at the beginning of 2012. The project's initiatives started between April and May 2012. The project had an initial duration of 12 months but, at the end of the first year, the programme was extended for one more year and it ended in October 2013.

3. Sampling and data

A common challenge when evaluating the impact of development programmes is related to non-random assignment of the treatment. Endogeneity bias due to non-random programme placement arises when beneficiaries are purposively selected following criteria that may also correlate with the outcome of interest. Random assignment of beneficiaries to a treatment and a control group ensures unbiased impact assessments. However, in our case random assignment of schools could not be implemented.

Both samples of treated and control schools were stratified at district and sub-county level[7]: all schools were located in the two districts of Gulu and Kitgum (in each district, five treated and five control schools). Moreover, three sub-counties were chosen in each district (Omiya Anyima, Lagoro and Namokora in Kitgum district; Lakwana, Lalogi and Odek in Gulu district) and, in each of these, at least one control and one treated school were selected.[8] Stratification is often seen as a tool to mitigate selection bias.

The treated schools were identified among those that AVSI had been supporting in the past, in collaboration with the District Education Office. This criterion allowed AVSI to implement the project more easily, because good relationships with the schools' management were already in place. However, no previous programme was related in any way to JFFS.[9] The control schools received neither external support nor other JFFS programmes throughout the evaluation exercise.

All schools, both in the treated and control group, were located in different villages. The distance between the villages is at least 10 kilometres. Although in principle we cannot exclude spillover between treated and control students, the presence of such spillover would bias our estimates downward. Table A1 (included in the 'Sampling and data' section available in Supplementary Materials) shows schools' sampling details.

A second potential source of selection is at the individual level, when participation in programme activities is open. This is a major issue in the case of FFSs, where more motivated and entrepreneurial individuals are likely to self-select into the programme, leading to a positive bias in the programme's evaluation (Larsen & Lilleør, 2014). In the AFA case, however, the programme's participants were identified by AVSI together with the school management and the local authorities. The programme targeted 30 students in each selected school as beneficiaries of the project. The targeted children were identified considering specific criteria, which included their degree of socio-economic vulnerability (they had to be orphans of one or two parents and they had to live in vulnerable conditions as assessed by the local stakeholders), school grade (primary school), and gender (to keep a proper gender balance). The same criteria were applied for the selection of students in control schools. Such design does not threaten the internal validity of the exercise, but weakens its external validity on the effects of JFFSs on untargeted students at primary school. However, JFFS programmes have normally been conceived to target vulnerable children in several contexts (FAO, 2007).

The data used in this study are based on two sources: household surveys and project records about students' level of agricultural knowledge. Survey data were collected in two points in time – before the treatment and nine months after the end of the programme. The baseline questionnaire was administered in May 2012 to 600 households, corresponding to 30 children for each of the 20 schools (10 treated, 10 control).[10] The majority of follow-up data were collected between August and October 2013. Interviews were addressed to the student's guardian, defined as the member of the household who is responsible for the child, who takes care of him/her materially and emotionally and who lives in the same house with him/her. The estimation sample includes the 559 households (279 in the treatment and 280 in the control group) for which we have information for both periods (see the 'Attrition analysis' section available in Supplementary Materials).

Baseline and follow-up questionnaires collected information on households and students: demographic characteristics, assets and land, agricultural production in the two seasons preceding the surveys, agricultural knowledge and adoption of good practices, income and expenditures, food sources and consumption and perception of guardians relative to their children's agricultural knowledge.[11] Questionnaires were translated in the local language (*luo*) and were administered by six independent enumerators.[12] One survey field manager coordinated the survey process and one auditor checked the questionnaires handed in by enumerators.

The second source of data contains results of a test administered by the AVSI staff to treated and control students before and after the programme. The test had the purpose of measuring the students' knowledge of some aspects of agriculture covered during the educational sessions. Moreover, in order to evaluate the extent to which students were involved in agricultural activities, after performing the test, students were asked how often they practiced agriculture, helped parents with agriculture, used fertiliser and cultivated their own piece of land. The baseline test was administered at the same time of the household survey, while the follow-up test for students took place in May–June 2014, around two years after the beginning of the interventions in schools.

Due to organisational and budget constraints, AVSI was unable to administer the test on the entire sample of students at the baseline and follow-up. More specifically, data are available for all 10 treated schools and for four control schools. The reason for such imbalance lies in the fact that AVSI had stronger requirements from the donor for monitoring data in treated school and a limited budget for data collection in control schools. As a result, we have data on 306 students at the baseline, whose guardians were also surveyed at the baseline, of which 221 were in the 10 treated schools and 85 were in four non-treated schools. At the follow-up, we are able to track 293 students, of which 223 were from the 10 treated schools and 70 were from four control schools (the same of the baseline). We end up with complete information at the baseline and follow-up for 211 units (162 in treated, 49 in control schools) that we use to compare outcomes (see the 'Attrition analysis' section in Supplementary Materials for more details).

Baseline summary statistics of the main characteristics of household heads, students, households and schools for the overall, treated and control samples are reported in Table A2 of the 'Sampling and data' section (available in Supplementary Materials). The table also shows mean differences between treatment and control groups and results of *t*-test for their statistical differences.[13] Overall, although our setting does not involve randomisation, we find a certain degree of homogeneity along the main observable characteristics at the baseline: no relevant difference emerges between treatment and control groups both at the individual and at the school level.

In order to define outcome variables, we relied on AVSI's theory of change and on the FAO Monitoring and Evaluation Toolkit for Junior Farmer Field and Life Schools (FAO, 2010b). First, we analyse the project's impact on a set of outcomes using data taken from the test on agricultural knowledge and on students' agricultural practices. Next, we evaluate the project's impact on students' agricultural knowledge and practices exploiting their guardians' perceptions. A second expected project's impact regards spillover effects in terms of increased household agricultural knowledge and practices. More specifically, we expect that JFFS participants transmit their newly acquired agricultural knowledge to their household members. Such a transmission mechanism might in turn impact on household agricultural practices. In view of this, first we consider the household's agricultural knowledge as a potential outcome. Next, we consider other outcomes related to the household's adoption of specific agricultural practices, such as opening all available land for agriculture or cultivating a sack or kitchen garden. The third set of outcomes is about spillover effects on household crop diversification. The final set of outcomes regards household food security and nutrition. We expect results in terms of greater awareness of the importance of a good and diversified nutrition which may lead to improvements in household eating habits.

Baseline mean values of all outcome variables are reported in columns 1 (treated group) and 2 (control group) of Tables 1–5, for the non-attrited sample. The way indicators for each set of outcomes was constructed is presented in the 'Outcome measure' section (available in Supplementary Materials).

4. Empirical strategy

The sampling procedure at both school and student level should reduce the potential bias due to endogenous placement and sorting of participants. Despite this, in order to rigorously identify the impact of the programme, our empirical strategy exploits the panel nature of the data and uses a differences-in-differences estimator (DID) to estimate the programme's effects (Heckman, Ichimura, & Todd, 1997, 1998). More specifically, we compare the variation in outcomes between treatment and control units from before to after the intervention, under the assumption that the evolution of the outcome in treated and control groups would have been the same in the absence of the project (*common trend assumption)*.

Moreover, we use matching techniques to increase similarity between the two samples along observable characteristics.

Throughout our evaluation exercise, we thus assume that the difference between the pre- and post-treatment outcome between treatment and control group, conditional on pre-programme observed characteristics, identifies the average effect of the programme, the so-called ATT (average effect of the treatment on the treated).[14]

We study the effect of AFA on outcome Y of individual i (being the student or the household) in school s at time$t$, by estimating the following OLS regression (Heckman & Robb, 1985):

$$Y_{ist} = \delta + \gamma T_s + \alpha t + \beta(T_s * t) + \rho x_{i0} + \varepsilon_{ist} \quad (1)$$

where T_s is a dummy variable equal to one if student i or his/her household belongs to a school selected for treatment and zero for those in the control group, $t$is equal to one for post-programme observations and equal to zero for pre-programme observations and x_{i0} is a vector of variables including head (gender, age, marital status, ability to read or write, level of schooling, agriculture as main activity, having formal employment and received external support in the previous season), student (gender, age, number of years of schooling and class attended) and household (size, number of people earning, wealth index and land extension) characteristics, measured at the baseline. β is the parameter of interest and gives the DID estimate of the average effect of AFA on outcome Y_i. δ is a constant term, γ is the treatment group specific effect, which accounts for average permanent differences between treatment and control individuals, and α gives the time trend effect common to control and treatment groups.

In order to better compare treatment and control groups, we repeat the exercise using propensity score matching. We construct a propensity score (Rosenbaum & Rubin, 1983) considering variables affecting both treatment and outcome, fixed over time, and found to be relevant in previous research. More specifically, the estimated propensity score includes head, student and household characteristics (vector x_{i0} of Equation (1)). The common support is always imposed. We use the kernel matching algorithm (Becker & Ichino, 2002) and cluster standard errors at school level to consider the presence

Table 1. Effect of JFFS on students' agricultural knowledge and practice

	Baseline value treated	Baseline value control	DID	DID PSM (kernel)	Nearest neighbour (k = 4)	Biweighted kernel	Radius	Critical *Γ*
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Knowledge score (0–6)	1.71	1.35	0.371	0.836	0.729***	0.851**	0.686**	>10
			(0.281)	(0.515)	(0.222)	(0.348)	(0.346)	
Practices agriculture everyday (0/1)	0.14	0.20	0.0249	0.205	0.172*	0.212	0.211	1–1.05
			(0.112)	(0.150)	(0.098)	(0.170)	(0.154)	
Helps with agriculture often (0/1)	0.35	0.51	0.382***	0.780***	0.720***	0.782***	0.788***	1.75–1.8
			(0.106)	(0.128)	(0.112)	(0.186)	(0.174)	
Uses fertiliser often (0/1)	0.04	0.04	0.0374	−0.025	−0.029	−0.019	−0.010	
			(0.0604)	(0.071)	(0.066)	(0.093)	(0.085)	
Cultivates own piece of land (0/1)	0.64	0.53	−0.0456	−0.113	−0.174*	−0.131	−0.170	1–1.05
			(0.112)	(0.155)	(0.100)	(0.177)	(0.157)	
Observations (treated)			324	308	95	155	95	
Observations (control)			98	86	49	49	49	
Observations (total)	162	49	422	422	144	204	144	

Notes: Robust standard errors in parenthesis are clustered at school level in columns 3 and 4 while they are bootstrapped in columns 5–7. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample size in columns 1 and 2 refers to the whole sample of data available at the baseline, while after-matching samples for treated and control units are reported for the following columns. ATT estimates in column 4 are obtained using the Stata command 'diff' which combines differences in differences and kernel matching. Estimates in columns 5–7 are obtained using the Stata command psmatch2. Estimates in column 5, 6 and 7 are obtained using, respectively, the nearest neighbour estimator with $k = 4$ and calliper equal to 0.01, the biweighted kernel estimator and the radius matching estimator with calliper equal to 0.01. Propensity score includes: head (gender, age, marital status, ability to read or write, level of schooling, agriculture as main activity, having a formal employment, received external support in the previous season), student (gender, age, number of years of schooling, class attended) and household (size, number of people earning, wealth index, land extension). Common support is always imposed. The score is balanced for all variables in each of the five blocks in which the sample has been divided. Critical level of hidden bias (Γ) in column 8 refers to ranges of the lowest Rosenbaum Gamma (Γ) at which the upper bound of the p-value from the Wilcoxon Sign Rank Test (in case of continuous outcome variables the Stata command rbounds is used) and from the Mantel-Haenszel test (in case of dichotomous outcomes the Stata command mhbounds is used) turns insignificant ($p > 0.05$).

Table 2. Effect of JFFS on students' agricultural knowledge and practice – guardians' perception

	Baseline value treated	Baseline value control	DID	DID PSM (kernel)	Nearest neighbour (k = 4)	Biweighted kernel	Radius	Critical Γ
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Student learned concepts and practice about agriculture (0/1)	0.69	0.25	0.198***	0.177**	0.162***	0.169***	0.158***	1.25–1.3
			(0.0572)	(0.077)	(0.050)	(0.055)	(0.058)	
Student works in home garden (0/1)	0.98	0.97	0.100***	0.081*	0.079***	0.088***	0.114***	1–1.05
			(0.0257)	(0.044)	(0.026)	(0.032)	(0.034)	
Observations (treated)			558	548	264	274	264	
Observations (control)			560	554	280	280	280	
Observations (total)	292	297	1118	1102	544	554	544	

Notes: See Table 1.

Table 3. Effect of JFFS on household agricultural knowledge and practices

Outcome variable	Baseline value treated (1)	Baseline value control (2)	DID (3)	DID PSM (kernel) (4)	Nearest neighbour (k = 4) (5)	Biweighted kernel (6)	Radius (7)	Critical Γ (8)
Agricultural knowledge score (0–15)	4.287	3.818	0.561	0.851**	0.815**	0.894***	0.902**	>10
			(0.385)	(0.352)	(0.326)	(0.334)	(0.352)	
Open all land to agriculture (0/1)	0.470	0.546	0.157**	0.200***	0.209***	0.208***	0.223***	1.45–1.5
			(0.0556)	(0.052)	(0.061)	(0.063)	(0.066)	
Cultivate a sack or kitchen garden (0/1)	0,706	0,711	0.0286	0.069	0.050	0.051	0.045	
			(0.0604)	(0.070)	(0.058)	(0.059)	(0.063)	
Agricultural good practices (0–10)	4.409	4.339	0.0588	0.139	0.078	0.083	0.069	
			(0.152)	(0.173)	(0.142)	(0.146)	(0.153)	
At least one practice learned from students (0/1)	0.168	0.154	0.201***	0.222***	0.188***	0.221***	0.218***	2.-2.05
			(0.0529)	(0.045)	(0.049)	(0.049)	(0.051)	
Observations (treated)			558	548	264	274	264	
Observations (control)			560	554	280	280	280	
Observations (total)	292	297	1118	1102	544	554	544	

Notes: See Table 1.

Table 4. Effect of JFFS on household agricultural production

	Baseline value treated	Baseline value control	DID	DID PSM (kernel)	Nearest neighbour (k = 4)	Biweighted kernel	Radius	Critical Γ
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nr of crops in the training adopted								
First season 2013 vs first season 2012	1.53	1.46	−0.224*	−0.193	−0.146	−0.234**	−0.293***	1–1.05§
			(0.115)	(0.123)	(0.096)	(0.105)	(0.110)	
Second season 2012 vs second season 2011	0.79	0.68	−0.0375	−0.028	−0.007	−0.015	−0.014	
			(0.131)	(0.133)	(0.075)	(0.080)	(0.084)	
New crops introduced (0/1)								
Second season 2012 vs second season 2011	0.80	0.80	0.0727	0.108	0.066	0.112**	0.119**	1.35–1.4
			(0.0647)	(0.076)	(0.054)	(0.056)	(0.059)	
First season 2013 vs first season 2012	0.90	0.91	0.0163	0.040	0.026	0.035	0.026	
			(0.0514)	(0.060)	(0.052)	(0.056)	(0.059)	
New crop introduces because of child suggestion (0/1)								
Second season 2012 vs second season 2011	0.00	0.00	0.00722	0.007	0.007	0.007	0.007	
			(0.00635)	(0.007)	(0.006)	(0.008)	(0.008)	
First season 2013 vs first season 2012	0.02	0.01	0.0150	0.025	0.031**	0.022	0.018	1–1.05
			(0.0198)	(0.026)	(0.016)	(0.016)	(0.017)	
Observations (treated)			558	548	264	274	264	
Observations (control)			560	554	280	280	280	
Observations (total)	292	297	1118	1102	544	554	544	

Notes: See Table 1. § refers to the lower bound.

Table 5. Effect of JFFS on household food security and nutrition

	Baseline value treated	Baseline value control	DID	DID PSM	Nearest neighbour	Biweighted kernel	Radius	Critical Γ
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FCS	38.51	40.90	4.100*	4.470	5.863***	4.292***	5.570***	>10
			(2.299)	(2.783)	(1.682)	(1.537)	(1.617)	
HDDS	6.932	7.021	0.191	0.316	0.313	0.296	0.386*	>10
			(0.246)	(0.247)	(0.204)	(0.189)	(0.199)	
Number of weekly food types	9.20	9.12	0.192	0.430	0.419	0.357	0.495	
			(0.382)	(0.413)	(0.321)	(0.303)	(0.314)	
Eat at least once per week (0/1)								
Cereals and tubers	0.98	1.00	0.0397***	0.042***	0.037**	0.038***	0.038**	1.1–1.2
			(0.0109)	(0.011)	(0.016)	(0.014)	(0.015)	
Pulses	0.78	0.75	−0.00453	0.032	−0.024	0.013	0.004	
			(0.0640)	(0.066)	(0.054)	(0.049)	(0.052)	
Vegetables	0.83	0.88	0.0675	0.049	0.067	0.050	0.064	
			(0.0511)	(0.059)	(0.046)	(0.041)	(0.044)	
Fruit	0.92	0.90	−0.0605	−0.069	−0.043	−0.058	−0.045	1–1.05§
			(0.0645)	(0.066)	(0.048)	(0.044)	(0.046)	
Meat and fish	0.62	0.74	0.155**	0.137**	0.126**	0.135**	0.139**	1.2–1.3
			(0.0572)	(0.065)	(0.064)	(0.059)	(0.062)	
Milk	0.07	0.06	0.0449	0.023	0.062**	0.025	0.059**	1.05–1.1
			(0.0316)	(0.039)	(0.030)	(0.029)	(0.030)	
Sugar	0.27	0.31	0.0926*	0.121**	0.135*	0.124**	0.139**	1–1.05
			(0.0523)	(0.054)	(0.057)	(0.053)	(0.056)	
Oil fats	0.72	0.62	0.0332	0.072	0.033	0.046	0.024	
			(0.0599)	(0.055)	(0.062)	(0.057)	(0.060)	
Observations (treated)			558	548	264	274	264	
Observations (control)			560	554	280	280	280	
Observations (total)	292	297	1118	1102	544	554	544	

Notes: See Table 1. § refers to the lower bound.

of correlated school-level shocks related to the way the programme is implemented, for instance due to school-specific teachers' ability or degree of students' interaction (Bertrand, Duflo, & Mullainathan, 2004). As a robustness check, we also run the nearest neighbour bias corrected matching estimator (Abadie, Drukker, Herr, & Imbens, 2004),[15] the biweight kernel and the radius matching algorithm on the differences in time of outcomes.[16] Finally, we assess the sensitivity of our results to hidden bias by running Rosenbaum bounds.

5. Results

Estimation results regarding the project's effects on children's agricultural knowledge and attitudes are presented in Tables 1 and 2. Spillover effects on households are shown in Tables 3–5. The reported coefficients correspond to the ATT (β in Equation (1)) of AFA.[17] Detailed descriptions of the way the propensity score was developed and matching procedures implemented are provided in the 'Propensity score matching' section (available in Supplementary Materials). We applied the Bonferroni correction for multiple hypothesis. Although the correction is extremely conservative, most of our results are robust to it.

Table 1 shows the impact of the programme on students' agricultural knowledge and practices, assessed using data collected from students. The first row of the table shows estimates of the AFA project on agricultural knowledge. The estimated ATT is consistent in terms of magnitude for the specifications implying PSM and corresponds to 0.77–0.95 SD (SD = 0.89), with levels of significance varying from less than 0.01 (column 5) to 0.13 (column 4). The coefficient from DID estimation is positive and of relevant economic significance (about 0.4 SD), although it is not statistically significant at standard levels. This can be due to lack of power, when clustering standard errors at the school level.[18] Moreover, results in Table 1 show that treated students seem to enhance their attitudes towards agriculture, as measured by their probability of practicing agriculture daily or of providing regular agriculture-specific help to their parents. Especially in this latter case, the ATT is high and statistically significant. On the contrary, the programme was not found to affect the frequency of fertiliser use and the probability of students cultivating their own piece of land. However, the absence of impact in the latter case may be related to the fact that not all children have the opportunity to cultivate a piece of land of their own.

The impact of the project on the children's agricultural knowledge and practices is evaluated also through their guardians' perception. In this case, we exploit information on the full sample. Table 2 shows the ATT of the project on guardians' perception outcomes. It shows that the project significantly increased the guardians' perception that children learned concepts and practices about agriculture and that they were more involved in gardening activities at home. In this case, the positive impact of AFA emerges whatever the evaluation methodology.[19]

We assess the presence of spillover effects from children to household members considering different outcomes at household level. First, if children participating in the JFFS transmit the concepts learned to their family members, we can expect that the households of the treated group will have a higher agricultural knowledge as compared to the control group.

The first line of Table 3 shows estimates of Equation (1) considering the score describing the household level of agricultural knowledge. We find a positive ATT with all matching algorithms employed (only in the case of DID without matching the coefficient is positive but not statistically significant – p-value = 0.16), suggesting that a process of information transmission from students to other household members is in place. However, the magnitude of the coefficient is significantly lower than in the case of students. The programme increases household agricultural knowledge, as measured by the score, by 0.17–0.25 SD.

Second, spillover effects might be related to the influence of the JFFS on the probability to adopt specific agricultural practices. Our results suggest that participation in JFFS increased the probability to open all land to agriculture, while we find no significant impact on the probability to cultivate a sack or kitchen garden.

As regards the programme's impact on more specific agricultural good practices, Table 3 shows that ATT coefficients, despite being always positive, are not statistically significant.

Finally, we find a positive ATT on the probability that at least one agricultural practice has been learned from children in school. This latter result confirms the presence of spillover effects, suggesting that children actually transmit the knowledge acquired through JFFSs to their household members.

An additional potential spillover effect is on the adoption of new crops: if children participating in the JFFS transmit the knowledge acquired to their household members, we can expect some change in household crop diversification due to the implementation of this improved knowledge as a supplementary project effect. However, in this case we do not find significant effects of the project on the number of crops included in the training actually adopted at household level, the number of crops newly introduced in general or because of child suggestion (Table 4). The ATT coefficients are never statistically significant regardless of the agricultural season considered or the estimation method.

A final important potential spillover effect of the project regards its impact on household food security and nutrition. Indeed, according to its first pillar, besides agricultural and gardening notions, the AFA project should provide students with food security and nutrition basics.[20] Table 5 displays ATT coefficients relative to household food security and nutrition. Results show that treated households improved their overall diet diversification as measured by all three indexes considered (food consumption score (FCS), household dietary diversity score (HDDS) and number of weekly food types), although the positive coefficients are not always statistically significant. More specifically, the coefficient of FCS is statistically significant excluding only the DID PSM estimate (p-value = 0.125). The magnitude of the effect ranges between 0.3 and 0.4 SD. Moreover, the targeted households seem to increase the animal protein content of their diet (fish and meat) and the consumption of cereals, tubers and sugar.

6. Discussion and conclusions

We analysed the effect of a JFFS project implemented in Northern Uganda in the 2011–2013 period. We evaluated the project's impact on several outcomes, both related to the exposed children and to their household (spillover effects). In order to identify the causal effect of the programme, we used a matching DID strategy comparing matched samples of treated and non-treated individuals before and after the treatment using different matching algorithms.

Based on findings obtained using direct information from students, we find suggestive evidence of the effectiveness of AFA on students' agricultural knowledge and practices. This evidence is corroborated by results obtained using indirect information from their guardians. We also find that the project significantly affected household agricultural knowledge. However, the effect on students' knowledge is two to three times larger than the spillover effect on households. This represents some evidence of inter-generational learning, which is further confirmed by the positive and significant effects on the variable 'at least one practice learned from students'. We also find a greater propensity to open all available land to agriculture in the households of the treated group as compared to the control group. The higher probability to open all land may be a potential channel to increase household income although, due to the unavailability of reliable data on quantities harvested and sold, we were unable to test this hypothesis more rigorously.

Despite these results, we find no impact either on the propensity to introduce new agricultural good practices or on crop diversification. This suggests that the agricultural knowledge transmitted from children to their household members did not translate, at least in the short run, to the adoption of new practices and crops. This lack of significance may be related to the time needed before the new knowledge acquired through spillover from treated children is transferred to actual practice implementation. Indeed, it is important to emphasise that little short-run spillover effects do not necessarily imply the lack of spillover effects. Students' knowledge may trigger change of behaviour over a longer time span, through the acquisition of greater credibility in the eyes of parents, with age, or through their direct action in the family fields. Moreover, we could expect long-run effects also on children.

These latter could develop their abilities to direct their own future development thanks to the improved agricultural knowledge. Unfortunately, we have no data to evaluate such potential long-run effects.

Finally, we find evidence of a positive spillover effect on household food security and on diet improvements. Given the lack of impact on agricultural practices and production decisions, we argue that such effect may be the outcome of a behavioural change in food management. Such behavioural change is likely related to the new knowledge and/or perceptions about food security learned during the AFA project's classes.

The qualitative indications on the effects of JFFS on students' attitudes and knowledge need to be considered in the evaluation of the possible long-run consequences of the programme. In particular, the fact that students tend to dedicate more time to agriculture, together with the evidence of positive effects on household agricultural knowledge, opens future possibilities of improvements thanks to enhanced parent-children interaction and to students' direct and more skilled contribution to agricultural production. Overall, our results point to the importance of adapting the basic principles of FFSs to children through junior farmer field schools, as they could improve short- and long-term food security and wellbeing of both children and their households.

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The data and STATA codes for the replication of our results are available upon request

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Disclosure statement

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Notes

1. An extensive review of impact evaluation studies on adult FFSs is in Waddington et al. (2014). Key recent contributions on the effects of FFS are Godtland, Sadoulet, de Janvry, Murgai, and Ortiz (2004); Feder, Murgai, and Quizon (2004); Tripp, Wijeratne, and Hiroshini Piyadasa (2005), Van den Berg and Jiggins (2007), Rejesus et al. (2012), Davis et al. (2012), Todo and Takahashi (2013) and Larsen and Lilleør (2014).
2. Other types of FFS programmes are business or marketing FFS, that are expected to develop additional skills with the aim of improving farmer livelihoods or to promote different types of farming, for instance through farmer livestock schools (Waddington et al., 2014).
3. Djeddah, Mavanga, and Hendrickx (2006) present anecdotal evidence on the implementation of a pilot programme in Mozambique targeting orphans and vulnerable children between 12 and 18 years living in communities highly impacted by HIV/AIDS. The project contributed to boosting school enrolment and it attracted children that were not included in the project to undertake agricultural activities. FAO implemented a JFFS in refugee camps within the host community in Kakuma and Dadaab (Kenya), providing the targeted young people some good knowledge on agriculture and life skills. However, according to the evaluation report, the project seemed to be too short to make a significant difference (FAO, 2010a).
4. Nakasone and Torero (2016) is the only paper analysing spillover effects from students to parents, although in a completely different context. They implemented a field experiment in a rural high school in the northern highlands of Peru where they showed agricultural extension videos to students in the school's computer lab. They find that the information provided to the teenagers increased parents' knowledge and adoption of agricultural practices.

5. AVSI is an international non-governmental organisation founded in Italy in 1972; it has been active in Uganda since 1984, maintaining a constant presence in the Northern regions even during periods of high insecurity. Throughout the years, several donors have funded AVSI projects in the health and HIV/AIDS, water and sanitation, education, protection, mine action, and food security and livelihood sectors.
6. In this study, we do not evaluate the impact of the programme's third pillar.
7. Ugandan districts are divided into counties and municipalities, and each county is in turn divided into sub-counties. On average, at the national level, there are 12.5 sub-counties per district. The average sub-county population is 26,111. In each sub-county there are 41 villages on average.
8. The only exception is in Kitgum district, where three treated and no control schools were selected in the sub-county Namokora.
9. The previous interventions were mainly based on a more traditional approach, for instance construction of classrooms, staff housing and latrines or delivery of desks and books in schools with scant or inadequate equipment.
10. Eleven baseline questionnaires (eight treated and three control) were discarded due to quality concerns, hence the final baseline sample is 589 observations.
11. The baseline and follow-up questionnaires are available upon request.
12. A survey-training manual was prepared and distributed to enumerators. It is available upon request.
13. Wild cluster bootstrapping was used given the small number of clusters in each group (Cameron, Gelbach, & Miller, 2008; Cameron & Miller, 2015).
14. The household survey perfectly maps the treated and control population, as it results from the contact details provided by AVSI. Although the questionnaire does not directly ask the guardian whether the student attended the project activities and we do not have data on actual participation of students to project activities, we do not have reason to believe that this was not the case for children still attending school. A question on school participation was asked and turns out that 4 out of 559 students dropped-out of school in 2012 (two in treatment and two in control schools), while 24 dropped-out during 2013 (13 in treatment and 11 in control schools). In none of the cases does dropping-out appear systematically related to the treatment status, therefore it does not represent a threat to our identification strategy. In any case, if one assumes that some of the treated students did not actively participate, this would imply that we would be estimating the Intention to Treat Effect (ITT) that would represent a lower bound of ATT.
15. We show results for $k = 4$, but they are consistent with $k = 1$ (available upon request).
16. Throughout PSM robustness specifications, standard errors are constructed through bootstrapping, as suggested by Caliendo and Kopeinig (2005).
17. We do not show other regressors' coefficients but they are available upon request.
18. One should remember that only data of students from 14 schools are available for this part of the analysis.
19. The large difference between treated and control individuals in the average baseline values of the variable 'Student learned concepts and practice about agriculture' based on guardians' perceptions may be related to the fact that the baseline survey was administered shortly after the starting initiatives of the project related to community events, open days and JFFS field days open to the children's parents. This might contribute to an increase in the baseline value for this variable among treated subjects and to a downward estimate of the ATT.
20. More precisely, Topic 4 of the Learning Module 4 is 'Diversity in what we eat'. In the facilitator's field training guide, it is explicitly stated that Topic 4 objectives are: (i) To understand the benefits of eating a variety of foods and (ii) To learn different ways to bring variety into our diet.

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