Tropentag 2009
University of Hamburg, October 6-8, 2009
Conference on International Research on Food Security, Natural Resource Management and Rural Development

Economic Impact of Livestock Research on Farmers' Knowledge and Productivity

Sabine Liebenehm[a*], Hippolyte Affognon[b] and Hermann Waibel[a]

[a] Leibniz Universität Hannover, Institut für Entwicklungs- und Agrarökonomie, Königsworther Platz 1, 30167 Hannover, Germany.
[b] International Livestok Research Institute (ILRI), P.O.Box 30709, Nairobi 00100, Kenya.

Introduction

Traditional livestock systems in tropical Africa, in particular cattle, contribute to a nutritious and diverse diet of poor households through meat and milk. In addition, they provide draft power for transport and field work and manure for fertilizing fields. Moreover the value of cattle involves the benefit in savings and security (STEINFELD, 1988). However, cattle diseases like African animal trypanosomosis (AAT) impose a serious constraint on the livelihood of cattle farm households (BUDD, 1999; SWALLOW, 1999; AFFOGNON, 2007). The research activities of the International Livestock Research Institute (ILRI) in the cotton zone of West Africa aimed at improving the management of the disease. As in many natural resource management projects, one component had been the extension to deliver a new technology to farmers (ZILBERMAN AND WAIBEL, 2007). In case of ILRI's research project the outreach activities correspond to the provision of information material in local language as well as the demonstration and practice of correct treatment. In particular, ILRI promoted the concept of rational drug use as a strategy to avoid inadequate application of trypanocides and minimize the development of pathogens' resistance (AFFOGNON, 2007).
The objective of this paper is to measure the impact of ILRI's activities on farmers' disease knowledge and management practices after the end of the research activities, but before the scaling-up of the research outputs generated by the project. Hence, the study serves as a baseline to appraise the immediate effect of livestock research activities on knowledge, measured by knowledge test score. This outcome variable is a composite variable including scores allocated to (i) knowledge about trypanosomosis itself (like signs and causes), (ii) curative treatment knowledge and actual control actions in case of trypanosomosis occurrence and (iii) preventive treatment knowledge and actual preventive strategies applied. In total, all points from the three categories above are summed up and all knowledge categories are calculated in percentage of the maximum possible score.
Generally, in order to infer the impact of an intervention on individual outcome, it is necessary in project design to create a suitable comparison group among a large group of non-participants, which is identical to the participating group, except in the attitude of treatment assignment. Given that all farmers in the research villages got access to information, there arises a problem of selective placement. To overcome the problem of selection bias, the propensity score matching (PSM) approach is applied.

Materials and Methods

The project villages in the region of Kénédougou, a zone split across south-eastern Mali and south-western Burkina Faso, were revisited from October to December 2007. The household head, i.e. the

* Corresponding author. Email: liebenehm@ifgb.uni-hannover.de.

decision maker, who is responsible for livestock production and animal health management, was asked to take a specific knowledge test about trypanosomosis and its control. In total, data from 508 cattle farmers were included in the analysis.

Matching on the probability of participation, given all observable treatment-independent covariates, solves the problem of selection bias. Given that the propensity score is a balancing score, the probability of participation conditional on observables will be balanced such that the distribution of observables will be the same for both participants and non-participants. The idea is to determine the probability of participation in the program for every respondent in the sample, take a pair of participants and non-participants, who are identical in their participation probability and measure the difference in their outcome performance (ROSENBAUM AND RUBIN, 1983).

In short, unbiased impact estimates can be obtained in three steps: (i) chose a binary response model with appropriate observable characteristics to predict the probability of participation; (ii) estimate the performance difference between treatment and control group according to selected matching methods that minimise the difference in observables of both groups; and (iii) analyse the effect of unobservable influences on the inference about impact estimates. Based on the implementation of these steps, the following results can be obtained.

Results

Based on a logit model to predict the probability of participation given observable characteristics capturing all relevant differences between participants and non-participants, Table 1 presents the differences in knowledge score between matched program participants and controls.

Table 1: Difference in outcome performance between matched participants and non-participants

	Knowledge score in % of high scores of		Average treatment effect on the treated
	Participants	Non-participants	
Nearest neighbour matching	Using the single closest neighbour		
Knowledge score on disease	25.3	22.93	2.37***
Knowledge score on control	23.54	19.29	4.25***
Knowledge score on prevention	16.01	13.0	3.01***
Total knowledge score	20.81	17.65	3.16***
Observations	211	211	
Radius matching	Using all neighbours within a caliper of 0.01		
Knowledge score on disease	25.04	23.22	1.82**
Knowledge score on control	23.17	19.27	3.9***
Knowledge score on prevention	15.79	13.18	2.6***
Total knowledge score	20.54	17.81	2.73***
Observations	194	294	
Kernel-based matching	Using a biweight kernel function and a smoothing parameter of 0.06		
Knowledge score on disease	25.28	23.37	1.91**
Knowledge score on control	23.55	19.91	3.64***
Knowledge score on prevention	16.03	13.18	2.85***
Total knowledge score	20.81	18.03	2.78***
Observations	210	293	

Note: *p<0.1, **p<0.05 and ***p<0.01.

Source: own survey

Although, the knowledge level in general is very low, ILRI's research activities contribute to a significant improvement in farmers' knowledge about the disease and its control. According to the three chosen matching algorithms, the highest increase in knowledge score can be identified in the second category of curative know-how, followed by the third category of preventive knowledge and activities. Hence, the program improves both treatment of infected animals and preventive measures to avoid cattle falling sick with AAT.

Due to the self-selection process of farmers, unobservables factors, like their intrinsic motivation, specific abilities or preferences might have an influence on the participation decision. Therefore, the robustness of impact estimates to hidden bias is analysed with the help of Rosenbaum's bounds (ROSENBAUM, 2002). Table 2 presents the upper bounds on the significance-level of treatment effect estimates for different impact levels of unobservable influences.

Table 2 Sensitivity analysis with Rosenbaum's bounds on probability values

	Upper bounds on the significance level for different values of e^{y}				
	e^{y}=1	e^{y}=1.25	e^{y}=1.5	e^{y}=1.75	e^{y}=2
Nearest neighbour matching	Using the single closest neighbour				
Knowledge score on disease	0.0001	0.0072	0.0871	0.327	0.6324
Knowledge score on control	<0.0001	0.0031	0.0494	0.2284	0.5151
Knowledge score on prevention	<0.0001	<0.0001	0.0018	0.0211	0.1009
Total knowledge score	<0.0001	<0.0001	0.004	0.0074	0.0465
Radius matching	Using all neighbours within a caliper of 0.01				
Knowledge score on disease	0.0005	0.0255	0.1884	0.505	0.785
Knowledge score on control	<0.0001	0.0009	0.019	0.1149	0.3267
Knowledge score on prevention	<0.0001	<0.0001	0.0015	0.0171	0.0832
Total knowledge score	<0.0001	<0.0001	0.0007	0.0099	0.0545
Kernel-based matching	Using a biweight kernel function and a smoothing parameter of 0.06				
Knowledge score on disease	0.0001	0.012	0.1254	0.4131	0.7202
Knowledge score on control	<0.0001	0.0008	0.0194	0.1241	0.3555
Knowledge score on prevention	<0.0001	<0.0001	0.0001	0.003	0.023
Total knowledge score	<0.0001	<0.0001	<0.0001	0.0017	0.0144

Source: own survey

Overall, robustness results produced by Rosenbaum's bounds are quite similar. However, kernel-based matching produces the most robust treatment effect estimates with respect to hidden bias especially in the category of preventive knowledge and action as well as in the fourth class were all points are summarised. Matched pairs might differ up to 100% (e^{γ}=2) in unobservable characteristics, while the impact of participation on preventive knowledge as well as on total knowledge would be still significant at a level of 5% (*p*-value = 0.023 and *p*-value = 0.0144, respectively).
Nevertheless, it has to be considered that these sensitivity results are worst-case scenarios, although they indicate information about uncertainty within the matching estimators of treatment effects (ROSENBAUM, 2002).

Conclusions

Propensity score matching allows measuring the short-term impact of a natural resource management project on farmers' knowledge and practice of trypanosomosis control. Due to the quasi-experimental design of the intervention, PSM is effective to produce adequate counterfactuals and hence, robust treatment effect estimates.

Common to all three matching algorithms, the strongest effect of the program is on the curative knowledge of AAT and subsequent adequate control decisions. Moreover, significant advancements in preventive strategies are also observable. Overall, the research project has been effective to increase farmers' knowledge and to improve their practices. Therefore, it can be recommended to provide farmers with access to diverse control inputs and know-how about their integrated use.

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