The effects of zero grazing in Ethiopia

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Abstract

In the high lands of Ethiopia, almost every plot of farmland is allotted for crop husbandry, leaving no or only road sides and marginal lands for grazing. However, land is scarce in these areas and this limits the role of crop production in poverty alleviation and it also limits the availability of local off-farm employment. Moreover, with the years, livestock feed has become scarce and crop residues are the major feed source for the animals. This feed problem also potentially affects crop production, if the straw is eaten for example, this affects soil quality negatively. Therefore, a potentially useful innovation against low productivity and limited availability of feed is a zero grazing approach. The aim of this approach is to reduce the number of animals to a level that can be supported by the available resources. This means shifting from the traditional type of livestock husbandry to a system that focuses on the quality and performance of the livestock.

An Ethiopian NGO implemented a project that focuses on zero grazing and improved heifer production targeted towards 1,700 farm households in Akaki and Ada'a districts and East Shoa Zone of Oromia National Regional State. In these areas a further motivation to implement the zero grazing is the high potential for dairy production, given that a market (the capital Addis Ababa) is relatively close and accessible.

The main goal of this paper is to understand if zero grazing is a way out of poverty and if dairy production is a good and feasible strategy to reduce poverty in Ethiopia.

Introduction

After experiencing severe country-wide famines in both the 1970s and 1980s, Ethiopia seems to have ventured on a pathway towards development and food security. Since 1992, the Ethiopian Government has adopted a strategy of Agricultural Development-Led industrialization, which involved substantial liberalisation of the economy. Per capita incomes increased by over 50 percent from 2001 to 2009, and poverty rates declined by 33 percent from the mid-1990s to 2011 (www.WorldBank.org). Yet the poverty rate is still high at 30% and the food security situation is precarious. In the past two decades there have been several major, though localized, food production shortfalls, and even in normal years an estimated 44 percent of the population is undernourished (Schmidt and Dorosh, 2009). Further broad-based development is thus needed to improve the situation of the remaining poor and food insecure.

Though growth in industry and services has outpaced agricultural growth, the latter has made a major contribution to overall growth and has been essential for poverty alleviation. Smallholder-dominated agriculture provides 46 percent of GDP and 79 percent of employment (www.WorldBank.org). However, Ethiopia's agriculture-leg development strategy is under debate (Dorosh and Rashid, 2012). Transport costs in Ethiopia's rugged terrain are high and most produce is traded locally. Will economic growth caused by increased agricultural production be sufficient to create sufficient demand for agricultural products to prevent a price-collapse?

A recent study on strategic priorities for agricultural development in Eastern and Central Africa concludes that milk would be the most important commodity subsector for growth-inducing investment and that milk is especially important for Ethiopia, Eritrea, and Sudan (Omamo et al, 2006). Ethiopia's dairy sector holds a large potential for development (Ahmed et al, 2004; Negassa et al, 2012). Income and population growth are expected to lead to substantial increases in the demand for dairy. The country holds the largest livestock population in Africa and the climate is suitable for dairying (Ahmed et al, 2004. Yet compared to the neighbouring countries, the government has done little to improve the dairy sector and its productivity is low (Negassa et al, 2012).

Development of the dairy sector may positively affect the lives of many people, as production is spread widely over the rural population. The traditional smallholder system produces 97 percent of Ethiopia's total milk production (Ahmed, et al 2004). Most milk is produced in the highlands on farms with mixed-crop livestock production systems and, increasingly scarce, communal grazing lands. Milk is mainly used for home consumption, and the marketed surplus is small. Households on average own two to four cattle, of which 45 percent are draft cattle and 25 percent is used for dairy production (Negassa et al, 2012). Most cattle are of indigenous breeds, with low production levels compared to crossbreds or exotic breeds.

Not just the production, but also marketing and processing is generally informal and small scale. Only a very small portion of the production is industrially processed. The remainder is administered by cooperatives and smallholders. These cottage dairy products and the fresh fluid milk are sold and consumed locally. Even in the dairy market in Addis Ababa, the majority (75%) of the products sold come from traditional processing; 17% are process in local industry and 8% is imported (Francesconi, 2009).

Previous research shows that the adoption of improved dairy technology results in higher per capita incomes and intake of calories, protein, and iron (Ahmed et al, 2004). Yet adoption is constrained by increasing fodder scarcity and a lack of economic incentives to produce marketable surplus (Lemma et al, 2008a). The demand for milk and milk products has increased, putting an upward pressure on prices, but marketing systems are not well-established (Lemma et al, 2008b). Also the lack of health infrastructure and veterinary services are a disincentive for acquiring improved breeds (Negassa et al, 2012). Improved dairy technologies related to housing, feeding and healthcare largely improve milk production performance for crossbred cows, but have only a limited effect on the productivity of local cows (Mekonnen et al, 2010). Sustainable commercialisation of smallholder dairy in Ethiopia therefore requires an integrated approach involving technological as well as institutional innovations.

While many projects have been initiated in recent years to boost dairy production and incomes, this has not resulted in substantial changes in the sector. The case study presented in this paper assesses the possibilities and constraints for improved dairy production through zero grazing in four rural districts relatively close to the urban market of Addis Abeba. Improved dairy technologies have been actively promoted by extension services, NGOs, local and international research centres and the district agricultural offices. Using data from 2012, we analyse the role of livestock in local livelihoods, the success of a specific targeted intervention, and the determinants of adoption of improved technologies. We conclude that the success of all activities has been limited......

Study area and data

Data were collected in four districts the neighouring Special Zone and East Shewa Zone of Oromia National Regional State: Akaki, Ada'a, Gimbichu, and Sebata. The districts are relatively close to Addis Abeba on the highway to Adama. Though infrastructure is poorly developed in most rural parts of the districts, some wards or *kebeles* can be accessed through dry weather roads. The area is characterized by black cotton soils and receives evenly distributed and adequate rainfall.

Like elsewhere in the Ethiopian highlands, rainfed agriculture is the main economic activity. Teff, chickpea and wheat are the principal crops produced, and farmers engage in livestock rearing as a supplementary activity. They rear different types of mostly local livestock for the purposes of generating draught power, source of food, source of income and asset accumulation. The returns from the traditional livestock rearing are meagre and declining. Almost every plot of farmland has been allotted to crop husbandry, leaving only marginal lands and road sides for grazing. Consequently crop residues, particularly cereal straws, are the major source of feed providing more than 50% of the annual requirements.

To stimulate dairy production, improved technologies –involving crossbred cows, improved feeds and feeding technology, and improved health management; have been promoted by the Debreziet Agricultural Research Center (DZARC) of the Ethiopian Institute of Agricultural Research (EIAR) and the International Livestock Research Center (ILRI) in collaboration with district agricultural offices. In addition, the extension service has since long promoted Artificial Insemination (AI). The success of these activities have been limited, and with support of international donations a local NGO executed an additional project targeted towards 1,700 farm households in 10 selected *kebeles* in Akaki and Ada'a between 2010 and 2012.

The project aimed to stimulate the introduction of improved breeds and the intensification of management through zero grazing. To improve the availability of feed and reduce the pressure on grazing land, a central nursery site was established to raise different multipurpose seedlings used for animal feed. Good quality forage seeds and planting materials would be distributed. To improve AI services, AI technicians were trained, AI crushes used for restraining cows during artificial insemination were constructed and various AI materials & Motor bikes were provided to the district livestock development, health and marketing agencies. Farmer access to support services and markets was promoted through the organization of workshops with community representatives and service providers. In addition, the capacity for zero grazing and improved livestock management was stimulated through training of experts, developments agents and farmers and through the facilitation of experience exchange among farmers.

The selection of the target *kebeles* was based, among others, on: the number of population/households in the area; the cattle population, especially improved and/or Borena breeds in the localities; and the accessibility of the localities so that technical and other supports be provided to target groups. Within the *kebeles*, specific farmers where selected for participation in training and representatives where invited to workshops with service providers. The project assumes that the results of these activities spill over to the remainder farmers in the community. Likewise, the establishment of nurseries and the provision of AI crushers are supposed to assist the entire *kebele*.

In September 2012, we did a survey among 495 farm households equally divided over 3 groups: farm households with direct participation in the project; farm households with dairy animals with indirect participation through spillover effects at the district level (but not in the same *kebele*), and farm households with dairy animals outside the project districts. The first group was randomly selected from project participants in four project *kebeles* (all project kebeles not involved in an earlier pilot), and the other households were randomly selected from farmers with dairy livestock in *kebeles* comparable to the project *kebeles* in terms of soils, rainfall, farm size, crops, role of livestock, infrastructure and other relevant characteristics. The questionnaire contains general questions on household composition and housing conditions, household expenditures and food security, crop production and consumption, land and livestock endowments, and detailed questions related to dairy cattle and production, involving grazing, fodder production, health, milk production, production costs, marketing, and home consumption.

Methodology

The analysis consists of two parts: an impact assessment of the targeted intervention and a more general analysis of adoption of improved dairy technologies. As there were no significant differences between the "spillover" and the control group, we merge these into a larger control or no-project group. We elaborate on this in the results section. To evaluate the impact of the intervention we opted for the propensity score methodology. Impact is measured as the difference in the values of key indicators between treatment and comparison groups. We use indicators that refer to both household wellbeing –expenditures and number of months with not enough food, and dairy –yearly milk per cow production, household dairy consumption, and number of months the dairy cattle has grazed in the past year. Adoption is analysed by regressing adoption indicators on a set of household and farm characteristics and project participation. We consider the following adoption indicators:...

The propensity score matching (PSM) is broadly used to estimate causal treatment effects (Rosenbaum and Rubin, 1983). It relies on the identifying assumption of unconfoundedness, or selection on observables. We might expect that treated and untreated (or controls) differ in characteristics that affect the outcome of interest. If we assume that observable characteristics can account for all outcome relevant differences, then we can use matching. Once the distributions of observable characteristics are reweighed and are made identical between treatment and control, all other differences are assumed irrelevant for the outcome and a straight comparison of means is possible. Since the interventions are multiple we use PSM to study the impact looking at different outcomes. In particular, we find the effect of treatment on the treated (ATT), that is the average gain from treatment for those who actually were treated.

The PSM relies on the following steps. First of all it is crucial to select the observable variables or covariates that allow the estimation of the propensity score. These variables need to be not affected by the treatment or intervention, but at the same time they need to influence simultaneously the participation decision and the outcome variable. We select as set of variables, X, the following variables: age, gender, marital status, education, main occupation, ethnic group, number of household members, dependency ratio, land ownership, number of indigenous, crossbred and exotic cows, number of draft animals and number of goats and sheep. To decide on the previous variables we follow Augurzky and Schmidt (2001). They define a set of covariates as a combination of variables that influence the treatment, but weekly the outcome, and variables that both affect the treatment and the outcome.

The second step is to estimate the probability of getting the treatment as a function of observable characteristics. We opt for the commonly used logit model. We then use the predicted values from estimation to generate propensity score P(X) for all treatment and control group members.

Figure 1 shows the distribution of the propensity score in the control and treated groups. A visual representation is useful to see if there are problems in the common support. In other words we check the overlap and the region of common support between the treatment and comparison group. The two distributions seem pretty similar, and we might expect to loose only few observations because not inside the common region.

A further step is to match the treated unit: for each unit we find a sample of controls with similar P(X). We use different matching algorithms: the nearest neighbour with and without replacement, the kernel with and without trimming level.

After every ATT estimation we test the balancing of the most relevant variables (age, gender, marital status, education, main occupation, ethnic group, number of household members, dependency ratio, land ownership). The tests are quite satisfactory. Extra diagnostic analysis will be done in the future.

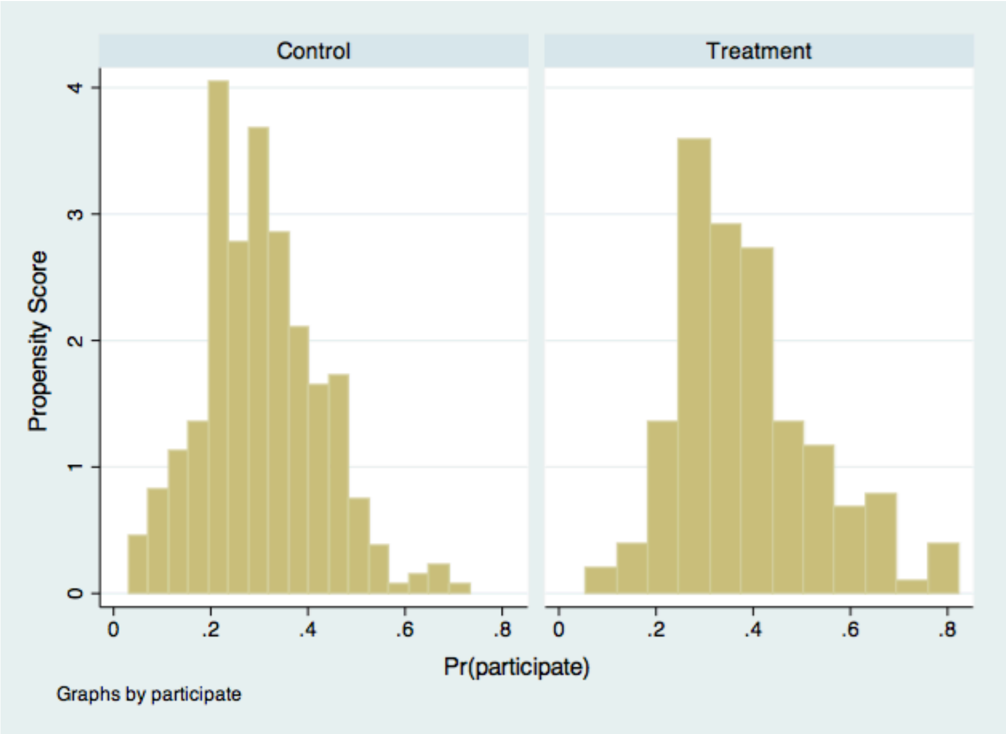

Figure 1: Distributions of the propensity scores in the control and treated groups.

Results

We found no significant differences between the control and the "spillover" groups in household characteristics and technology adoption. This suggests that there a no significant spillover effects of the intervention. Such effects were expected because households in the "spillover" group would benefit from the improvements in the AI service. Unfortunately, these improvements were nor realised. The Livestock development, Health and Marketing agency was unable to assign trained AI staff to Artificial Insemination. Besides, the office transferred the trained AI to other locations. This means that although trainings were given, this has not resulted in better trained AI staff in the treatment kebeles. As indicated before, we therefore merge the spillover and control groups into one large non-project group and the remainder of his section distinguishes these two groups only.

Descriptive statistics

Most of the household heads in the sample are Oromo men with farming as primary occupation (Table 1). They own on average 2 hectares of land for a family of 7. Education is low, but slightly higher for the project kebeles, 2.7 years on average compared to 2.1. This is associated with a higher average food security and less dependents per adult family members.

Table 1 Household descriptives

Variable	All *Mean (sd)* *N=495*	Non-project kebeles *Mean (sd)* *N=330*	Project kebeles *Mean (sd)* *N=165*	T/chi-squared °
Characteristics of the household head				
Age	44.54	45.95	43.44	1.41
	(12.16)	(12.30)	(11.65)	(0.16)
Gender (male=1)	0.89	0.88	0.9	0.15
				(0.70)
Clan (Oromo= 1)	0.9	0.92	0.85	6.06
				(0.01)
Years of education	2.12	1.85	2.66	-2.72
	(3.12)	(2.85)	(3.55)	(0.01)
Marital status (married=1)	0.87	0.87	0.86	0.16
				(0.69)
Main occupation (farmer=1)	0.94	0.93	0.96	1.6
				(0.20)
Household characteristics				
Household's members	6.72	6.76	6.63	0.58
	(2.32)	(2.20)	(2.53)	(0.56)
Dependency ratio	168.38	175.97	153.17	3.03
	(79.42)	(77.41)	(81.43)	(0.00)
Land owned	2.2	2.24	2.11	0.76
	(1.83)	(1.62)	(2.18)	(0.45)
Total yearly expenditures (ETB)	13698	13327	14439	-1.01
	(11562)	(10242)	(13835)	(0.31)
Number of months without enough food for the family in the last 12 months.	0.2	0.27	0.07	3
	(0.68)	(0.80)	(0.32)	(0.00)

Note: ° Tests for difference in means between project and non-project kebeles. Probability levels in parentheses.

Table 2 Livestock ownership and dairy

Variable	All *Mean (sd)* *N=495*	Non-project kebeles *Mean (sd)* *N=330*	Project kebeles *Mean (sd)* *N=165*	T/chi-squared °
Livestock ownership (numbers)				
Pack animals	2.39	2.38	2.43	-0.35
	(1.59)	(1.62)	(1.52)	(0.72)
Draft animals	3	2.97	3.066667	-0.55
	(1.77)	(1.75)	(1.825)	(0.58)
Goats and sheep	3.89	3.71	4.27	-1.11
	(5.26)	(5.46)	(4.83)	(0.27)
Indigenous cows	8.01	7.51	9	-2.31
	(6.78)	(5.59)	(8.61)	(0.02)
Crossbred cows	0.39	0.31	0.55	-1.25
	(2.05)	(1.56)	(2.77)	(0.21)
Exotic cows	0.09	0.11	0.04	1.44
	(0.51)	(0.59)	(0.30)	(0.15)
Bulls	0.77	0.75	0.81	-0.72
	(0.94)	(0.94)	(0.94)	(0.47)
Dairy				
Yearly milk production/cow (liters)	207.3588	217.57	187.82	1.27
	(223.35)	(229.95)	(209.55)	(0.20)
Home consumption of dairy/week (kg) °°	10.7	11.5	9.26	1.26
	(18.28)	(17.86)	(18.99)	(0.21)
Number of grazing months	10.69	10.9	10.27	2.8
	(2.40)	(2.05)	(2.94)	(0.00)
Use of AI (yes = 1)	0.07	0.08	0.02	8.47
				(0.01)
Effectiveness of AI°°° (ETB)	20	17	44	-1.63
	(32)	(23)	(71)	(0.11)

Notes: ° probability level in parentheses.

°° All dairy products are converted to kgs of fresh milk

°°° The effectiveness of the artificial insemination technique is the total cost for the insemination times the number of cows that got pregnant divided by the total number of cows inseminated

Ownership of non-dairy livestock does not differ between the two groups. The average farmer owns 2 pack animals, 3 oxen, 4 sheep and one bull (Table 2). Households in the project kebeles own 9 cows on average compared to 8 cows for those in non-project kebeles. One average, less than one of these cows is crossbred or exotic. Milk production is low, about 200 liters per cow per year. Only three farmers (in the non-project kebeles) sold millk. As expected, AI is equally effective for both groups. Yet it is practiced slightly more in the non-project villages. On average, cows graze almost 11 months of the year, so there is very little zero grazing. Yet, cows in the target kebeles graze a bit less on average than those in the controls: 10.3 months compared to 10.7 months.

Project impact

Table 3 reports all the ATT estimates with the respective statistic. The table shows that the average treatment of the treated on all the outcomes is null. It seems that there is no impact, besides a slightly significant effect if we consider the number of grazing months. If we use the nearest neighbour matching without replacement, but not with bootstrapped standard errors (not reported in the table), and the neighbour matching with replacement and caliper we see that the ATT is about 0.6. This means that there is about 60% decrease in the number of grazing months if the household is treated. This is expected, given that the intervention aims at reducing the grazing period.

Table 3: ATT estimates using different matching algorithms.

Outcomes	**Nearest Neighbour without replacement** ATT (p-value)	***5*-Nearest Neighbour with replacement** ATT *t-stat*	**Nearest Neighbour with replacement & caliper=0.01** ATT *t-stat*	**Kernel bootstrap se** ATT (p-value)	**Kernel with trimming=3 bootstrap se** ATT (p-value)
Expenditures	-189.37	-199.41	676.8	301.189	301.19
	(0.88)	*-0.16*	*0.42*	(0.76)	(0.772)
Milk production per cow	-19.57	-30.77	-35.13	-25.337	-25.34
	(0.43)	*-1.16*	*-1.16*	(0.34)	(0.285)
Consumption of dairy products	-1.15	-1.68	-2.81	-1.77	-1.45
	(0.54)	*-0.78*	*-1.17*	(0.32)	(0.46)
Months of grazing	-0.6	-0.51	-0.64	-0.44	-0.44

	(0.08)	*-1.86*	*-2.17*	(0.13)	(0.094)

Notes: The boostrap fails for the case of NN matching with replacement on a continousus covariate (Abadie and Imbens, 2006)
*F*or the boostrap we use 100 replications
Note: all the estimates are on the common support

The limited evidence of impact does not come as a surprise. There was high staff turnover in the NGO and the targeted organisarions. Moreover, the NGO experienced difficulties in getting the community for the training due to various meeting organized by the government. This means that the effects of trainings and meetings will be more limited than planned.

Further analysis and diagnostic need to be done before driving the final conclusions.

Technology adoption

Table 4 report regressions for the most relevant innovations in our study: use of AI, fodder production, grazing months, and crossbred ownership. *Ceteris paribus,* project farmers make less use of AI, but graze their cattle less and produce more fodder. This suggests that despite all problems the project was at least to some extent successful. Education increased the probability of AI, but not adoption of the other innovations. Adoption of improved technologies was more likely when the farmer already owned crossbred of exotic cows. These cows are more likely to be fertilized using AI, and innovations like zero grazing are more productive for improved breeds. Perhaps surprisingly, ownership of non-dairy livestock and land do not affect technology adoption. Households with relatively more dependents are more likely to produce fodder and keep their cows enclosed for more time. Possibly, labor-intensive collection of feed is done by children.

Table 5 Adoption of innovations, all kebeles

	Use of AI (logit)	Fodder production (logit)	Grazing months (ols)	Crossbred ownership (logit)
sex	0.437	0.720	-0.822	-1.999**
	(1.034)	(0.486)	(0.539)	(0.906)
Age_year	0.00880	-0.000804	-0.00163	-0.0262
	(0.0197)	(0.00956)	(0.0108)	(0.0198)
marital	-0.471	-0.715	1.300***	2.428**
	(0.889)	(0.439)	(0.487)	(1.054)
members	0.152	0.0297	0.0135	-0.0175
	(0.101)	(0.0518)	(0.0584)	(0.0986)
educyears	0.137**	-0.000120	-0.0138	0.0928*
	(0.0566)	(0.0327)	(0.0368)	(0.0495)
ethnic	-0.383	0.222	0.744**	-0.539
	(0.612)	(0.334)	(0.372)	(0.510)
job	0.00753	-0.286	-0.0634	2.047
	(0.862)	(0.432)	(0.483)	(1.365)
depratio	-0.00430	0.00232*	0.00303**	0.000641
	(0.00281)	(0.00126)	(0.00142)	(0.00231)
land	-0.146	0.0569	0.0688	0.0230
	(0.146)	(0.0714)	(0.0809)	(0.134)
indigenous	-0.0351	0.0128	0.0332*	0.0141
	(0.0409)	(0.0162)	(0.0180)	(0.0225)
exotic	0.388*	0.308	0.349	1.050***
	(0.234)	(0.211)	(0.219)	(0.253)
crossbred	0.121**	-0.0123	-0.151***	
	(0.0608)	(0.0468)	(0.0532)	
oxen	0.182	0.0629	-0.0612	0.109
	(0.119)	(0.0694)	(0.0773)	(0.112)
goatsheep	-0.0408	0.0380	-0.000485	0.0354
	(0.0400)	(0.0235)	(0.0245)	(0.0346)
treat	-1.801***	0.663***	-0.407*	0.464
	(0.591)	(0.209)	(0.236)	(0.353)
_cons	-2.914**	-1.485**	9.107***	-4.274**
	(1.421)	(0.699)	(0.783)	(1.751)
N	481	484	484	484
R-sq			0.082	

Standard errors in parentheses
="* p<0.10 ** p<0.05 *** p<0.01"

Conclusions

Despite many efforts to increase dairy production and productivity, dairy production in the study area is still highly traditional. Most cows are of indigenous breed and graze year-around. Yet we do find some evidence of impact of a targeted project.. Impacts were probably limited due to high turnover of staff in project and support aencies. Moreover, the project focuses only on technology and inputs, not on sales of outputs. Almost on farmer is selling milk at present, and coordinated action may be needed to link to the market.

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