Network management for dairy productivity and quality in Ethiopia

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Abstract

Ethiopian smallholders could generate relevant income flows through small-scale dairy farming. However their market access is highly constrained by a set of unique transaction costs. Horizontal and market institutions such as collective co-operatives are potential catalysts for mitigating these costs. This article presents unique data linking farm characteristics, production records and lab-results across cooperative members and non - members. Main outcome of the study is that co-operative membership tends to contribute to productivity, yet, its impact on quality and milk safety is limited.

Key-words: Dairy production, Milk quality, Agricultural development, Ethiopia

1. Introduction

Milk and dairy production is of great importance for agriculture in East Africa. Recent calculations expect the demand for food of animal origin in developing countries to double over the next 20 years. Delgado (1999) estimated a growth in demand for dairy products in sub-Sahara Africa with 3.8-4% from reference year 1993 to 2020 as a result of population increase and income growth. Similarly, it is expected that Ethiopian dairy market will expand. Yet the main challenge is matching demand by increasing production, in particular from small-scale farmers. Milk is an omnipresent animal product that farmers produce. A majority of milk cows is kept on family farms, yet often small-scale, and production of milk low in quantity and quality. ILRI calculated that in the Kenyan formal dairy industry 0.2 to 0.4 jobs were created per 100 litres of milk handled daily, while the same amount creates employment for 2 to 3 informal traders in Kenya and Tanzania (ILRI, 2004).

Small-scale farmers dominate dairy sector in all African countries with exception of South Africa and Zimbabwe, and most commonly in integrated crop-dairy farming system. The transaction costs involved with dairy production are generally high, which results in the finding that much of the milk production occurs around consumption centres (Omiti & Staal, 1996). According to Staal et al. (1997) transaction costs arise from (1) the perishable nature of raw milk; (2) its high water content making it a bulky commodity; and (3) the variability of milk composition and quality. High transaction and marketing costs arise as milk has to be transported quickly to the consumer or processor, its bulkiness limits the amount a farmer can transport without vehicle and monitoring its quality and composition is costly and may lead to high levels of rejection (Staal et al., 1997). Case studies show how innovation in institutional arrangements lowers these transaction costs sufficiently for the farmers to benefit from marketing. Milk groups or farmers' cooperative in Ethiopia and Kenya has been proved to be a first step in creating market access by reducing transaction costs. Yet, these and other studies on the dairy sector in East Africa have mainly focussed on the amount of milk marketed and its resulting potential for income generation (Staal et al., 1997; Holloway et al., 2000). The intrinsic quality of dairy products has not been an issue of much research in development economics writings. This is regardless of its importance for the health of its

consumers and the high rejection rates of milk at processing points. Furthermore, a major part of the milk market is informal and thus outside the formal cold-chain including pasteurisation and packaging.

In the paper, we discuss aspects of quality and safety from an institutional point of view in a case study of dairy smallholders in Ethiopia. Preliminary results of our survey indicate that the influence zone of the milk cooperatives is restricted to its immediate vicinity, and does not reach farmers in the rural settlements. It has major contribution to the improvement of the genetic composition of the livestock, yet only a limited impact on quality. We therefore put forward that collective action in cooperatives is conducive to productivity, however it will need to increase efforts towards monitoring and control of milk quality and safety.

The paper is organised as follows. Section 2 describes the major characteristics of diary sector in Ethiopia. Section 3 gives a short overview of the survey and presents general characteristics of the farmers interviewed. The next section shows the main results of the analysis, which are discussed in section 5. Section 6 concludes with some critical issues and challenges for future research in the Ethiopian dairy sector.

2. Dairy sector in Ethiopia

Ethiopia is one of the poorest countries in the world. The World Bank (2004) estimates that 45% of the population is living below the minimum basic needs at a GNP per capita of 100US$ in 2002. Agriculture is a key economic sector, its value added accounting for more than 40% of the GDP. Within the agricultural sector, livestock and livestock products represent about 40%. The non-monetary contribution of livestock to the households, i.e. draft power fuel, manure and transportation should be added to this figure. Ethiopia counts the largest livestock population in Africa (Redda, 2001; Ahmed et al., 2004). The increase in milk production has benefited much from policy reforms starting from 1993. Along with population growth and technological intervention, policy reforms contributed to an estimate growth rate of milk production of 3% compared to 1.8% in the period of 1975-1992 (Ahmed et al., 2004).

The demand for milk in Ehtiopia is expected to increase, in particular in urban areas. Demand is geographically differentiated in the sense that households in lowlands daily consume milk, while in highlands milk is mainly consumed by children and elderly.

Most milk is sold as raw milk (50 million litres in 2002) or processed in butter or cheese (285 million litres). Raw milk is not often bought but taken from own production (home consumption accounts to 370 million litres). Cheese, or ayib, accounts for 9% of the total milk produced (Ahmed et al., 2004).

After major policy reforms since the beginning of the 90s, the market liberalisation created opportunities for commercial private enterprises in the Ethiopian dairy sector. Three types of dairy farming and four marketing channels are distinguished (Figure 1). First, the smallholder dairy households keep the majority of the cattle in Ethiopia accounting for 97% of all milk produced and 75% of commercial milk production. They own mainly indigenous cows of low-productivity native zebu breed, producing between 400 to 680 kg milk/cow per lactation period. Secondly, state farms that have been privatised or are in the process of privatisation, use high-graded animals. The third group are peri-urban or urban households, mainly keeping crossbred animals in the central highland plateaus. These cows can produce 1,120-2,500 litres per lactation period (Ahmed et al. citing Gebre Wold et al, 2000).

In terms of marketing, the large-scale formal processors include the state dairy enterprise and few large private dairy firms. They mainly produce for deliveries to formal shops that are supplied by state farms and a number of large private dairy farms. The small

peri-urban diary households can deliver milk to one of the 30 cooperatives or to informal urban traders. The monitoring and control of the milk and dairy regarding quality still remains limited. The deliveries at the cooperative are reviewed with an alcohol test and a gravity test to check on basic food safety and possible fraud. Rural farmers sell surplus production of raw milk on the rural market as well as butter and cheese (Figure 1).

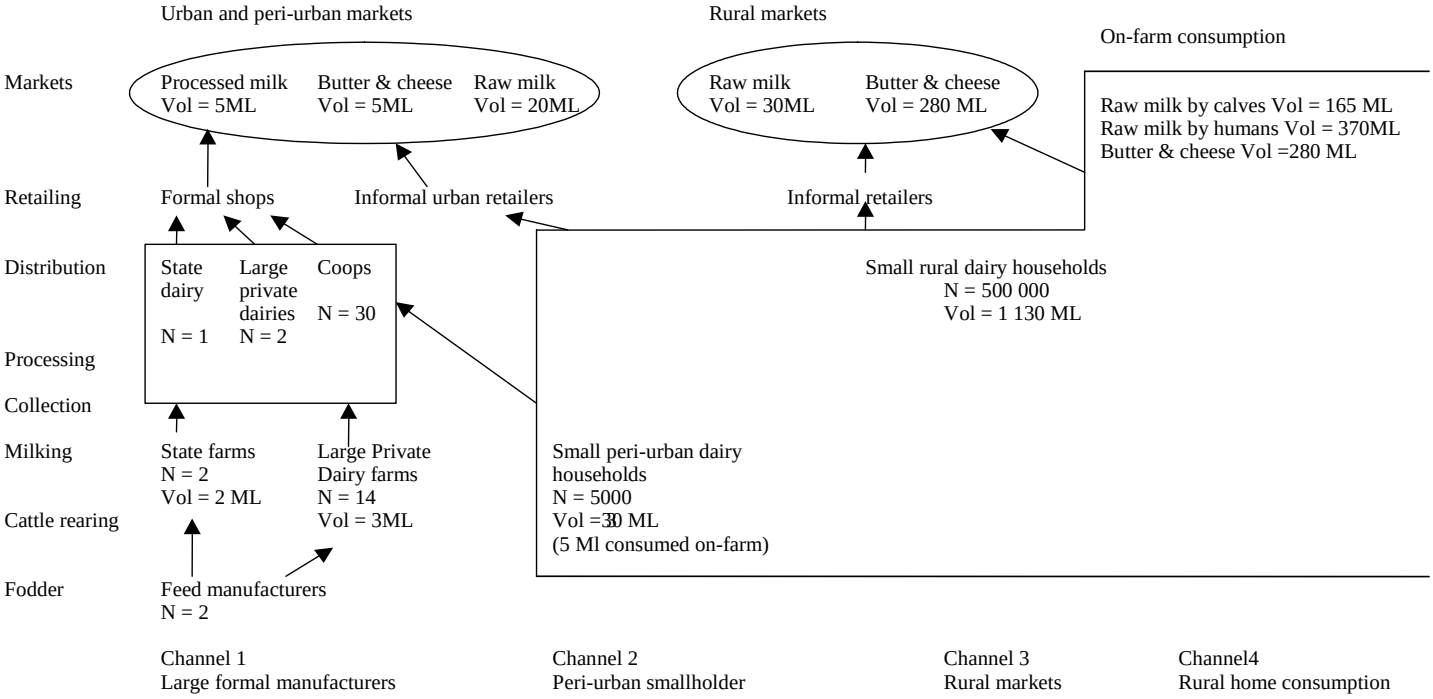

Figure 1. Schematic overview of dairy marketing channels with indication of volumes of production and trade (Vol in millions of litres) and number of producers (N) (Source: Ahmed et al., 2004)

3. Data and methods

A random sample was taken of 70 small dairy farms. Due to missing records, not all cases could be used in the various regressions. Besides general household information, farm, farm infrastructure, dairy production records and milk-handling characteristics were assessed. All participants where selected from the urban and peri-urban and rural areas of Debre Zeit that is a village 50 km south of Addis Ababa. Members of the cooperative were randomly selected from the list handed by the cooperatives, while non-members were randomly selected on the census of the local unit of the Agriculture ministry. From each farm a sample of raw milk was collected and analysed using standard microbiological and chemical sampling procedures at farm gate. This enabled us to build a unique data set combining farm and household data with records on fat content, and results from tests on total bacterial count (TBC) and acidity level.

This paper presents an analysis of variables that explain productivity of milk production, milk composition, acidity levels and TBC counts using different statistical methods. We describe general statistics, the effect of co-operation on the farming system and milk composition. The productivity of milk is defined as the amount of milk produced on farm divided by the number of cows. It is regressed on farm characteristics including the farm

location as a proxy of potential access to a formal market through a cooperative and access to its extension services.

The TBC count revealed a binary distribution, with some farmers having major problems with bacterial contamination, and others less. We therefore divided the sample over two groups, and created a new TBC-related dummy variable. A probit test was then performed on this new variable, comparing the influence of farm characteristics and cooperative membership on the probability of showing a high TBC count.

To analyse which factors are influencing the bacterial contamination within the group of farmers member of the cooperative, a two-step Heckman procedure was used to regress acidity levels. In the first step, the variables influencing the probabilities on a farmer being member of the cooperative or not are assessed in a probit analysis. The Inverse Mills ratio resulting from the probit is then entered with other farm characterising in a regression of the dependent variable, i.e. acidity level, for the members of the cooperative. This procedure enables to check for sample selection bias.

4. Results

This section presents the results of various tests ran on the data collected in Ethiopia. We first sketch the major characteristics of the farmers in our sample. Next we describe the role of the cooperative and its apparent influence on the farming system. This is followed by the analysis of the impact of location on the milk output. Finally we discuss three important quality factors.

4.1 General characteristics

Section 2 provided an overview of the dairy sector in Ethiopia, indicating the large group of small-scale farmers. The farmers in our sample own between one or two cows, with an average milk production per cow per day of 4.5 litres per cow per day (Table 1). The average production on farm is less than 11 litres. The average age of the farmers in the sample is relatively high, compared to the life expectancy at birth of 42.1 year (World Bank estimates for 2002). The average monthly expenditure on feed on the farm is equivalent to 8.9 Euro/cow (Exchange rate in February, 2005).

Table 1. General characteristics of members and non-members of the cooperative

	Non-member (n=35) (0)		Member (n=35) (1)		t- stat
	Mean	**Std.Dev**	**Mean**	**Std. Dev**	
Age (yrs)	46.03	16.40	49.97	11.63	-1.160
Family size (members)	5.74	2.44	6.46	2.59	-1.186
Education level (1:illitterate –7:bachelor)	2.06	1.33	3.74	2.05	-4.086**
Source of information (1:extension–4: parents)	3.88	0.58	3.57	0.85	1.804*
Cows (number)	1.46	0.61	2.11	1.39	-2.563**
Cattle (number)	4.28	3.03	4.06	2.51	0.343
Feed per cow (Birr per month)	86.15	72.87	112.9	69.06	-1.577
Concentrates per cow (Birr per month)	45.45	49.62	53.60	42.01	-0.742
Roughage per cow (Birr per month)	40.69	42.60	59.31	60.98	-1.480
Distance of farm to major market (km)	5.66	4.05	1.25	1.32	6.114**
Income from dairy (% of total household income)	17.14	34.94	29.71	37.49	-1.451
Milk production of farm (litre per day)	4.06	2.96	15.04	10.10	-6.169**
Milk per cow (litre per cow per day)	3.05	2.63	6.70	1.81	-6.384**

Time milk preserved on-farm (hrs)	52.28	164.37	24.28	26.96	0.995
Fat content (%)	4.69	1.14	4.18	0.79	2.119**
Acidity level (%)	0.21	0.02	0.21	0.02	0.630

Dairy is for most of the households not the main income source. Farms are located on average 3.42 km away from the market, which is usually accessed on foot. Only two farmers in the sample transport their milk by bike and another two by car. Not all milk is sold as part of the milk is consumed within the household. Some households in the survey produce butter (n=21; 29%), and some ayib or cheese (n=23; 31.9%) for own consumption or the informal market. The number of farms on which yoghurt is made is insignificant (n=2). Women are not only responsible for the production of these dairy products, but they are in charge of dairy in general, including milking, selling milk and dairy products and management.

4.2 Importance of the cooperative

The survey included an almost equal distribution of farmers member of the cooperative and non-members. The average number of cows of members is 2.1, while 1.46 for non-members (Table 1). Furthermore, mean production and productivity are not equal, with higher production and productivity of farmers member of the cooperative compared to non-members. Farmers member of the cooperative sell milk towards the formal markets, while non-members in the rural areas sell on the informal market, being the local market or for a major part at farm gate to friends, neighbours or relatives. Table 2 shows that the majority of the farmers member of the cooperative are living in urban areas. The farmers member in our survey all keep crossbred-type cows, while two-third of the non-members have Zebu-type cows.

Table 2. Distribution of farmer over cooperative membership, location and breed of cows kept (number of farmers)

	Non-member (n=35)	**Members (n=35)**	**Total (n=70)**
Location			
Urban (1)	12	30	42
Peri-urban (2)	6	1	7
Rural (3)	17	4	21
Breed			
Zebu-type (0)	23	0	23
Cross-bred – type (1)	12	35	47

The probit analysis in Table 3 gives the factors related to the probability of being member of the cooperative. It shows that age is important, thus the older the farmer, the higher the probability of membership of the cooperative. Education is significant: as the higher the education level, the higher the probability of membership. Also location reveals to be an important factor, as the collection centre is situated in the urban area, it are merely the urban and peri-urban farmers who are member of the cooperative. Sex, family size and whether or not the farmer has an income outside agriculture do not influence membership probability.

All farmers member of the cooperative indicated that they changed their farming system since becoming member, namely: feed input increased (n=29 of 35 members in the sample), more veterinary services (n=19), general improvement of health of the cows (n=24), better breed (n=25), increased in herd size (n=21), increased yield (n=22), better market access (n=32), increase in income (n=29) and increase in hygiene on farm (n=34). However, farmers are not satisfied with the extension services of the cooperative, for 26 of them it is considered poor. Farmers who are not member indicate poor yield as a major reason why

they do not join a cooperative (n=25; 71% of non-members), with the membership fee as second reason (n=6; 17% of non-members).

Table 3. Probit analysis of membership counts using Huber/White/sandwich estimator of variance ((1) member n= 35; (0) non-member n=35)

	Coef.	Std. Err.	Z	P>[z]
Age (yrs)	0.036	0.017	2.15	0.031
Location (1: urban -3: rural)	-0.781	0.186	-4.18	0.000
Family size (number)	0.064	0.069	0.92	0.359
Education level (1:illitterate –7:bachelor)	0.427	0.114	3.74	0.000
Sex of respondent (0:female, 1:male)	-0.058	0.399	-0.15	0.884
Income from outside agriculture (0:no, 1:yes)	-0.075	0.443	-0.17	0.865
Constant	-2.042	1.022	-2.00	0.046
Wald chi^2: 34.88 Prob > Chi^2: 0.000 Pseudo R^2: 0.3825				
Log likelihood: -29.96				
Percentage correctly classified: 81.43%				

Farmers member of the cooperative recognise the importance of quality yet, almost a third of the farmers member did not know which tests are used to monitor the quality of their milk (n=12 for members, n=31 for non-members). They point out the fluctuation of the milk price as their main problem (n=17), followed by the prices of feed (n=11) and quality control (n=6).

The following sections investigate the relative impact of membership of the cooperative on milk output and milk quality.

4.3 Milk productivity

While crossbred cows are more common on the urban farms, the rural farmers in our analysis keep indigenous, Zebu, animals which have low production performance. The average cow lactation yield is 525l (of lactation of 239d) of which 286l is suckled by the calf (Ketema & Tshehay, 1995). Similarly, we found a difference between milk output per cow for members (6.707 l per cow per day) and non-members (3.05l per cow per day) (Table 1).

Table 4 shows the results of a regression of milk output per cow on farm characteristics. These results show that age is important, with a concave shape, thus younger and older farmers are associated with lower productivity. Furthermore, location is significant, showing a negative coefficient indicating an increased relationship towards the urban areas. Interestingly, we note a positive coefficient of the square of number of cows, while the number of cows is negatively related to the productivity at 90% confidence level. This indicates a convex relationship, with higher productivity levels on smaller farms. Education and family size are not significant.

Table 4. Regression of milk output per cow (litre per day) (n=64)

	Coef.	Std.Err.	t	P>[t]
Age (yrs)	0.337	0.167	2.01	0.049
Age^2	-0.003	0.001	-2.01	0.049
Cows (number)	-2.049	1.203	-1.70	0.094
$Cows^2$	0.487	0.225	2.16	0.035
Location (1: urban -3: rural)	-1.703	0.367	-4.64	0.000
Family size (member)	0.099	0.132	0.75	0.456
Education level (1-7)	0.139	0.176	0.79	0.432
Constant	0.569	4.495	0.13	0.900
F(7,56): 7.81 Prob > F : 0.000	Adj. R^2 : 0.431			

4.4 Milk quality

In the following sections we investigate the influence of farm characteristics on performance in milk quality. We look into milk composition, acidity levels and microbial contamination.

Milk composition: fat content

Figure 2 shows a histogram of fat content. The fat content falls between 2.5% and 7% with the highest frequency at 4.5%. We find an average higher fat content for farmers who are non-member of the cooperative (mean: 4.69%) compared to members (mean: 4.18%). Yet higher fat contents are preferred as it contributes to a higher amount of butter and cheese that can be produced from one litre of milk. Musangi (1971; in FAO (1990)) found on average 5.5% fat in milk in East-African Zebu's. Normal fat content of milk in temperate zones ranges between 3.5% and 6%. Table 5 presents a regression of the fat content over farm characteristics.

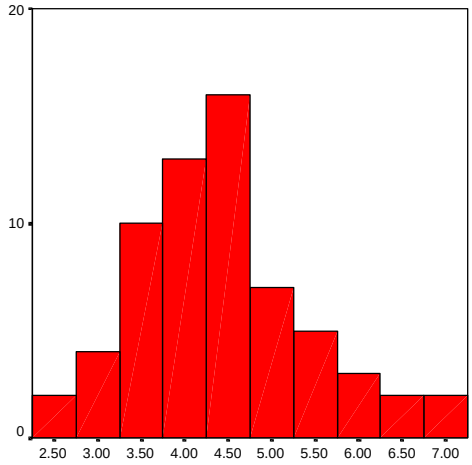

Figure 2. Fat content of milk (%)

Table 5. Regression of fat content in milk (%) (n=64)

	Coef.	Std.Err.	t	P>[t]
Age (yrs)	-0.178	0.068	-2.62	0.011
Age²	0.002	0.000	2.60	0.012
Gender ratio (number men)	0.268	0.101	2.65	0.011
Sex	-0.130	0.262	-0.50	0.620
Location (1: urban -3: rural)	0.249	0.176	1.42	0.161
Cattle (number)	-0.035	0.058	-0.60	0.550
Feed per cow (Birr per month)	-0.002	0.002	-1.03	0.310
Constant	7.838	1.533	5.11	0.000
F(7,56): 2.44	Prob > F : 0.029	Adj. R² : 0.138		

We find that fat contents increase with decreasing age of the farmer, along a convex curve. This would suggest that younger farmers farmers are have better knowledge of feeding techniques compared to older farmers; this however stabilizes towards the oldest farmers in the sample. Secondly, gender ratio in the household seems to matter, with increasing fat content along with more men in the household. Location and families endowments in cattle are not significant, nor are the expenditure on feed per month per cow. The model gives some indication, but is not highly significant. Other variables such as breed could probably explain much of the difference in fat content between members and non-members, but were not entered in the regression due to endogeneity problems. Milk of Zebu's kept in the rural areas

is in general more concentrated in terms of total solids and fat than milk of diary breeds of temperate countries (FAO, 1990).

Total Bacterial Count (TBC)

Milk and dairy products are highly perishable. Hygiene levels on farms in Ethiopia are considered unsatisfactory due to poor housing, inadequate ways of milking and the type of milking vessels used (FAO, 1990). This was confirmed in our survey; our survey; 87.3% of farmers did not test the first strip of milk during milking; there were still farmers who do not clean the udder before milking (n=11; 15%) and sometimes did not dry it after washing (n=24; 33.8%). The lack of hygiene on farms can result in bacterial contamination.

Table 6 shows the results of a probit analysis on the TBC counts. Factors contributing to a higher probability on bacterial contamination include: (a) small herd livestock, (b) higher yield per cow, (c) high distance to the collection centre or market and (d) the source of information on farming (this goes from formal to informal, thus highest score is given for experience through parents). The more remote farms thus seem to have more problems of milk contamination. The model furthermore suggests that farms with higher productivity show a higher bacterial contamination. Higher productivity is merely the result of genetic improvement, from indigenous Zebu cattle to higher yielding cross-bred cows. Yet the indigeneous Zebu cows are better adapted to the environment (i.e. feeding regime, diseases, temperature, and water). This explains why higher productive cows may be more vulnerable to diseases and thus milk contamination. Furthermore, the small herds have a higher probability towards bacterial contamination. This can be due to low quality inputs that are available to the smaller farms. Farms with more cattle endowment are the ones better off, thus having more access to, for example, feed of better quality and veterinary care. Also the source of information seems to be important, with households farming along traditions learned from their parents showing a higher probability on high bacterial contamination.

Table 6. Probit analysis of TBC counts using Huber/White/sandwich estimator of variance ((1) high counts n= 35; (0) low counts n=29)

	Coeff.	Std. Err.	z	P>[z]
Cattle (number)	-0.137	0.685	-2.00	0.045
Milk per cow (litre per day)	0.164	0.071	2.30	0.021
Distance of farm to major market (km)	0.133	0.054	2.44	0.026
Source of information (1-4)	0.450	0.258	1.74	0.081
Age (yrs)	-0.005	0.013	-0.39	0.694
Family size (members)	-0.03	0.069	-0.43	0.664
Constant	-1.77	1.373	-1.29	0.197
Wald chi^2: 12.68 Prob > Chi^2: 0.0484 Pseudo R^2: 0.1626				
Log likelihood: -36.912				
Percentage correctly classified: 68.75%				

Other factors as age and size of household are not significant. The model is significant, yet not convincingly presenting the whole picture. We suspect that other factors are important to explain the occurrence of high bacterial counts, yet we lack the necessary quantitative data on milking and milk handling. Other factors not influencing a probability on high TBC counts include education, expenditures on concentrates and roughage, and location. The latter could not be included in the probit analysis reported here due to high correlation with other variables. For similar reasons, the impact of cooperative membership on the TBC counts could not be established in this test due to endogeneity problems. We could furthermore not establish, given the available data, a relationship between TBC counts and cooperative membership in other models.

Acidity levels

Acidity in milk results from bacteria fermentation activity. The more bacteria in the milk, the more acid it is. Acid milk means either that the milk is old, i.e. not fresh, or fresh but highly contaminated with bacteria. Normal acidity range is between 0.14% and 0.17%. Milk samples included in the study showed high levels of acidity, all equal to 0.17% or above. The factors influencing acidity levels of members of the cooperative are assessed in a two-step Heckmann analysis to control for selection bias. The fist step, a probit analysis on cooperative membership, was similar to the one discussed above. The regression of acidity levels in the second step shows the significance of household, farm and institutional characteristics. Lower acidity levels are found on farms with smaller family size (shown by less men). Furthermore, negative relation is found with time that milk is preserved on the farm. Also the higher the farm's expenditure on concentrates, the higher the acidity level. High levels of concentrates (in particular if concentrates exceed 40% of feed), or if its quality is poor, it might affect the cows metabolism in the rumen, resulting in ketosis. Ketosis may furthermore increase risk of mastitis and thus milk contamination. It furthermore shows that the higher the expenditure, the more problems the farm has with acid milk. The coefficient of the mills ratio is not significant, indicating that there is no selection bias.

Table 7. Analysis of acidity levels (%) using a two-step Heckman analysis
Second step: OLS Regression on acidity levels

	Coef.	Std. Err.	z	P>[z]
Gender ratio (number of men)	-0.0131	0.0028	-4.64	0.000
Time milk preserved on farm (hrs)	-0.0008	0.0002	-4.51	0.000
Exp. on conc. (Birr per month)	0.0001	0.0000	2.58	0.010
Age (yrs)	-0.0019	0.0037	-0.52	0.603
Age²	0.0000	0.0000	0.87	0.382
Education level (1:illitterate –7:bachelor)	-0.0028	0.0032	-0.88	0.380
Distance of farm to major market (km)	-0.0024	0.0030	-0.79	0.430
Milk per cow (l per day per cow)	-0.0012	0.0025	-0.48	0.634
Exp. on rough (Birr per month)	-0.0000	0.0000	-1.31	0.190
Constant	0.2858	0.0817	3.50	0.000
Mill lambda	0.0129	0.0174	0.74	0.459
Number of obs.: 60; Censored obs.: 33; Uncensored obs.: 27				
Wald Chi²: 61.85 Prob> Ch²: 0.000				

5. Discussion

The above results clearly show the effect of the cooperative on production and productivity levels. This may be due to changes in the farming system (breed and farm size) induced by efforts to promote dairy production in the urban area, including the cooperative. Yet we did not find any evidence that membership of the cooperative is conducive towards milk quality as measured in bacterial contamination and acidity levels.

We saw that rural farmers mainly sell on informal markets, neighbours, friends or just at farm-gate. Furthermore, it concerns mostly the sales of surplus production as the household consumes part of the milk. What is not sold can be processed into butter or cheese. This means that the transaction costs of selling the milk are low. Farmers do not bear much risk, little negotiation, any long term contracting and limited transport costs. The buyers of the milk generally trust the farmer on the basis of close social ties, or past experience. In their current livelihood strategies rural farmers do not have to invest in specific assets. As shown

above, it concerns small numbers of Zebu cows, with limited additional feeding and farm infrastructure and a minimum of monitoring and control of milk quality. Quality is not mentioned after control, it is not measured so that it is also not rewarded in a better price.

On the other hand, in (peri)urban areas households have more opportunities for selling the dairy produce. Yet entering the more formal processing chain presents higher requirements in terms of quantity and quality. Income opportunities in more formal sales may be better, but as quality standards are higher, rejection rates are higher. As a consequence smallholders face the need for more asset specific investments and more risk. The resulting increase in transaction costs can be too high for accessing the market individually, making the cooperative an interesting alternative. Instead of trading on a spot market, pooling efforts in a hybrid organisation structure becomes profitable (Williamson, 1991; see also Williamson (2003) and Ménard (2004)).

The cooperative structure, as analysed in this paper, principally serves as a collection point where milk is sold in bulk. This benefits the farmers in terms of reduction in transaction and marketing costs and it increases the bargaining power of the farmers as a group (Staal et al., 1997; Holloway et al., 2000). The cooperative as a network thus involves contracts on two levels, namely between the farmers in the coop and between the collective of farmers and the clients of the cooperative. Lazzarini et al. (2001) names these institutional arrangements netchains, based on strong social ties and dense networks, with co-specialiation of knowledge as sources of value, coordinated by mutual adjustment with agents that are bound by reciprocal interdependencies as a result of pooling of resources and knowledge.

The cooperative, or more general the proximity of the market, gives the farmers an incentive to invest in their livestock, buying more cows of a better breed, and thereby generates positive externalities of co-specialisation. Yet, problems of quality standards persist. For both levels of contracts, requirements of quantity and quality need to be respected. Although quality control at the cooperative is limited to an alcohol test and a specific gravity test, rejection rates remain significant, which are immediate income losses for the farmers. The cooperative seems not to have an impact on the monitoring on-farm towards better quality and safety of the milk. The lack of quality of the milk could also become problematic for the performance of the cooperative in the supply chain. To secure its selling contracts, the cooperative needs to increase quality control at collecting points and monitoring at the farms. This is likely to increase transaction costs even more.

Furthermore, the success of the cooperative depends largely on how well the coop is securing itself against free-riding (if one farmer adds water to its milk or its quality is not adequate, it can spoil the whole tank); and investment horizon problems (this is that the farmers as a group should think in investing on a longer term, and not just once because if the NGO or ILRI stops its aid to the coop it might not "survive") (see Sykuta & Cook (2001) for more insights in this discussion). Much will then depend on how much the farmers trust each other within the cooperative, and how the cooperative acts as third-party control mechanism.

6. Conclusion and implications for future research

The high levels of bacterial contamination are a matter of concern for food safety. Consumers are entitled to safe and fresh milk of acceptable quality levels. Yet on the informal market, quality is not formally controlled. The results of our study show that milk collection and collective action towards accessing a formal market are an incentive to increase number of cows and invest in better breeds. This seems to pay off in terms of relative higher levels of production as well as productivity. However, impact on quality is limited. Bacterial contamination is high, as shown by high TBC counts and high acidity levels. In other words, networking is conducive to the quantity of produce, yet transition towards increased quality

appears to be more difficult. Farmers' interest in quality needs to be promoted along with increased monitoring and control of quality management at farm-level. We believe that the cooperative has a particular role to play in extending and improving its information campaigns in order to increase quality standards of its members. This could result in a decrease in rejection rates of milk at collection point or at processor level, and thereby increase the farmers' income levels. Moreover, it strengthens the position of the cooperative in the supply chain.

In this paper we presented a comparison of productivity and quality performance of member and non-members. Yet, further research is needed to analyse the difference in information acquired by the farmers and to find out how this has influenced the willingness to participate in the cooperative, and its possible impact on farming system and milk handling. This should help to formulate better strategies for future network management.

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