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Dairy Cattle Market Participation and Performance in Selected Urban and Peri-urban Areas of Ethiopia

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ይህ ጽሁፍ የከተማና ከተማ-ገብ አባቢዎች የወተት ከብቶች ግብርናና ልማትን የምርት ገበያ ተሳትፎ የሚፈታተኑ ማነቆዎችን ለመለየትና የማሻሻያ ፖሊሲ ሀሳብ ለማመንጨት በተካሄደ የዳሰሳ ጥናት ላይ ተደግፎ ገላጭ እንዲሁም የግብይት ደረጃዎችን መሰረት ያደረገ የኢኮኖሜትሪክስ (ደብል ሻርድል) የትንተና ሞዴል በመጠቀም የተዘጋጀ ነው። ውጤቱ እንደሚያመለክተው የወተት ከብት አርቢዎች የገበያ ተሳትፎና የገበያ ስርዓት ያልዳበረና ወደ ልማዳዊ (ኢ-መደበኛ) የግብይት ስርዓት የሚያደላ እንደሆነ በአንጻሩም የወተት ከብት አርቢዎች የገበያ ተሳትፎአቸው ከቦታ ወደ ቦታ እንዲሁም በከብት ብዛትና በአርቢዎቹ ማህበራዊና ኢኮኖሚያዊ ሁኔታ አንጻር ቢለያይም አብዛኛዎቹ ከመግዛት ይልቅ ወደ መሸጥ ያዘነበሉ መሆናቸው ታውቋል። የወተት አርቢዎች ወደ መሸጥ እንዲያዘነብሉ የተገደዱባቸው ምክንያቶች የወተት ከብቶች ማርቢያ ቦታ እጥረት፣ የበሽታ መከሰትና የከብቶች እርጅና መሆናቸው ታውቋል። በሌላ በኩል የአርቢዎቹ የግብይት ውሳኔዎች በሁለት ደረጃዎች የሚከናወንና እያንዳንዱ የውሳኔ ደረጃ በአርቢዎቹ፣ በእርባታ ስፍራዎችና ከእርባታ ውጭ በሆኑ ባህርያት ላይ የተመሰረቱ መሆኑን የትንተናው ውጤት ያመላክታል። እነዚህ ሁኔታዎች ከቀጠሉ የወተት ልማት ስራው የሚዳከምና የወተት ምርቱን እጥረት የሚያባብሰው ይሆናል። ስለሆነም በከተማና ዙሪያው ያሉ የወተት ልማት ፖሊሲዎችና አተገባበራቸውን መፈተሸና ማሻሻል እንዲሁም ህጋዊና ኢ-መደበኛ ያልሆኑ የግብይት ስርዓቶች እንዲዳብሩ የወተት ልማትና ግብይት ትስስር ማዕከላት የሚበረታቱበት ሁኔታዎች መፈጠር በተለይም ለግብይት ተሳትፎ አለመዘመን ሁኔታዎችና ማነቆዎች የአርቢዎቹን የውሳኔ ደረጃዎች መለያየትን በማገናዘብ የምክርና አስተዳደራዊ ድጋፍ መስጠት ለወተት ከብት ግብይትና ልማት ከፍተኛ ጠቀሜታ ይኖረዋል።

Abstract

This study examined important factors determining the market participation of dairy cattle farmers in selected urban and peri-urban areas of Ethiopia. Descriptive and double-hurdle negative binomial count data (econometric) models were used to analyze the cross-sectional data that was collected from the farmers through a household survey. Results indicate that dairy farmers' market participation and the marketing system in which they operate are poorly developed and are inclined to be informal. Though dairy farms' market participation varied by region, herd size, and farm owners' socio-economic characteristics, more involvement was observed in the selling than in the buying of dairy cattle mainly due to limited space, disease incidence, and old age. Results from the econometric model suggest that farm owners' selling and buying decisions took place in two separate stages (conception and action) and that each stage was influenced by sets of farm owners, farm and non-farm specific characteristics. The implication would be that most of the dairy farms would be forced to close business and the demand and supply gap would continue to persist. Improvement of the existing government attention towards dairy cattle business in urban and peri-urban areas is crucial for achieving better performance in the dairy marketing system and might be achieved through enforcement of urban-dairy production policies and organized (formal) market development such as the establishment of dairy production and cattle

marketing hubs in peri-urban areas and trainings in animal husbandry practices considering the decision-making stages practiced by dairy farmers.

Keywords: Dairy farms; Market participation; Decision levels

Introduction

In Ethiopia, livestock plays a significant role in supporting and sustaining the livelihoods of an estimated 80 percent of the rural poor as well as the agri-business sector (Birara and Zemen, 2016). Livestock account for about 45 percent of the total value of agricultural production (FAO, 2019).

Dairy animals make up 32 percent of the livestock population (CSA, 2017) and represent a significant source of income for the farming community (EEA, 2002). High population density and animal stocking rates, as well as easy access to markets, make the dairy industry attractive, especially in peri-urban areas of the country (Tangka *et al.*, 2002). The increasing demand for dairy products in the country, spearheaded by rapid population growth (estimated at 3 percent annually), increased urbanization, and expected growth in incomes, is expected to induce rapid growth in the dairy sector (IFPRI, 2004). Also, the shift towards stimulating private-sector participation in agriculture and value-addition (agro-processing industrial parks) in most parts of the country is one driver for dairy production.

Despite these emerging opportunities, Ethiopia's dairy sector has yet to realize its potential for increasing production, improving standards, and bringing high-quality, locally-produced, affordable dairy products to the market. The dairy cattle marketing is mainly informal (Tadesse *et al.*, 2017), with dairy farms tending to obtain new and replacement stock through informal networks made up of neighbors, dealers, and local communities. Efficient systems for the marketing of dairy cattle; such as organized cattle breeding and supply schemes, developed technical capacity, market infrastructure, and policy environment, are necessary if the potential for increased production is to be realized.

There is a need for an up-to-date assessment of the roles and marketing decisions of dairy farms in the context of the internal and external socio-economic circumstances which influence them, to enhance producers' and policy-makers commitment to boosting the economic contribution of the dairy sector. Development initiatives require information on marketing problems to address the dairy development gaps and opportunities. Therefore, the main focus of this paper is to assess the nature of dairy farmers' market participation and the most important factors affecting their participation in the marketing of dairy cattle in selected urban and peri-urban areas of Ethiopia where dairy farming is exemplary model.

Materials and Methods

The study sites

The study focused on five urban and four peri-urban districts in Ethiopia. Multistage sampling was carried out to identify sample dairy farms in each site. In the first stage, four urban centers and five peri-urban districts were selected. In the second stage, 450 farms were identified from the study sites. We used proportional to size stratified sampling and sample size within a stratum was determined by Thrusfield's formula (Thrusfield, 2005) given that the strata have different variances. Finally, individual dairy farms in each cluster were identified using a simple random sampling technique. The frequency distribution of the sample farms is provided in Table 1.

Table 1. Study sample distribution by herd size

Category	Regional states	Study sites (districts)	Herd size of dairy cattle			Total
			Small-herd farm (5-19)	Medium-herd farm (20-49)	Large-herd farm (>49)	
Urban	Addis Ababa	Addis Ababa city	123	34	7	164
	Amhara	Gondar	51	8	3	62
	Tigray	Mekele	50	7	1	58
	SNNP	Hawassa	19	12	1	32
Peri-urban	Oromia	DebreZeit/Bishoftu/	12	9	5	26
		Sululta	12	6	3	21
		Holeta	24	7	2	33
		Sendafa	17	4	4	25
		Sebeta	16	9	4	29
Total			324	96	30	450

SNNP=Southern Nations Nationalities and Peoples

The geographical distribution of the study areas is shown below in Fig. 1.

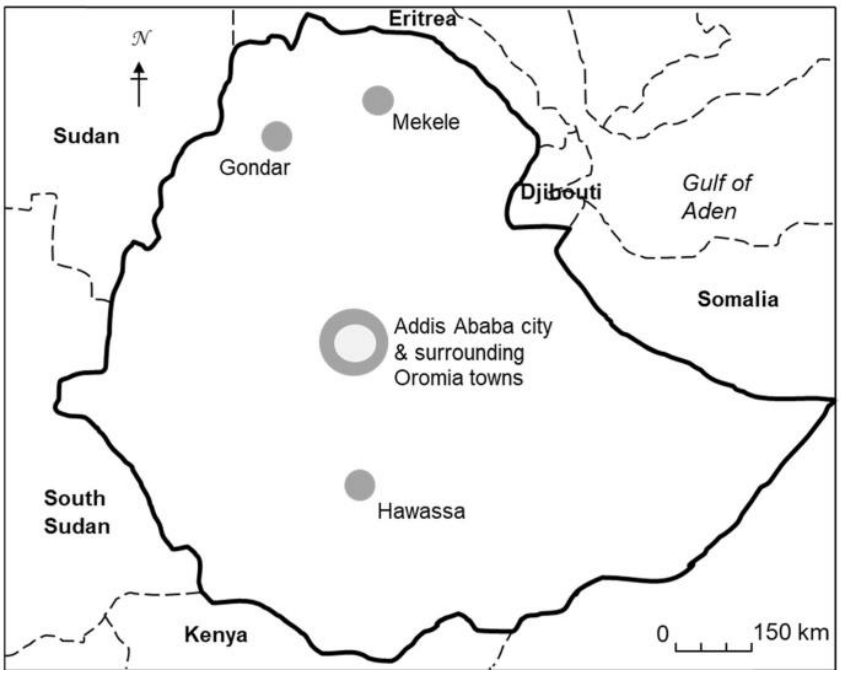

Figure 1. The study areas

Data analysis

The study used primary data, collected from the sampled dairy farms through pretested structured questionnaires and trained enumerators. This data includes the socioeconomic characteristics of dairy farm owners, farm characteristics, and the institutional environment of the dairy farms.

Descriptive methods and econometric models were used for data analysis. Descriptive methods involving mean, standard deviation, frequencies, and statistical tests were used to characterize the farms and their market participation in terms of socioeconomic and environmental factors.

A Poisson regression econometric model was employed to analyze count data on the number of dairy cattle sold and purchased during the study period. The Poisson model has been advocated as a benchmark model for assessing count data (Greene, 2005, 2007; StataCorp. 2013). For model fitness, the standard Poisson regression model was tested against the Negative Binomial regression model using Log-likelihood Ratio (LR), Akakie Information Criteria (AIC), and Vuong tests (Vuong, 1989; Long and Freese, 2014; Hilbe, 2014; Santos Silva *et al.*, 2015) and the test for the competing models showed that the Hurdle Negative Binomial model was significantly (p<0.000) superior to the standard Poisson model, justifying the existence of over dispersion (unobserved heterogeneity) in the data which renders the assumption of a Poisson distribution for the error process

untenable (Cameron and Trivedi, 1998). In addition, the literature suggests the use of the Hurdle model to allow for a systematic difference in the statistical process governing observations below the hurdle and observations above the hurdle (Mullahy, 1986). The hurdle model is flexible and can handle both under- and over-dispersion problems (Gurmu, 1998). Model test results also proved that the test statistic was significant at 1% level (Wald $Chi^2(19)=55.28$ in the case of cattle sales and Wald $Chi^2(19)=44.64$ in the case of cattle purchases). Thus, the standard Poisson regression model was rejected in favor of the Hurdle Negative Binomial model for assessing factors influencing cattle sales or purchases.

The functional form of the hurdle model explaining the distribution of the response variable (probability function) of the hurdle-at-zero model (Seyed *et al.*, 2012; Greene, 2005) is given by:

$$\Pr(Y_i = y_i) = \begin{cases} W_0, & y_i = 0 \\ 1 - W_0 \dfrac{\Gamma(y_i + \alpha^{-1})}{\Gamma(y_i + 1)\Gamma(\alpha^{-1})} \dfrac{(1+\alpha\mu_i)^{-\alpha^{-1}-y_i}\alpha^{y_i}{\mu_i}^{y_i}}{1-(1+\alpha\mu_i)^{-\alpha^{-1}}}, & y_i > 0 \end{cases}$$

Where, Y_i (i = 1, 2. . . n) is the response variable (a nonnegative integer-valued random variable); α=a dispersion parameter assumed not to depend on covariate; W_0=the first hurdle where the latent variable $y_i = 0$

The above hurdle model involves two models:

a) the probability model, specified as

$P(y_i = 0|w_i) = \frac{\exp(W_i'\gamma)}{1+\exp(W_i'\gamma)}$, and

b) the occurrence model, specified as

$$Pr(y_i = j|y_i > 0, X_i) = \frac{Pr(y_i = j \;\&\; y_i > 0|X_i)}{Pr(y_i > 0|X_i)} = \frac{\exp(X_i'\beta)^j e^{-(X_i'\beta)}}{j!\,[1-e^{-(X_i'\beta)}]}, j = 1,2, \ldots$$

Thus, the log-likelihood function of a hurdle model can be expressed as:

$$ll = \sum_{i=1}^{n} I_{\{y_i=0\}} \log f_1(0;\theta_i) + I_{\{y_i>0\}} \log(1 - f_1(0;\theta_i)) + \sum_{i=1}^{n} l_{(y_i>0\}} \log \frac{f_2(y_i;\theta_i)}{1-f_2(0;\theta_i)}$$

where, $f_1 and\ f_2$ are the first and the second hurdles, respectively

Results and Discussion

Socioeconomic profile of sampled farm owners

Results of analysis of the socioeconomic characteristics of the sampled farm owners indicate that the average age of dairy farm owners who sold cattle was 51 years old with a tertiary (high) school level of education (Table 2). The farmers

own on average 1.3ha (ranging between 0.002ha and 31.2ha) of dairy farms with an average farm age of about 22 years. Each farm employed about five workers. In each farm, there were about two types of other animals such as dogs, cats, or poultry; i.e. the practice of herd mixing could be a sign for suspecting bovine tuberculosis due to poor biosecurity. The sampled farm owners were also described in terms of their position as sellers and as buyers as below.

Socioeconomic profile of sampled farm owners as sellers

Dairy cattle sellers and not sellers were identified based on their responses to whether they categorize themselves as sellers or not sellers and their practices during the study period. The dairy cattle sellers' farms were found to share similar socioeconomic characteristics as the total sample considered under this study (Table 2). However, they are located on average about 2kms away from the nearest cattle market. Further results relating to the participation of farms in dairy cattle sales suggest that sellers and non-sellers differed significantly in terms of the education level of the farm owner, the farm's age, access to extension services, the experience of the cattle trade, training in animal husbandry and laboratory-based bovine tuberculosis (bTB) positivity test results expressed in percentage (Tables 2 and 3). This suggests that sellers, when compared to non-sellers, were more affluent in terms of those characteristics. The statistically significant association between bTB positive test results and selling activities could signal that an increased level of positive animals was found among the relatively old-aged sellers and those sellers who were involved in cattle sales for culling out bTB positive animals.

Table 2. Comparison of sellers and non-sellers of dairy cattle (Continuous variables)

Variables	All (n=450)		Not seller (n=103)		Seller (n=347)		t-value
	Mean	SD	Mean	SD	Mean	SD	
Age of owner (years)	50.3	13.7	49.1	14.5	50.6	13.4	-0.973
Seller's level of education (0=basic, 1=secondary, 3=tertiary, 4=higher)	2.5	1.3	2.3	1. 4	2.6	1.3	-1.939*
Farm age	22.1	10.8	20.4	10.5	22.1	10.8	-1.83*
Number of farmworkers	4.6	2.6	4.5	2.9	4.7	2.5	-0.603
Land operated (ha)	1.4	3.6	1.7	3.6	1.3	3.6	0.989
Distance to nearest livestock market (km)	2.3	4.4	2.7	4.1	2.1	4.5	1.163
Diversity of other animals living on-farm (no. of animal types)	2.2	1.5	2.2	1.5	2.2	1.5	0.046
bTB test result (% positive)	15.5	1.1	11.1	1.9	16.9	1.4	-2.183**

Results of descriptive analysis of binary response variables showed that 85% of the seller dairy farms were privately owned and the remainder was owned

cooperatively. The data on market participation of farms in terms of dairy cattle sales showed that 93% of seller farm owners had previous experience of cattle marketing, 27.6% received livestock extension services and 62% had received training on animal husbandry (Table 3). Over the last 3 years, about 33% of the farms were able to access bTB tests.

Table 3. Comparison of sellers and non-sellers of dairy cattle (binary response)

Variables	All	Not seller	Seller	x^2 value
Farm ownership (private)	382 (84.9)	86 (84.3)	296 (85.1)	0.034
Extension service (yes)	115 (25.5)	19 (18.6)	96 (27.6)	3.328*
Experience in cattle marketing (yes)	391 (86.9)	68 (66.7)	323 (92.8)	47.346***
Test for bTB during last 3 years (yes)	149 (33.1)	35 (34.3)	114 (32.8)	0.086
Training on animal husbandry (yes)	279 (62.0)	52 (50.9)	227 (62.0)	6.798***

Note: Figures in parenthesis represent percentages.

Socioeconomic profile of sampled farm owners as buyers

Results indicate that on average, the dairy cattle buying farm owners were 47 years old with a tertiary (high) school level of education (Table 4). They operated on an average farm size of 1.5ha and the average farm age was about 20 years old. The buyer farms are located 2.2 km away from the nearest cattle market, on average. Each buyer farm employed about five workers. On each farm, there were about two types of other animals (dogs, cats, or poultry).

Results of the analysis of data relating to dairy cattle purchasing reveal that buyers and non-buyers exhibit significant differences, in terms of the age of the farm owner and the farms, farmers' experience in cattle trade, herd size, training in animal husbandry and site; i.e., being in Mekele and Hawasa (Tables 4 and 5).

Table 4. Comparison of buyers and not-buyers of dairy cattle (Continuous variables)

Variables	All (n=450)		Not a buyer (n=331)		Buyer (n=119)		*t* value
	Mean	SD	Mean	SD	Mean	SD	
Age of owner	50.2	13.7	51.3	13.9	47.4	12.6	2.707***
Buyer's level of education (0=basic, 1=secondary, 3=tertiary, 4=higher)	2.5	1.3	2.5	1.3	2.6	1.3	-0.183
Farm age	22.1	10.8	23.0	11.1	19.5	8.537	3.036***
Number of farmworkers	4.6	2.6	4.7	2.6	4.5	2.4	0.507
Land operated (ha)	1.4	3.6	1.3	3.4	1.5	3.9	-0.563
Distance to nearest livestock market (km)	2.3	4.4	2.3	4.2	2.2	5.1	0.301
Diversity of other animals living on-farm (no. of animal types)	2.2	1.5	2.1	1.5	2.2	1.5	-0.43
bTB test result (% positive)	16.3	1.2	15.8	1.4	17.9	2.3	0.439

Results of analysis of binary response variables considered show that 81.5% of the buyer dairy farms were privately owned whereas the remaining was owned cooperatively. About 28% and 66% of the buyer farms had access to livestock extension services and training on animal husbandry, respectively. Over the last 3 years, about 31% of the buyer farms were able to access bTB tests. In terms of market participation, 91.6% of the buyer farms had experience with cattle marketing before the study period (Table 5).

Table 5. Comparison of buyers and not-buyers of dairy cattle (binary response variables)

Variables	All	Not a buyer	Buyer	x^2 value
Farm ownership (0=cooperative, 1=private)	382 (84.9)	285 (86.1)	97 (81.5)	1.438
Extension service (1=yes)	115 (25.6)	81 (24.5)	34 (28.6)	0.774
Experience in cattle marketing (1=yes)	391 (86.9)	282 (85.2)	109 (91.6)	3.147*
Test for bTB during last 3 years (1=yes)	149 (33.1)	112 (33.8)	37 (31.1)	0.298
Training on animal husbandry (1=yes)	279 (62.0)	200 (60.4)	79 (66.4)	1.321

Note: Figures in parenthesis are percent

Cattle purchases

Table 6 provides results on the number of cattle sold and bought by dairy farm owners in the sample. Both cross-bred and local cattle types were sold and bought during the study period. The sampled dairy farms sold the largest numbers of exotic/crossbred cows, followed then by calves, bulls, and heifers. Most of the cattle are sold for destocking and few are sold for making a profit. Farmers usually sell male calves rather than female calves in expectation of the higher return on the reproductive performance of the latter. In the case of market participation through purchasing, cows, followed by heifers and then bulls were dominant, both in terms of the number of buyers participating and the total number of cattle bought. In a year-long period, the average number of cattle sold per farm ranged between 1 and 46 with a grand mean of 4.4 per seller, whereas the number bought ranged between 1 and 23 per seller with a grand mean of 3 per buyer.

Table 6. Distribution of cattle sales and purchases

Cattle type	Dairy cattle sales			Dairy cattle purchases		
	No. of sellers	Mean	Total cattle sold	No. of buyers	Mean	Total cattle bought
Crossbred /exotic cows	192	3.0	571	78	2.6	202
Local bred cows	11	1.6	18	3	1.0	3
Crossbred/exotic bulls	88	2.0	170	9	1.7	15
Local bred bulls	18	3.4	62	13	4.7	61
Crossbred/exotic calves	185	3.2	501	-	-	-
Local bred calves	5	2.0	10	-	-	-
Crossbred/exotic heifers	50	1.8	89	37	1.9	69
Local bred heifers	4	1.5	6	3	1.7	5
Total	**347**	**4.4**	**1527**	**119**	**3.0**	**355**

Analysis of the relative frequency distribution of sellers and buyers in terms of farm size showed that 84 (18.7%) of the farms were neither sellers nor buyers, 18 (4%) are buyers only, 242 (538%) sellers only, and 106 (23.5%) both buyers and sellers of dairy cattle during the study period (Table 7). The overall performance of farms in dairy cattle marketing showed statistically significant difference among buyers and sellers (X^2=6.487, sig. at 1% level) indicating that there was a lack of association between the two groups in terms of their activities (i.e., more engagement was observed in the selling than in the buying). Further analysis by herd size revealed that differences existed among smallholder farms (X^2=4.564, sig. at 5% level) and not among the medium and large farms.

Table 7. Comparison of buyers and sellers of dairy cattle by herd size

Farm size	Sellers	Buyers		Total	X^2 value
		No	Yes		
Small farms	No	72 (29.2)	13 (16.9)	85 (26.2)	4.564**
	Yes	175 (70.8)	64 (83.1)	239 (73.8)	
	Total	247 (100.0)	77 (100.0)	324 (100.0)	
Medium farms	No	8 (13.8)	4 (10.5)	12 (12.5)	0.224
	Yes	50 (86.2)	34 (89.5)	84 (87.5)	
	Total	58 (100.0)	38 (100.0)	96 (100.0)	
Large farms	No	4 (19.1)	1 (11.1)	5 (16.7)	0.286
	Yes	17 (80.9)	8 (88.9)	25 (83.3)	
	Total	21 (100.0)	9 (100.0)	30 (100.0)	
Pooled (all farms)	No	84 (25.8)	18 (14.5)	102 (22.7)	6.487***
	Yes	242 (74.2)	106 (85.5)	348 (77.3)	
	Total	326 (100.0)	124 (100.0)	450	

Note: Items in parenthesis are percentages

Results of analysis of market participation in terms of dairy cattle sales revealed that sales of crossbred/exotic cows and calves were dominant (Table 8). The highest sales were observed in Addis Ababa city and Central Ethiopia (Oromia region) followed by Mekelle (Tigray region) and Gondar (Amhara region). Sales were low in Hawassa (SNNPR). The per-farm sales were high in Tigray (6.3 cattle on average) followed by Oromia (4.9 on average) and the rest (3.8 on average). Total sales show that 450 farms were involved in selling a total of 1527 dairy cattle.

Table 8. Dairy cattle market participation by region (sales).

Cattle type	Addis Ababa		Oromia		Amhara		Tigray		SNNPR	
	Mean	Total	Mean	Total	Mean	Total	Mean	Total	Mean	Total
Crossbred /exotic cows	2.6	197	2.9	155	2.9	76	5.2	110	2.1	33
Local bred cows	1	2	1.3	8	1	2	6	6	-	-
Crossbred/exotic bulls	1.3	22	2.5	59	1.6	35	1.2	11	2.5	43
Local bred bulls	3	9	2.8	31	5.5	11	-	-	5,5	11
Crossbred/exotic calves	2.5	254	4.8	203	2.4	59	5.1	77	2.7	8
Local bred calves	1	1	2	4	1	1	-	-	4	4
Crossbred/exotic heifers	1.6	21	1.5	27	1.7	17	4.2	17	1.4	7
Local bred heifers	1.0	1	2.0	4					1.0	1
Total	**3.8**	**507**	**4.9**	**491**	**3.9**	**201**	**6.3**	**221**	**3.9**	**107**

Results from the analysis of market participation in terms of dairy cattle purchasing (Table 9) revealed that, compared to others, a greater number of cattle purchases were made in Addis Ababa (n=163) and in Oromia (n=94) followed by SNNP (n=48) and Amhara (n=43). The highest purchases of cross-bred/exotic cows and heifers were observed in Addis Ababa. Dairy cattle purchases were very low in Tigray. The per-farm purchases were high in Addis Ababa (3.4 cattle on average) followed by Amhara (3.1 cattle on average), SNNP (2.8 cattle on average), Oromia (2.7 cattle on average), and Tigray (1.4 cattle on average).

Table 9. Dairy cattle market participation (average and total purchases) by study regions

Cattle type	Addis Ababa		Oromia		Amhara		Tigray		SNNPR	
	Mean	Total	Mean	Total	Mean	Total	Mean	Total	Mean	Total
Crossbred /exotic cows	2.9	89	2.6	58	2.1	23	1.5	6	2.3	26
Local bred cows	-	-	-	-	1	3	-	-	-	-
Crossbred/exotic bulls	1.5	6	2	8	-	-	1	1	-	-
Local bred bulls	4.8	24	2.6	13	11	11	-	-	6.5	13
Crossbred/exotic heifers	2.1	44	1.4	10	2	6	-	-	1.5	9
Local bred heifers	-	-	-	-	1.7	5	-	-	-	-
Total	**3.4**	**163**	**2.7**	**94**	**3.1**	**43**	**1.4**	**7**	**2.8**	**48**

From the above-mentioned results, it may be concluded that the market participation (expressed as buying and selling practices) of farmers differed across the study locations. Market participation of farms in Addis Ababa city and Central Ethiopia in terms of dairy cattle sold and bought was higher than those cattle farms located in the other study sites. Differences were also observed in terms of the two marketing practices as the farms were involved more in selling (mainly for destocking) than in buying (mainly for herd maintenance) dairy cattle. However, the share of cross-bred cows was high in both the buying and selling practices. Destocking of dairy cattle was mainly associated with aging of the cattle, closure

of some farms due to reallocation of land to other business opportunities (such as building construction in Mekele), and generating better profit. However, the replacement of dairy cattle was constrained by the unavailability of improved dairy cattle ranches which stood out as a serious constraint limiting dairy cattle development.

Dairy market participation decision

Participation in dairy cattle sales

The results of the negative binomial-logit hurdle model provide that different sets of variables affected the probability of participation in dairy cattle sales and the number of dairy cattle sold (Table 10).

Considering the results from the first hurdle, the positive and statistically significant influence of the level of education, experience in cattle marketing, and training in animal husbandry of farm owners would mean that an increased level of each one of these factors increases the likelihood that the farm owners would make sales decisions. A possible reason for this effect could be that information, education, and experience either individually, or in a specific combination, place farm owners in better positions from which to access and process evidence regarding the advantages and disadvantages of selling their cattle and enable them to equip themselves with enhanced capacity for making knowledge-based market-participation decisions (Martey *et al.*, 2012; 2013). Correspondingly, those farms with access to information about the health condition of their dairy cattle were less likely to make the decision to sell than those who did not receive such information. This could be due to the advantage that information about the health situation of dairy cattle has in making the right decision of whether or not to sell the cattle. The decision to participate was also positively associated with medium herd size, meaning that those farm owners with medium-sized dairy herds were more tempted to sell their cattle than those with small herd sizes. The implication would be that farm owners with a greater number of dairy cattle are in a better position to make a positive decision about selling their cattle than those with a smaller number of dairy cattle due to economies of scale. The lack of statistical significance in the regional variable coefficients implies that the location of farms has no influence on the passing of the first hurdle; i.e. on the decision of whether or not to sell dairy cattle.

In the case of the second hurdle, male farm owners were found to be in a better position to sell the dairy cattle than female farm owners. This could be due to the fact that male owners were more educated (t=-1.914; $p<0.1$) and hence had better access to information about cattle trade than did their female counterparts. The positive association between education and access to market information has also

been defined in Lapar *et al.* (2003). Both medium and large herd owners sold their cattle. However, it is to be noted that the market participation of medium-sized herd owners, expressed in terms of the number of cattle sold, was reinforced by the previous decision to sell (a two-stage process) whereas that of the large herd owners was concurrent. Distance to the nearest market has a positive influence on the volume of dairy cattle sold, implying that farm owners might have opted to sell their cattle at distant markets rather than those close by. This is possibly due to either the legacy of the market in those areas in terms of offering potential buyers and better price incentives or the farms are located far away from the main marketplace. Those farms keeping different kinds of animals (i.e. including dogs, cats, pack animals, poultry, and dairy) sold more cattle than those that kept fewer kinds of (less diversified) animals, implying that diversity in terms of the kind of animals kept triggered the sale of dairy cattle, probably because the interaction of other animals with dairy cattle might aggravate the transfer of zoonotic diseases to the cattle and exclusion of cattle through sales has been practiced. Those farms with a large number of workers sold fewer dairy cattle than those with a smaller number of workers. This could be because farms with higher numbers of farmworkers are less constrained by human resources, making it more likely that cattle are maintained on-farm than is disposed-off, compared to those with a limited number of farmworkers. Thus, it could mean that large farms hire a greater number of workers to keep their cattle on the farm. The employment of a greater number of farmworkers is also an indicator of the size and strength of the farm to carry out a profitable business by improving the productivity and production of dairy farming. The coefficient on the Tigray region was positive and significant indicating that, compared to Addis Ababa, dairy cattle selling has been significant in the Tigray region. The probable reason could be that since dairy farming was flourishing in the region and, due to the demand thus created, sales of heifers has been considered an attractive business.

Further assessment of the results shows that both the decision to sell and the number of dairy cattle sold are governed positively by herd size, i.e. farms with increased herd size tend to participate more in the selling of dairy cattle, compared to those with small herd size.

Table 10. Determinants of cattle sold

Variables	Negative Binomial-Logit Hurdle Regression			
	Logit		**Negative binomial**	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err
Sex of owner (1=Male)	-0. 205	0.303	**0.327*****	0.126
Age of owner	0.004	0.010	-0.002	0.005
Level of education of the owner	**0.174***	0.102	0.049	0.047
Farm age	0.367	0.331	-0.076	0.156
Number of farmworkers	0.011	0.062	-0.047	0.031
Medium herd (1=yes)	**0.725***	0.383	**0.633*****	0.134
Large herd (1=yes)	0.233	0.632	**1.743*****	0.303
Farm ownership (0=cooperative, 1=private)	-0.118	0.410	-0.217	0.169
Extension service (1=yes)	0.237	0.308	0.062	0.128
Distance to nearest livestock market (km)	0.003	0.028	**0.029*****	0.009
Experience in cattle marketing (1=yes)	**1.718*****	0.349	0.288	0.304
Land operated (ha)	-0.228	0.208	-0.095	0.092
Test for bTB (experience) during last 3 years (1=yes)	**-0.621****	0.316	**0.489*****	0.152
Current bTB test result (%)	0.005	0.007	**0.008*****	0.003
Interaction of experience and bTB test result	0.003	0.011	**-0.012*****	0.004
Diversity of other animals living on the farm	-0.035	0.098	**0.078***	0.040
Training on animal husbandry (1=yes)	0.421	0.275	-0.078	0.126
Oromia (1=yes)	0.077	0.351	**-0.292***	0.152
Amhara (1=yes)	0.235	0.418	-0.030	0.183
Tigray (1=yes)	-0.389	0.432	**0.463***	0.266
SNNP (1=yes)	0.105	0.608	-0.008	0.252
_cons	-1.903*	1.076	0.580	0.536
/lnalpha			**-0.493*****	0.169
Alpha				
Number of observations	450			
Wald $chi^2(21)$	57.47			
Prob > chi^2	0.000			
Pseudo R^2				
Log pseudo-likelihood	-965.381			

*, ** and *** indicates statistical significance at 10%, 5% and 1% levels

Participation in dairy cattle purchases

Results (Table 11) show that, in the logit model, farm age, herd size, and location have a significant influence on the probability of farm owners' participation in buying dairy cattle. Farm age and location of a farm in the Tigray region (Mekele) have a negative association with the likelihood of buying dairy cattle. A possible reason for this could be that long experience in dairy farming provides the market decision-makers with insight into trading opportunities (Matungul *et al.,* 2001). It could also be related to the fact that dairying with improved cattle is a recent phenomenon in Tigray and buying activities are positively associated with the new farms. The positive association of herd size with the decision to make cattle purchases means that those farm owners with medium-sized dairy herds tend to replenish their farms, while those with small herd sizes do so less often. The implication could be that farm owners with more dairy cattle tend to have more space and capital and so can add even more cattle to their herds and thus expand their businesses. This positive attitude towards buying more cattle is more common amongst farm owners located in Hawassa, compared to those in Addis Ababa city. This could be because local conditions such as availability of feed, land area, the legality of urban and peri-urban dairy activity as rendered by the local government are relatively more favorable in Hawassa than those in Addis Ababa city, where the land shortage is severe.

In the truncated Poisson scenario, farm age, herd size, distance to the nearest market, land resources and location are significant factors affecting the volume of cattle bought. Farm age, land resources, and location (specifically in Mekele) acted negatively and significantly as barriers to market participation. On the other hand, herd size and distance to the nearest market are positively significant factors, enhancing the participation level of farm owners in the purchase of dairy cattle.

Farm age is related to the experience of farming, while a greater number of years spent in dairy farming is an indicator of business sustainability, which is further expressed through cattle maintenance and business expansion. These conditions make the disposal of cattle less likely. Therefore, it can be inferred that farm owners with many years of experience in dairy farming, expressed in the data as increased farm age, sell fewer cattle than their counterparts.

Farms with larger herd sizes participated in cattle purchasing due to economies of scale, i.e. due to the access to more space to accommodate more cattle and their financial/economic position for expanding business. Those with smaller herds tended to have more limited possibilities to add more cattle (e.g. limited access to resources). Distance to market was positively related to improved participation in purchasing dairy cattle. The result confirms the reality that improved dairy cattle are located in the far-off markets (as also indicated by figure 2, friends living far

off are the dominant sources of crossbred cattle) due to economies of land size compared to that in the urban areas and that the farms involved in cattle purchases are usually located in peri-urban areas. On the other hand, an increase in the land worked by the farm has a negative influence on the buying practices of dairy farm owners. A possible explanation for this could be that access to more land provides farm owners with the possibility of keeping more cattle instead of selling them out of the farm. All other things being equal, farm owners living in Mekele buy fewer cattle than those living in Addis Ababa city.

From the above results, the overall decision to buy and the decision surrounding the number of dairy cattle sold are governed positively by herd size, i.e. farms with increased herd size tend to participate more in 'selling out' of dairy cattle. The decision is governed negatively by farm age and by a farm's location being in the Tigray region. This seems to imply that the two actions can be modeled recursively, considering these factors, whereas the other factors can be treated independently without the influence.

Further analysis of the market participation of farm owners in sales and purchases of dairy cattle are articulated by different sets and magnitudes of factors considered in the two models. In this analysis, herd size remains a cross-cutting factor influencing the selling and buying behavior of dairy farm owners. Also, within each scenario the two processes of decision making (whether to participate or not and the level of participation) are governed by different sets of factors: Information and knowledge are the key factors in the decision-making required to participate in dairy cattle sales at the first hurdle (decision to sell), whereas herd size is important in both hurdles (decision to sell and decision about how many cattle to sell). In the case of cattle purchases, farm age, herd size, and location is cross-cutting factors, influencing both the first and the second hurdles of dairy cattle purchase (the decision to purchase and the decision about how many cattle to buy). Distance from the market and herd size are also important in the second hurdles of both sales and purchases; i.e. influencing the numbers of cattle sold and bought.

Table 11. Determinants of dairy cattle purchases

Variables	Negative Binomial-Logit Hurdle Regression			
	Logit		**Negative binomial**	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err
Sex of owner (1=Male)	0.041	0.268	0.090	0.296
Age of owner	-0.015	0.011	**0.022****	0.011
Level of education of the owner	-0.123	0.104	0.168	0.107
Farm age	**-0.910*****	0.335	**-0.962*****	0.291
Number of farmworkers	-0.062	0.056	0.057	0.058
Medium herd (1=yes)	**0.951*****	0.302	**0.720*****	0.317
Large herd (1=yes)	0.501	0.615	**2.294*****	0.513
Farm ownership (0=cooperative, 1=private)	-0.252	0.402	**0.762****	0.360
Extension service (1=yes)	0.133	0.289	0.290	0.308
Distance to nearest livestock market (km)	0.028	0.024	**0.058****	0.026
Experience in cattle marketing (1=yes)	0.482	0.423	-0.528	0.399
Land operated (ha)	-0.362	0.232	**-0.393****	0.187
Test for bTB during last 3 years (1=yes)	-0.030	0.326	**0.957*****	0.347
Current bTB test result (%)	0.007	0.006	**0.012*****	0.004
Interaction of experience and bTB test result	-0.006	0.009	**-0.036*****	0.009
Diversity of other animals living on a farm	0.092	0.091	**-0.195****	0.095
Training on animal husbandry (1=yes)	0.171	0.268	**0.592***	0.304
Oromia (1=yes)	-0.166	0.339	-0.431	0.286
Amhara (1=yes)	0.046	0.387	-0.774	0.503
Tigray (1=yes)	**-1.403****	0.568	**-1.372****	0.567
SNNP (1=yes)	**1.041****	0.479	0.062	0.474
_cons	2.230**	1.127	0.735	1.795
/lnalpha			-0.518	0.462
alpha				
Number of observations	450			
Wald $chi^2(21)$	53.03			
Prob > chi^2	0.000			
Pseudo R^2				
Log pseudolikelihood	-418.045			

*, ** and *** indicates statistical significance at 10%, 5% and 1% levels

Conclusion

An urban and peri-urban dairy cattle farming is common in Ethiopia. However, as provided by this study, the urban and peri-urban dairy cattle farms were not found to be guided by market principles to determine net sales or net purchases as these were found to be practiced sporadically and independently and dairying was more about milk production rather than cattle marketing. The dairy cattle selling and buying activities were largely performed for the destocking and replacement of the cattle. Market outlets (destinations and sources of cattle) are not well established, indicating that buyers' and sellers' markets are poorly developed. On the other hand, it was found out that the dairy cattle farms were faced by different sets of a farm (e.g., herd size, herd structure), farm owner (experience, education, training), institutional (veterinary services, market, labor) and environmental (location/region) characteristics. Such a practice of poor cattle marketing and destocking intensified by the different sets of socio-economic problems could contribute to the poor performance and gradual withdrawal of dairy farms and the widening of the gap between demand and supply of dairy products. Therefore, improvement of the existing government attention towards dairy cattle business in urban and peri-urban areas through enforcement of urban-dairy production policies and organized (formal) market development such as the establishment of dairy production and cattle marketing hubs in peri-urban areas and training on animal husbandry taking into consideration the decision-making stages practiced by dairy farmers would be vital.

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