Effect of transaction costs on the supply of milk to the market for small dairy farmers in Nyagatare District, Rwanda

Sangano Germain, Patrick Mulyungi, Eucabeth Majiwa, Ntaganira Eric, Aimable Nsengiyumva

Abstract - Markets are one of the rural development strategies promoted to address the challenge of smallholders' integration in markets. However, smallholder participation in dairy value chain is low. This study examines effect of transaction costs on supply of milk to the market for small dairy farmers in Nyagatare District, Rwanda. Multi-stage sampling techniques was employed to select 162 households from three sectors in Nyagatare district Eastern Province, Rwanda. Probit model was used to determine transaction cost factors influencing milk supply to the market and gross margin and marketing costs was employed to estimate costs and revenues of data collected through semi-structured questionnaires. The key results from the probit model revealed that average milk price and feed costs are transaction cost factors influence milk production for smallholder supply of milk to the market in Rwanda. The findings also indicated that there are variation of buying price and selling price per key node of milk markets value chain (wholesaler node, farmer trader node, milk processors and cooperative union (MCC) and finally along the whole milk market value chain the total percentage of gross market margin was computed by 91.9% from the production to final consumer). The study concludes that the Government of Rwanda through Ministry of Agriculture and Animal Resources should design institutional arrangements that aim at reducing transaction costs among dairy farmers in the study area.

Key words: Value chain, Market, Probit model, Smallholder dairy farmers, Nyagatare District, Rwanda

1. INTRODUCTION

Rwanda produces around 185 million liters of milk annually (2013 data, estimates),which translates into an average daily yield per cow of just 3.2 liters, an unsurprisingly low yield given that improved breeds constitute less than 10% of the 157 thousand milking cattle in the country, and given that their nutrition is inadequate. While the government is undertaking a number of initiatives to improve the dairy sector (e.g. "One cow, one household" which aims to alleviate rural poverty by providing a heifer to each family), given execution challenges, it will take time to effect widespread change (Miklyaev, Afra, & Hashemi, 2017).The Eastern Province is commonly referred to as Umutara. Farmers here have unusually large plots of land, though land reform will soon reduce the size of the farms. As a result of the large farm sizes, most farmers are serious cattle-keepers, raising herds of 100 or more Ankole cows. Milking cattle constitute a small proportion of the total cattle; the majority of milking cattle are Ankole, with approximately 9% crossbreeds. Farmers in this region generally pursue an open grazing system; the combination of the breed and feeding method leads to low milk yields in dry season, with ~1.5 liters per Ankole cow. The yield can double and reach between 3 and 5 liters per Ankole during the rainy season (Bingi & Tondel, 2015). Milk revenue is insufficient to support the family much less additional investments in cattle like feed purchase. Furthermore, many farmers are not knowledgeable about forage that can be grown on their farms. Most farmers in this region report selling cattle in order to provide for basic needs (Bingi & Tondel, 2015). Annual milk production in Rwanda range from 0.7 liters per cow per day is 3.2 liters. The 2006 Agriculture Survey reported that milk production for the first half of 2006was 20,283,160 liters and the annual production was 258 liters per cow, which is equivalent 0.7 liters per cow per day. However, the 2007 MINAGRI Annual Report indicated that 185,410,395 liters of milk were produced in 2006 were 3.2 liters (annual yield is 1,177 liters per cow). Despite the significant variance between these estimates, it is clear that productivity in Rwanda is low. Annual milk consumption per capita is reported at 12 liters compared to approx. 100 liters per capita in Kenya and 22 liters per capita in Uganda. Developed nations can achieve up to 8-9,000 liters per cow annually. The main reasons for Rwanda's low yield are the prevalence of local breeds, which by nature do not supply high yields, and inadequate nutrition through either grazing or feed, milk prices fluctuate per season, inputs is low due to limited knowledge of feeds and their benefits, inability to pay, and the challenge of physically procuring materials. It is unclear whether the volume of dairy products will indeed increase (these processors also produce mineral water and juices). Retailers in Rwanda can be split into three categories based on the products they sell and their scale. The first is sellers of raw fresh milk and some processed goods, the second is sellers of boiled fresh milk and finally is sellers of processed dairy

products only (supermarkets) (Bingi & Tondel, 2015). Sellers of raw fresh milk can be very profitable, due to the minimal costs of the operation. Most shop owners maximize profit by forcing the farmer or hawker to take on milk transport costs. Sellers of processed dairy products are making healthy margins, with some reporting success in selling products with ~10-20% markup. The open grazing farmer achieves a profit margin of ~60% due to his minimization of costs (no money is spent on feed or Napier growing). For the semi-grazing farmer, labor accounts for almost 50% of monthly costs, while feed constitutes an additional ~40%. This farmer segment suffers from the greatest economic challenges because of relatively lower milk production while exotic cattle are growing and increased expenses for feed. Dairy consumption is difficult to assess because of the large volume of milk that is sold in the informal market (defined as sales of unprocessed milk). Techno Serve estimated that approximately 96% of milk marketed is in the informal market, and that approximately half of all the milk produced never makes it to the market (due to losses along the chain as well as on-farm consumption). The value of milk produced annually is estimated to be ~64billion USD using data collected in September/October 2008. Processed milk sells for between 2 to 2.5 times fresh raw milk. That dramatic price difference between the informal and formal markets helps to explain the popularity of the informal market, even amongst those who can afford processed milk (Bingi & Tondel, 2015). Dairy marketing systems play a decisive role in vibrant national economy in the supply chains linking producers to consumers but it is faced with difficulties in accessing markets which consequently leads to higher cost production and timely delivery of the products (Zeberga, 2010).

Review of empirical findings

Eighty five percent of sampled dairy household were identified to be milk market participants and about 65% of milk produced by sampled household was supplied to market. Dairy producers, retailers, farmer traders, traders, dairy producers' cooperatives and semi-wholesale were found to be important milk and butter market intermediaries of the milk shed (Geleti, Hailemariam, Mengistu, & Tolera, 2014).

According to (Vakunta, 2015), market chain actors are those involved in producing, processing, trading or consuming a particular agricultural product, they include direct chain producers, traders, retailers, consumers and indirect actors which provide financial or non-financial support service, such as bank and credit agencies, business service providers, government, researchers and extensions. Value chain actors are those involved in supplying inputs, producing, processing, marketing, and consuming agricultural products, they can be those that directly involved in the value chain (rural and urban farmers, cooperatives, processors, traders, retailers, cafes and consumers) or indirect actors who provide financial or non-financial support services, such as credit agencies, business service and government, researchers and extension agents (Hellin, Lundy, & Meijer, 2009). E

2. METHODOLOGY

Study Area

The present study was carried out in Rwanda, Eastern Province, in Nyagatare District .The described zone have been chosen due to the fact that Nyagatare district has a lot of livestock and milk collection centers.

Research design

A research design is a guideline for the collection, measurement, and analysis of data. It develops procedures and techniques for collecting and analyzing data (Kothari, 2012).This study adopted a cross-sectional survey. Both quantitative and qualitative data was collected. Depth interviews of key informants from selected dairy actors (NGOs, Microfinance institutions, dairy assemblers and supermarkets) will be conducted. Primary data was collected from respondents through semi-structured questionnaires.

Target population

According to Adeoye and Popoola (2011),population is the mass of units of analysis (e.g. respondents) about which, the researcher measured his variables. The study population was 260 actors. Out of the total population the sample was divided as follows dairy farmers 122, traders 20 Semi-wholesalers, 4 Dairy Cooperative Union, 1 Processer, and 15 Retailers.

Sampling techniques

Sampling therefore refers to the process of selecting individuals in the sample. Sampling is necessary because population interest is large, diverse and scattered over a large geographic area (Kothari 2008). The study has two parts that are traders and dairy household surveys. Two-stage random sampling technique was employed to select sample households for this study. The district was selected purposively as it known by milk production. In the first stage, four sectors were selected from this district by using stratify random sampling procedure based on their number of dairy cows owned (local and cross breed). In the second stage, a total of 122 sample respondents were randomly selected from the sampling frame of milk producers by using simple random sampling technique. Taking the number of households in each sector into account, the sample size of respondents was allocated for four sectors based on probability proportional to size. The milk traders (Semi-wholesalers, Dairy Cooperative Union, Processers and Retailers) were from Nyagatare, Rwimiyaga, Karangazi and Matimba sub-town of the study area. The whole milk traders were considered for this study. This included 20 Semi-wholesalers, 4 Dairy Cooperative Union, 1 Processer, and 15 Retailers.

Data Collection instruments

For this study, both questionnaire and focus group discussion was used. The questionnaire was designed for both producers and for traders/distributors. The structure of the questionnaire was designed as both open ended and close ended. The major data collection methods used include discussions with individual, groups and key informant and focus groups, rapid market appraisal, observation, formal survey and visual aids.

Methods of Data Analysis

The

$$TGMM = \frac{\text{End buyer price} - \text{first seller price}}{\text{End buyer price}} \times 100 \quad \text{(i)}$$

Where, TGMM=Total Gross Marketing Margin.
The producer's margin is calculated as a difference:

$$GMM_P = \frac{\text{End buyer price} - \text{marketing gross margin}}{\text{End buyer price}} \times 100 \quad \text{(ii)}$$

Where GMM p= the producer's share in consumer price or

$$PS = \frac{PP}{CP} = 1 - \frac{MM}{CP}$$

data collected from the farmers, traders and other sources was analyzed using descriptive and inferential statistics and econometric models was also applied by the help of statistical software packages such as SPSS and STATA. The descriptive statistics analysis employed using diagrams, charts, ratios, percentages, means, variances and standard deviations in examining the dairy marketing system as well as farmers' demographic and socio-economic characteristics.

Descriptive statistics
Data analysis employed descriptive statistics such as percentage, and comparison and standard deviations. Because precise costs are frequently difficult to determine in many agricultural marketing chains for the reasons that costs are often cash and imputed, the Total Gross Marketing Margin (TGMM) will be calculated (Takele, 2010). It is expressed as a percentage of the difference between end buyer and first seller prices.
Profitability for market performance analysis and probit selection model to determine factors supplied to the market.
Where: PS=producers share. The Pp=producers price, Cp=consumer price and MM=marketing margin. It is useful to introduce the idea of farmer's participation, farmers' portion, or farmers Gross Marketing Margin (GMMp) which is the portion of the price paid by the consumer that goes to the farmer.

3. RESULTS AND DISCUSSION

Transaction cost factors
Results from table 1 indicated the summary of econometric findings of Probit model. The results revealed that among the five explanatory variables such as average milk price, feed costs, and cost of medical expenses, cost of labor and distance to nearest milk markets only two variables average milk price and feed costs were the transaction cost factors influencing supply of milk to the market and were statistically significant at 5% level of significant.
Milk price was determined as the transaction cost factors influencing supply of milk to the market and good price of milk produce could increase the milk producer' revenue. Expectedly, there is a positive relationship between milk price and milk market participation. One unit increase in milk price, the volume of milk marketed increased by 1.01percent. This variable was found out to be significant at 5% level and was related positively. This sign indicated that consumers who were sensitive to consume milk paid higher price compared to selling price. Our study findings are supported by Kilic, Akbay, and Tiryaki (2009), who reported the statistically significant and negative coefficients of price variable for packed fluid milk equation. In addition, these findings are supported by the study of Celik Ates and Ceylan (2010), emphasized that survey results showed that there is about twofold price difference between unpacked and processed fluid milk. Due to price concerns, many households were more likely to select unpacked and processed-unpacked fluid milk and less likely to choose processed fluid milk.

These results are consistent with Mutura, Nyairo, Mwangi, and Wambugu (2016), study who reported a positively relationship between volume of milk produced by the farmer per day and choice of cooperatives marketing channel. This could be due to the cost reduction on the sides of cooperatives espe-

Application of Probit model

According to Sebopetji and Belete (2009), Probit model constrains the estimated probabilities to be between 0 and 1 and relaxes the constraint that the effect of the independent variable is constant across different predicted values of the dependent variable. The probit model assumes that while we only observe the values of 0 and 1 for the variable Y, there is a latent, unobserved continuous variable Y* that determines the value of Y. The other advantages of the probit model include believable error term distribution as well as realistic probabilities (Anang, Sipilainen, Backman, & Kola, 2015). Thus, for this study the probit model is preferred and used. We assume that Y* can be specified as follows:

$$Y_i^* = \beta_0 + \beta_1 x_{1i} + \beta_2 x_5 + \cdots + \beta_k x_{ki} + U_i$$ And that:

$\{Y_i = 1$ if Y*>0; and $\{Y_i = 0$ otherwise where x1, x2… xk represents vector of random variables, β represents a vector of unknown parameters and U represents a random disturbance term (Sebopetji & Belete, 2009).

Model specification

The probit model specified in this study to analyze farmers' decision to participate can be expressed as follows:

$$Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + U_i$$

Where Yi is the Small-scale farmers' decision to participate in diary value chain (dependent variable) which takes the value of 1 if the farmer participates, 0 otherwise for non-participant

Whereby:

X1: feed costs
X2: Medicine costs
X3: transport costs
X4: location characteristics

cially on transport where the cooperative collects milk from its members from collection centres. Spatial distribution of small producers will have implications of the cooperative society operating costs. Consequently, the quality of milk produced by big farmers having been argued to be of higher quality than small producers since big farmers have access to veterinary services (Sharma, Kumar, & Singh, 2009). The implication of these results is that dairy farmers who produce fewer litres of milk could simply sell to vendors at the gate to avoid transport costs.

Results from the probit model presented in table 1 showed that animal feed costs was statistically significant transaction cost factor influenced the milk market participation in the study area. Unexpectedly, there is a positive relationship between feed cost and milk market participation and one unity increase in feed cost, the milk market participation increased by 0.001 percent and these the total transaction cost incurred by a household as results there is an increase the likelihood for such a household selling its milk through the farm gate over cooperative union and other milk markets actors. The longer the distance, the higher the transportation costs of the cow feeds. The channel which is associated with higher transport costs reduces farmers' gross margins. This research finding is consistent with the results of Iruria, Odhiambo, and Mairura (2009) who reported that high transport costs significantly reduced the percentage of milk supplied to the marketing channel because they reduced farmers' gross margins. More so, the higher the transaction cost incurred by dairy farmers, the less the interest of participation in the channel (Artukoglu & Olgun, 2008). These results are contrary to Manyong et al. (2008), who found out that institutional innovation such as group marketing mitigate the costs of accessing markets.

Table 1: Transaction cost factors influencing supply of milk to the market

Milk market participation	Coef.	Std. Err.	Z	P>|z|
Average milk price	0.1007	0.0489	2.06	0.040*
Feed costs	0.0001	0.0001	1.22	0.024*
Cost of medical expenses	0.0000	0.0000	0.02	0.988
Cost of labor	0.0000	0.0001	0.22	0.829
Distance to nearest milk markets	0.0166	0.1340	0.12	0.902
_cons	-18.98	9.7317	-1.95	0.051
Probit regression; Number of Obs=91; LR chi2(4) = 7.82;Prob> chi2=0.0985; Log likelihood = -5.7045; Pseudo R^2 = 0.4066				

Marketing costs and margins along dairy marketing channels

The prices of milk at different nodes along the chain and the costs accrued in milk trading were computed and presented in table 2. The table shows that, at wholesaler node, the purchase prices of milk varied between 200Frws to 250Frws per litre and the average mean was 233Frws per litre while the selling price of milk ranged from 170Frws to 200Frws per litre and the average selling price was 198Frws. In this stage of wholesaling, the percent margin price ranged from to 15%Frws to 20%Frws and average mean percent margin was 15.22%Frws. For the case of farmer trader the buying price shifted from 150Frws to 600Frws and the average mean was 258Frws per litre and the corresponding selling price at this stage was 200Frws per litre and for farmer trader the percent margin price was 22.62%. At the node of milk processors, the buying milk price was 199Frws/L; selling milk price was 250Frws/L and percent margin was 20.4%. For milk retailers, the milk price was ranged from 100Frws to 500Frws per litre and the average buying price was 230Frws/L; while the selling price was 200Frws/L and associated % margin was 12.95% respectively. At the key node of cooperative union (MCC), the buying price was valued by 200 Frws to 500Frws per litre and the average milk price at this node was 250Frws/ L; mean while the selling price from the collection point was ranged from 119Frws to 200Frws per litre and the average milk price was 198Frws/L; the percent margin price for MCC was 20.7%. Finally along the whole milk market value chain the total percentage of gross market margin was computed by 91.9% from the production to final consumer.

However, at the production level, sampled respondents did not purchase milk because they are the ones who produced and sold milk. Irrespective of the dairy chain node the prices were higher during the two nodes. The costs accrued in milk trading were also computed as presented in table 2. The total cost accrued in transport ranged from 250Frws to 4,500Frws and the average mean cost in transport was 2,598Frws; the cost of hired labor in milk transport shifted from 1000Frws to 25,000Frws and average mean cost accrued in milk trading was 3,720Frws.

The cost of vehicle hired in milk transportation during the milk trading ranged from 400Frws to 15,000Frws and the average mean cost of vehicle in milk transportation was

3,231Frws. The total cost related to license and taxes paid in milk trading nodes ranged 500Frws to 15,000Frws while the associated average mean costs during this stage was 4,900Frws respectively. As observed, the labor cost is higher than in other notes of milk trading stage. Our study findings relayed on the research report of Rwanda (2008) in which their findings stated that labor still accounts for the largest proportion of monthly costs at almost 50%; but feed accounts for an additional ~40% of monthly costs. Feed costs are either in the form of supplements or cultivating a hectare of Napier. This farmer segment suffers from the greatest economic challenges because of relatively lower milk production while exotic cattle are growing and increased expenses for feed. Indeed, the semi-grazing farmer only achieves a profit margin of ~30% and an annual milk profit of~320,000 RWF (~600 USD), which places a family of five in almost extreme poverty. The situation is somewhat improved when one considers that a farmer may be able earn additional revenue by selling cattle or manure. Interviews suggest that in regions where manure is needed, a farmer can earn 6,000 RWF (~1,000 USD) per cow per month from manure sales (Karenzi, Mashaku, Nshimiyimana, Munyanganizi, & Thonart, 2013; Rwanda, 2008).

Table 1 Average milk marketing costs and margins

Variable	Mean	Std. Dev.	Min	Max
Average purchase price	277.44	109.9	180	600
Cost of transport	2,597.83	1,226.46	250	4,500
Cost of hired labor in milk transport	3,720	4,672.79	1000	25,000
Cost of vehicle in milk transportation	3,231.03	2,644.28	400	15,000
Cost related to milk search	1,500	.	1,500	1,500
Cost related to milk spoiled	2,283.33	499.67	1500	3,000
Cost related to license and taxes paid	4,900	5,824.52	500	15,000
Other costs	2,105	2,185.87	350	8,000
Average selling price	564.53	143.66	500	900
Variable	Mean	Std. Dev.	Min	Max
Wholesaler				
Buying price	233.33	25.00	200	250
Selling Price	197.81	7.16	170	200
Margins	35.52	-	30	50
% Margins	15.22%	-	15	20
Farmer Trader				
Buying price	258.46	100.93	150	600
Selling Price	200.00	-	200	200
Margins	58.46	-	-50	400
% Margins	22.62%	-	-33.33	66.67
Processor				
Buying price	250.00	0.00	250	250
Selling Price	199.00	-	199	199
Margins	51.00	-	51	51
% Margins	20.4%	-	20.4	20.4
Retailer				
Buying price	229.76	55.28	100	500
Selling Price	200.00	0.00	200	200
Margins	29.76	-	-100	300
% Margins	12.95%	-	-100	60
Cooperative Union				
Buying price	250.00	103.51	200	500
Selling Price	198.24	10.46	119	200
Margins	51.76	-	81	300

% Margins	20.7%	-	40.5	60
TGMM (%)	***91.9%***	-	-	-

4. RECOMMENDATIONS

Improvement of infrastructure and transportation services should be revitalized. Value addition through processing was found to be a means of generating higher profits at the cooperative union like MCC. Processing of milk however was partly constrained by high operating costs resulting from high transportation costs due to poor road networks and transportation systems. Improvement in infrastructure and services is an important factor for integration of value chain activities.

Improved conditions of infrastructure will in one way or another enhance implementation of the strategies for the improvement of the dairy sub sector. Improvement in infrastructure and transportation services should particularly be emphasized by the government towards; improved public transport systems and good road networks. In certain cases, there is a need to target improvement of infrastructure to areas of high potential for milk business.

The milk price and farmer's profit from small dairy farmers were not consistent. However there was inconsistency between the milk producers who insisted that milk prices are too low to enable them to make any profit, and the milk consumers who claimed milk products were very expensive for them to afford for everyday use

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- ***Sangano Germain***, the first author of this paper, is finishing his thesis of MSc in Agriculture and applied economics in Jomo Kenyata University of Agriculture and Technology (JKUAT), He is currently the the Head of Agriculture, Livestock and Environment Department of MOF/RF

- ***Patrick Mulyungi (PhD),*** is the senior lecturer at Jomo Kenyata University of Agriculture and Technology, JKUAT

- ***Eucabeth Majiwa (PhD)***, *i*s the senior lecturer at JKUAT

- ***Ntaganira Eric***, is MSc holder in Agriculture and applied economics from JKUAT, the former Assistant Lecturer at JKUAT, Kigali Cumpus, a consultat in Agricultue Sector.
- ***Aimable Nsengiyumva,*** is MSc holder in Agriculture and applied economics from JKUAT, the former Assistant Lecturer at JKUAT, Kigali Cumpus, He is now the Secretary to the Scientific Committee of Rwanda Agriculture Board.