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Determinants of Milk Commercialization through Milk Collection Centres of the Smallholder Dairy Value Chain in Zimbabwe

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Abstract
The dairy development programme schemes in Zimbabwe form the basis for the participation of smallholder dairy milk producers in the dairy value chains. Smallholder producers participate in the semi-formal value chain (in which milk is processed at the milk collection centres and sold locally) and formal dairy value chains (in which milk delivered to milk collection centres by smallholder producers is delivered to established formal milk processors). Although the dairy development programme was formed in the early 1980s, the smallholder value chains have failed to make significant impact, with only 5% of the milk coming from the value chains. The objective of this study was to determine the main reasons for the low commercialized milk entering the smallholder dairy value chains through the milk collection centres. A sample of 185 dairy producers from four smallholder dairy schemes were randomly selected. A Tobit regression model was used to assess the main determinants of commercialization. The results indicate that access to information, distance to the MCC from the farmers' homestead and producer price of milk paid by the MCC were the major determinants of the commercialization of the milk sold to the MCC. The main conclusions of the study are that in order to improve the role of the MCC in milk marketing, policy interventions have to be targeted and prioritized at improving market access. The MCCs play a central role in integrating smallholder farmers to value chains and markets that have potential to incentivize farmers to increase the quantities marketed through the MCCs, if favourable market and price policies are developed and implemented. Establishing sub-centre MCC within easy reach of farmers would enhance smallholder farmers' participation and commercialization of the milk output from the smallholder dairy value chain.
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1. Introduction

At the attainment of independence in 1980, the Government of Zimbabwe pursued a policy of growth with equity in order to correct colonial imbalances and improve the productivity and participation of smallholder farmers in formal markets. The new government stressed its commitment to improving conditions in the communal areas and other smallholder groups by encouraging farmers to increase their participation in the market (Muir-Leresche 2006). In the dairy sector, the government formed the Dairy Development Programme (DDP) in order to bring the disadvantaged smallholder farmers into mainstream dairying. Pilot dairy schemes were initially set up in the early 1980s, and over the years, the number of smallholder dairy schemes has grown to the total of 28 located throughout the country. About four of the diary schemes under the DDP supply milk to private processors, while the rest process the milk into various products sold to the local communities (DDP 2007).

The main thrust of the DDP was to develop dairy value chain marketing infrastructure through setting up milk collection centres (MCC) at each dairy scheme and to train and advise smallholder dairy farmers. As part of the development of the smallholder dairy schemes, farmers were required to organize and constitute themselves into formal bodies for purposes of being accountable to their group members, Dairy Marketing Board (DMB) and to Government (DMB 1988). Farmers initially organized themselves as farmer associations. The associations were to be registered with the Dairy Marketing Board (DMB) as a single producer (DMB 1988). However, in order to access funding from donors and financial institutions required that the farmers organized themselves along business lines. As a result, the associations transformed to form farmer organized and managed milk marketing cooperatives. The role of the marketing cooperatives are to collect the milk produced by individual farmers in the dairy scheme for delivery to processors, or participate in the processing of the milk at the milk collection centre and selling the products to consumers. The milk marketing cooperatives are managed by a management committee selected by member farmers.

The milk marketing cooperatives are responsible for running the milk collection centres (MCC), which form an important part of the smallholder dairy value chain. Besides collection of milk from producers, the MCC

have become an important infrastructure in providing smallholder producers access to a number of services. The MCC provides access to extension services, credit facilities, and dairy information, among others. The MCC were expected to form an important component for the improved and increased participation and commercialization of milk from the smallholder dairy value chains. However, it is now more than 31 years since the establishment of the first smallholder dairy scheme, and the smallholder dairy value chains have failed to make significant impact and only contribute 5% of the milk entering the formal value chains. This is in contrast to countries like Kenya where 80% of the milk entering formal markets comes from smallholder farmers (Moll et al 2007). The objective of this study therefore was to assess the major determinants of commercialization of milk though MCCs of the smallholder dairy value chains.

2. Materials and Methods

2.1 Study Sites and Data Collection

The study sites were four smallholder dairy development programme (DDP) schemes. The schemes were Chikwaka, Nharira-Lancashire, Marirangwe and Rusitu. These schemes were purposively selected on the basis of the type of production system (communal farming area, resettlement area, and small scale commercial farming area), agro-ecological location, and performance in terms of average daily milk delivered to the Milk Collection Centre (MCC), and linkages to formal modern processors (formal value chain) or processing of the milk at the MCC (semi-formal value chain).

The pretested questionnaire was the main primary data collection tool at the household level, complimented by key informant interviews. The questionnaire consisted of both pre-coded and open ended questions.

2.2 Sampling Procedures

The target population for the study were all smallholder dairy producers under the DDP dairy schemes in the target study sites. The lists of all members of the smallholder dairy schemes were obtained from the MCC. The list included producers who were delivering milk at the time of the study and those who were not delivering milk at the time of the study. The list for each respective smallholder dairy scheme formed the sampling frame for the sample survey for that dairy scheme. The sampling frames were comprised of 125 producers in Nharira-Lancashire, 65 producers in Chikwaka, 35 in Marirangwe and 245 in Rusitu. The aim in the survey was to interview at least 50 producers from each smallholder dairy scheme within the limits of the available research resources. Simple random sampling was used to select the sample of smallholder dairy producers included in the study. In Marirangwe, the sample of farmers included in the study were all the producers in the sampling frame since the sampling frame for the smallholder dairy scheme was less than 50. The total number of households interviewed in the four smallholder dairy schemes was therefore 185 farmers.

2.3 Level of Household Commercialization

Commercialization in smallholder agriculture usually creates problems of measurement, mainly related to the indices used for measurement. A farm household is assumed to be commercialized if it is producing a significant amount of cash commodities, allocating a proportion of its resources to marketable commodities, or selling a considerable proportion of its agricultural output (Immink and Alarcon 1993; Strasberg 1999). Jaleta et al (2009) discuss the issues of smallholder commercialization in terms of processes, determinants and impact. Generally, they argue that although there are various indicators and indexes that have been developed, there is no well accepted and comprehensive definition that could give a multidimensional view to smallholder commercialization concept so that one can easily judge to what extent a given farm household is commercialized in its overall production, marketing and consumption decisions (Jaleta et al 2009).

Besides problems in conceptualization, studies have been performed to assess the commercialization of smallholder agriculture making use of various indices such as the household commercialization index, among others (for example, Govereh et al 1999). This study used the commercialization index to assess the degree of milk commercialization through the MCC of the smallholder dairy value chain. According to Jaleta et al (2009), one of the most common approaches to measure the degree of commercialization at a household level is to use the proportion of sales from the total value of agricultural production. This is the approach used in this study, but it considered the degree of commercialization at the household level as the proportion of milk sold from the total household milk production.

2.4 Tobit Model

The Tobit regression model was used to analyze the determinants of milk commercialization through the MCC of the smallholder dairy value chain. The key aspect of using the Tobit model is use of latent quantities of the commercialized milk output of non-participating households. Smallholder dairy producers in this study are divided into two groups, those who actually sell milk to the MCC, on which information is available on the regressand (commercialized milk output) and the regressors, and another group where information is only

available on the regressors, but not the regressand. The regressand or dependent variable takes on positive and zero values. When a zero value is observed, it is assumed the household in question, rather than possessing an excess of the marketable product (commercialized milk in this case), actually has the demand for the commodity (that is negative supply) (Laper et al 2002). Hence the quantity sold (commercialized milk output) is left censored at 0 and the Tobit model is also known as a censored regression model. According to Gujarati (2004) statistically the Tobit model can be expressed as:

$Y_i = \beta_1 + \beta 2X_i + u_i$ (1)

if Right Hand Side (RHS) > 0, or = 0, otherwise.

The model used in this study is expressed as follows:

$Y = \beta_1 + \beta_2X_1 + \beta_3X_2 + \beta_4X_3 + \beta_5X_4 + \beta_5X_{4+} \mu$ (2)

Where Y – commercialization index
X1 – participation in milk marketing cooperative activities.
X2 – access to credit.
X3 – access to information.
X4 – distance to the MCC (representing access to market)
X5 – Price of milk delivered to the MCC
βi - Coefficients to be determined, and μ - error term.
The independent variables were identified based on economic theories and empirical studies as follows (Table 1).
Table 1: Description of variables used in the Tobit model

Variable	Description	Values, Expected sign
Participation in milk marketing cooperative activities	Whether farmer participates in activities or not (Dummy 1=participates, 0=otherwise)	+
Access to credit	Dummy (1=access, 0=otherwise)	+
Access to information	Access to information from the MCC through the mobile phone, Dummy (1=yes, 0=no)	+
Distance to MCC	Distance to MCC representing access to market	Km, ±
Price of milk	Continuous variable	USD, +
Commercialization index	Commercialized output of the milk produced	

Source: Author Compilation

The dependent variable used in the model was the commercialization index which was calculated as the quantity of milk sold per month divided by the total milk produced by the household per month multiplied by 100 (ComIndex). The explanatory variables were participation in activities of farmer milk marketing cooperatives (PartAss), access to credit (AccCred), milk producer price (MilkPrice), access to information (AccInfo) and access to markets (DistKmMCC). Participation in cooperative activities was measured as a dichotomous variable (1=yes, 0=no) where the yes indicated the farmer actively participated in cooperative activities through being a registered member who had paid joining fees, access to credit was measured in terms of whether the farmers had accessed credit in the last five years (1=yes, 0=no), and access to information was a dummy (where 1=access) to the information from the MCC which was provided through mobile phones and zero otherwise. Distance to the MCC was used as a proxy for market access and was measured in kilometers from the farmers' homestead to the MCC.

3. Results and Discussion

3.1 Socioeconomic Characteristics of Households

The results of the socio-economic characteristics of households in the smallholder dairy schemes studied show that most the farmers had paid joining fees for the Milk Collection Centre (MCC) cooperative (99.5%), and were therefore actively participating in the activities of the centre. The average age of the head of household was 57 years old, mostly males (about 74%) and married (about 77%). About 70% of the households used mobile phones to access dairy enterprise information (Table 2).

Table 2: Socioeconomic characteristics of households in the study sites

Characteristic	Value
Total number of households interviewed	N=185
Registered and paid MCC joining fees (%)	99.5
% of household head (males)	74.1
% of household head (married)	77.3
% of farmers accessing credit for dairy in last five years	58.9
% of farmers using cellphone for dairy enterprise information	69.7
Age of household head (years) Mean (SD)	57.0 (13.5)
Period dairying (years) Mean (SD)	16.8 (10.6)
Total arable land owned by the household (Ha) Mean (SD)	7.50 (15.9)
Distance to MCC from homestead (Km) Mean (SD)	5.40 (5.80)
Number of dairy cattle owned Mean (SD)	4.40 (7.60)
Milk output from the dairy herd litres per day	17.0 (29.7)
Amount of milk sold litres per day	15.3 (29.4)
Price of milk USD per litre	0.49 (0.50)

3.2 Access to Services Provided by the Milk Collection Centres

Farmers were also asked to give their perceptions as to whether their membership of the MCC of the smallholder dairy value chain has improved their access to services over the years. The majority of farmers responded positively in terms of indicating that membership of the MCC has improved their access to services over the years. The top five services frequently indicated by farmers were access to dairy inputs (about 92% of farmers reporting in the four study sites), access to information on milk handling and good farm management practices (88%), %), improved dairy production (87.6%), access to feed and concentrates (87%), education and training (87%) and access to extension services (86.5%) (Table 3).

Table 3: Farmer perceptions on whether membership of the farmer cooperative improved access to services in the study sites

	Total
% Yes improved:	n=185
Access to inputs	91.9
Access to milk handling and good farm management practices	88.1
Improved dairy production	87.6
Access to feed and concentrates	87.0
Access to education and training	87.0
Access to extension	86.5
Access to AI	80.5
Access to modern marketing facilities	79.5
Access to technology	76.8
Access to credit for dairy	70.8
Access to milk markets that offer higher prices	69.7
Other	3.20

3.3 Determinants of Milk Commercialization

The results show that participation in milk marketing cooperative activities and access to credit were not significant, while distance to the MCC was negative and significant, and access to information and prices were positive and significant at the 5% level. The results of the Tobit regression analysis are given in Table 4.

Table 4: Results of Tobit Regression Analysis

					Number of obs =	180
					LR chi2 (4) =	68.21
					Prob > chi2 =	0.0000
					Pseudo R2 =	0.36
Log likelihood =	-60.28					
ComIndex	Coef.	Std Err.	t	P>|t|	[95% Conf. Interval]	
PartAss	-0.124	0.295	-0.42	0.673	-0.707	0.458
AccCred	-0.026	0.049	-0.53	0.600	-0.123	-0.071
AccInfo	0.155	0.052	2.97	0.003	0.052	0.259
DistKmMCC	-0.00823	0.004	-2.18	0.031	-0.016	-0.000768
MilkPrice	2.64	0.466	5.68	0.000	1.73	3.567
_cons	-0.471	0.366	-1.29	0.200	-1.19	0.251
/sigma	0.292	0.017			0.258	0.327
Obs. Summary	24 left censored observations at ComIndex <= 0					
	156 uncensored observations					
	0 right - censored observations					

3.4 Membership and Services Provided by the MCC

The MCC plays an important role in the smallholder dairy value chains. In both the schemes that participate in the semi-formal and the formal value chain, the MCC provides the market for the milk from the producers as they are the entry point into the respective value chains for milk from smallholder dairy producers. Following liberalization in the 1990s and the break-up of the Dairy Marketing Board (DMB) monopoly, smallholder producers could market the milk to entities other than the DMB. The MCC were then encouraged and equipped to process the milk they were receiving from farmers. The two main products produced were pasteurized and cultured milk. As a result, some of the MCC moved into milk processing, while some remained delivering milk to the privatized Dairibord Zimbabwe Limited (DZL), the successor to the DMB. The MCC thus retained its central role in providing markets to the smallholder dairy producers, whether the milk was processed on site at the MCC or delivered to processors.

Over the years, most of the farmers' perceptions were that membership of the MCC had improved their access to these services. This is mainly because if one is not a member, they are not able to access services provided by the milk marketing cooperatives through the MCC. In the semi-formal value chain, the milk is processed on-site at the MCC, and the management committee of the cooperative ensures the milk and milk products have a market in order to enable them to pay the member producers. The milk and milk products for the semi-formal value chain are predominantly sold to consumers in the local area. In the formal value chain, the milk is delivered to processors based in the urban areas, and the management committee is responsible for negotiating prices with processors that should ensure the viability of the dairy producers and the MCC. Farmers perceive membership of the milk marketing cooperative has over the years generally improved their access to these services.

3.5 Determinants of Milk Commercialization

The Tobit model indicated that access to information, distance to the MCC from the farmers' homestead and producer price of milk paid by the MCC were the major determinants of the commercialization of the milk sold to the MCC. The results indicate the central role of the MCC in providing markets to farmers in the smallholder dairy value chain. Access to information was positive and significant at the 5% level, indicating the importance of information provided through the MCC run by the cooperatives in smallholder milk commercialization. The information is provided through mobile phones, and hence one can infer that the information was timely and relevant to the decision making of the smallholder dairy producer. Studies in other countries have also indicated the significance of information for smallholder dairy farmers provided through the MCC (Nkwasibwe et al 2015). Omiti et al (2009) also observed the use of market information generated by certain market channels increased output sales of farmers in the market. Since the MCC is the main entry point for milk in the value chain in Zimbabwe, the MCC are better placed to provide up to date information on prices and other dairy related information relevant to the needs of farmers.

The results of the Tobit model regression of distance to the MCC from the farmers' homestead indicates the relationship with the commercialization index was negative and significant at the 5% level. This indicates that distance to the MCC is critical in order for farmers to deliver the perishable milk commodity before it is spoiled. The MCCs that are run by the cooperatives provide the cooling facilities through bulk milk tanks located at the MCC. In the semi-formal value chains schemes, this provides temporary storage before the milk is processed and the products are sold through various market outlets. In the smallholder dairy schemes supplying the formal value chain, this provides temporary storage until the milk is collected by urban based processors. Distance to the MCC is also a major determinant of the transportation costs incurred by farmers, hence its central role in incentivizing or dis-incentivizing smallholder producers to participate in milk markets and as a determinant of the quantities commercialized. Key informant interviews also indicated that farmers located further away from the MCC deliver milk once per day, instead of twice per day for producers located nearer to the MCC. Sharma et al (2009) in a study in India also found that farmers prefer to sell milk to market outlets that are near to them in order to reduce transportation costs. Omiti et al (2009) in a study in Kenya also reported that distance to the point of sale is the major constraint to increasing milk market participation. The results indicate that the distance the farmer has to travel to deliver milk is a major determinant of the level of commercialization of milk from the smallholder dairy value chain.

The third significant predictor of commercialization of milk delivered to the MCC was the producer price paid by the MCCs run by the cooperatives. The producer price of milk was positive and significant at the 5% level. Prices provide the incentives for producers to commercialize a higher proportion of the milk produced. The prices paid to producers in the smallholder dairy schemes studied are determined by the management committee of the Cooperative that runs the MCC. In the smallholder dairy schemes where milk is processed on site at the MCC (to supply the semi-formal value chain), the prices paid to producers are dependent on the average product prices realized for processed milk and milk products sales in the various consumer market outlets less the MCC running costs. For smallholder dairy schemes that deliver to urban processors (to supply the formal value chain), the average prices paid by processors less the MCC running costs determines the prices paid to producers. The prices are generally higher for schemes supplying the formal value chain compared to the semi-formal value chain. Farmers are paid twice per month, that is, mid-month and at the end of the month. Nkwasibwe et al (2015) used Tobit regression in a study in Uganda and the results also showed that price was major determinant of the proportion of milk sales for milk sold to the formal market. Prices provide the major incentive for producers to participate in the market and also the proportion of the milk produced that is commercialized.

4. Conclusion

The Tobit regression model indicated the main determinants of the commercialization of milk sales through the MCC run by the cooperatives were access to information, distance of the MCC from the farmers' homestead and the price paid to farmers for milk delivered to the MCC. Therefore, in order to improve the role of the MCC in milk marketing, policy interventions have to be targeted and prioritized at improving market access. The MCCs play a central role in integrating smallholder farmers to value chains and markets that have potential to incentivize farmers to increase the quantities marketed through the MCCs, if favourable market and price policies are developed and implemented. Establishing sub-centre MCC within easy reach of farmers would enhance smallholder farmers' participation and commercialization of the milk output from the smallholder dairy value chain.

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