Evaluation of quality beef supply chain efficiency in Tanzania's niche markets: a case study of Arusha and Dar-es-Salam cities

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Abstract

Improvement of quality attributes of beef is important since it lessens the risks to public health which is associated with consumption of contaminated beef. However, improvement of quality beef involves extra costs that lead the beef to be unaffordable to a wide range of consumers. This indicates that sustainable production and supply of quality beef in Tanzania is dependent on addressing issues of efficiency in using available resources to produce, process and distribute quality beef at relatively low cost that is affordable to consumers. This study used cost efficiency ratios and return on investment to analyze efficiency of supplying Quality Beef (QB) in Tanzania's niche markets. Primary data were collected using structured interviews from two cattle fattening companies, three auction markets, six beef processors, 11 supermarkets, 34 tourist hotels and one beef importing company.

The study findings showed that the cost of processing QB was the highest (2,075Tsh/kg) compared to production and distribution costs which stood at 233Tsh/kg and 1,487Tsh/kg respectively. Electricity was the major component of processing and distribution costs that stood at 84% and 73% respectively. The authors recommended that stakeholders in the beef industry need to invest in local QB supply as it is profitable; and invest in low cost alternative energy sources such as biogas and solar power to reduce processing cost to make the venture more profitable. Moreover, linkages of major importers of QB with local QB producers should be made with proper taxation of imported beef to make locally produced QB more competitive.

Key words: *quality beef, returns on investment, supply chain efficiency measures, Tanzania*

Introduction

Generally, there is no standard measure of quality beef since the concept is subjective from one consumer to another. However, quality meat is understood as a multifaceted trait being influenced by flavor, juiciness, tenderness, leanness and freshness (Mushi et al 2008; Marreiros and Ness 2009; Inness and Cranfield 2009). It is generally accepted that tenderness is the main quality attribute among meat consumers (Burke and Monahan 2003; Madsen et al, 2010). Other meat quality attributes reported by consumers are safety assurance attributes that include: marks of meat inspection stamps, hygiene of slaughter and butcher premises as well as hygiene of equipment used and the staff handling the meat (Kurwijila et al 2009). It is also acknowledged that cattle management practices influence tenderness of beef (Asimwe et al 2012; Mwilawa 2012). Hence, the term quality

beef as used in this paper refers to beef made from fattened cattle that was, slaughtered under hygienic conditions, aged to make it tender and sold in a hygienic meat shop.

Despite the fact that Tanzania beef industry is dominated by traditional sector (98%) the sector is still underdeveloped such that it poses health risk to the general public. *Compylobactor species* is acknowledged to be the major species that is commonly transmitted to humans through consumption of contaminated beef (Mahundi et al 2011; Ntanga et al 2014; Kashoma et al 2016). Mahundi et al (2011) estimated contaminated beef in the traditional sector to account for 15.5% and 34.7% for the beef consumed as roasted and stewed respectively in Arusha municipality. Ntanga et al 2014 revealed that beef in Morogoro municipality was highly contaminated along the supply chain from abattoir to meat shops. Moreover, Kashoma et al (2016) estimated prevalence of *Campylobacter* to account for 9.5% among 253 cattle dressed carcass swab samples from Iringa, Arusha and Morogoro municipalities. Therefore, improving the quality of beef is a key to reducing health risk to beef consumers. However, production of quality beef involves extra cost of production compared to conventional beef (Mwilawa 2012; Mlote et al 2012). The extra cost makes the price of quality beef higher by 300% compared to the conventional beef (Kamugisha 2015). As a result most consumers cannot afford quality beef. This suggests that there is an element of inefficiency in the supply chain that needs to be addressed.

In order to supply affordable quality beef in Tanzania there is a need to use available resources in the beef industry efficiently. Similarly Trieken (2011) contended that supply chain must seek for efficiencies at every stage of the chain to control costs. This study intended to analyze efficiency of supplying Quality Beef (QB) in Tanzania's markets. Specifically, the study investigated the efficiency of production, processing and distribution of beef along the quality beef supply chain in Dar es Salaam and Arusha cities of Tanzania.

The government has developed various initiatives to commercialize traditional cattle sector by promoting cattle fattening. One of the initiatives was to privatize some of the NARCO ranches into pieces of 2 000 to 4 000 hectares each capable of holding over 120 000 beef cattle and subleased them to local investors for commercial cattle farming (Njombe and Msanga 2008). In addition, the government has established a system for livestock identification, registration and traceability through the beef supply chain (Maiseli et al 2010). Despite these efforts that aimed to promote and support beef cattle fattening through a feedlot system; the response by the supply chain actors towards beef cattle fattening has been very low (UNIDO 2012). Only a few enterprising individuals from among agro-pastoral and pastoral areas especially in Mwanza, Shinyanga, Mara, Dodoma, Morogoro, Arusha, Manyara and Coast regions have embarked on beef fattening to improve the quality of beef animals for sale in niche market within East Africa and the Comoro Island. Mlote et al (2012) revealed that cattle traders purchase unfattened cattle from traditional cattle farmers, fatten them for up to three months and resell them to the local and/or export markets at prices higher than that paid to traditional cattle farmers. UNIDO (2012) estimated the number of cattle fatteners in the country to be about 100 holding at least 5 550 heads of cattle at any point in time.

Scant information exists on the efficiency of beef supply chain in Tanzania. Two studies on efficiencies of beef supply chain in the country have been conducted (Mlote et al 2013_a). Mlote et al (2013_a) estimated technical efficiency of small scale cattle fattening in Tanzania using stochastic frontier production function. The results indicated that farm average technical efficiency was 91% suggesting that beef cattle fatteners in the study area were highly efficient. To the knowledge of authors, there is no study on supply chain efficiency in meat industry that has been conducted in Tanzania. Given information gap on meat supply chain efficiency in developing countries and Tanzania in particular, this paper evaluated efficiency of producing, processing and distributing

quality beef along the chain. The information from the study will contribute to improve the competitiveness of quality beef supply chain.

Methodology

Theoretical framework

The neoclassical economic theory identifies three efficiency measures: technical, allocative, and economic efficiency (Boris et al 1997; Onyenweaku and Effiong 2006). Technical efficiency is reached when it is impossible for a firm to produce large outputs from the same level of inputs, or a given output from fewer inputs (Greene 1993; Barnes et al 2010). In practice, efficiency of the firm is measured by considering relative position in terms of efficiency of a particular firm compared to others (Farrell 1957; Shahooth and Battall 2006).

The supply chain efficiency is the efficiency of individual nodes along the chain focusing on satisfying the end user (Cooper et al 2000; Vorst 2000; Wong and Wong 2007). Several models of measuring efficiency of supply chains exists (Gerber 2010). These include: Spider/radar diagram and Z chart (Yakovieva et al 2009; Gerber 2010; Mishra 2012); Data Envelopment Analysis (DEA) (Charnes et al 1978; Fare and Primont 1984; Seiford and Zhu 1999; Golany et al 2003; Chen and Zhu 2004; Rayeni and Saljooghi 2010); and stochastic frontier Approaches (SFA) (Broeck et al 1994; Tsionas 2002; Galany et al 2012).

Spider/radar diagram and Z chart were not found suitable to analyze QB supply chain since they are too graphical in nature that cannot measure efficiency using multiple inputs and outputs. The DEA and SFA deal with isolated parts of the supply chain system such as supply – production, production – distribution; or inventory – distribution (Yang et al 2006). Therefore DEA and SFA models were not employed in measuring efficiency of QB supply chain in this paper. This is because the chain involves a series of simple business functions (cattle farming, cattle slaughtering, beef processing, and distribution of beef and beef products). The efficiency of QB supply chain was then measured by computing cost efficiency ratios and returns on investment at respective nodes of the chain as it was found most appropriate than other analytical approaches.

Data collection

Data were collected from two cattle fattening companies, six beef processors, 11 supermarkets, 34 tourist hotels and one beef importer using three sets of structured questionnaires during February 2012 – June 2012. The first and second questionnaires were designed to capture data from tourist hotels and supermarkets. The third questionnaire was designed for QB cattle producers. Finally, a checklist was made for soliciting data from beef importers.

Various techniques were executed in primary data collection (Table 1). Key informant interviews involved downstream beef supply chain actors that include slaughtering and meat processors. Structured questionnaires were used to collect data from tourist hotels, supermarket operators, and cattle fatteners. Appointments were made two days before the date of interview through extensionists and Wards Executives. Interviews were conducted at respondents' offices. The interviews were conducted in Kiswahili and English languages. Kiswahili language was used during interviews with Tanzanian respondents while English was used during interviews with non–Kiswahili speaking respondents in Modern butchers, supermarkets and beef importing companies.

Table 1. Techniques used for primary data collection from sampled actors

Id.	Actor's name	Data collection technique
1	Fatteners	Structured interviews
2	Cattle slaughtering and Beef Processors	Key informant interviews
3	Supermarkets	Structured interviews
4	Tourist hotels	Structured interviews

Arusha, Dar-es-Salaam and Manyara regions were purposely selected as a case study. The Arusha and Dar-es-Salaam regions were chosen due to the presence of meat processing factories, tourist hotels and supermarkets in the regions. Moreover, Arusha's cattle population (1 699 541 heads), ranks second after Shinyanga in the country (NSCA 2012). Manyara region was sampled to explore cattle fattening since the region was the only one dealing with commercial cattle fattening during data collection exercise in the northern zone.

Analytical framework

Efficiency was computed from two different orientations: input orientation and output orientation. Cost efficiency ratios at successive stages of beef supply chain were computed using equation 1.

Where: CER_{ii} is cost efficiency ratio at node i, P_{xi} is price of inputs at node i and Q_{xi} is the quantity of variable inputs at node i. Q_{yi} is the quantity of outputs at node i. *The lower ratio the higher efficiency.* Table 2 shows cost items involved in the estimation of costs at each node of the conventional and quality beef supply chain.

Table 2. Costs incurred along beef supply chains

Chain node	Costs incurred along quality beef channel
Production	Cattle purchase, transport of cattle to farm, feeds purchase,

	veterinary services, grazing costs
Processing	Cattle purchase, transporting cattle to factory premises, slaughtering and chilling, packaging materials
Distribution (retailing)	Carcass purchase, utilities: water and electricity, packaging materials

On the other hand, efficiency from output orientation was computed using equation 2.

Where: R_{oi} - Return per shilling invested at node i ; TR_i - Total Revenue at node i; and TVC_i – Total variable costs at node i. i represents different nodes of the quality beef supply chain e.g. cattle production, cattle slaughtering and processing, and beef retailing node. *The higher the ratio the higher the efficiency.*

Results and discussion

Efficiency of traditional cattle producers

The study findings indicate that veterinary services and grazing comprised major components of variable costs accounting for 57% and 38% respectively. The remaining cost components accounted for only 5% of the total variable cost (Table 3). The reasons behind higher cost component of veterinary services might be attributed to long distance between cattle farmers' homes and the locations of the centers of veterinary services that was estimated to be about 40 km. Moreover, dominance of grazing cost component might be aggravated by aridity nature in the surveyed area whereby cattle farmers were forced to trek cattle long distances in search for pastures. Sometimes, cattle farmers were forced to leave their homes and feed away cattle for some months during dry seasons. These findings are in contrast with findings by SAGCOT (2011) who revealed that labour, feeds and other costs accounted for 5.05%, 93.43% and 1.52% respectively of the total variable costs which were incurred in beef production in southern corridor of Tanzania.

Furthermore, Table 3 shows that the cost incurred to produce a kilo of beef was 1 900Tsh (1.14 USD). This cost is more than twice the cost of producing a kilo of beef reported by Mlote et al (2012) and Kadigi et al (2013) in the Lake Zone. Higher costs of producing beef in the study area might be due to constraints in the availability of pastures and water especially during dry season. Moreover, findings in Table 4 revealed that gross margin was 40% implying that every shilling invested in cattle production in the conventional beef chain would yield 40 cents. Although it can be judged that, traditional cattle production business is paying due to higher returns, the length of time employed in cattle production (6 years) outweighs financial feasibility of cattle production. Hence, cattle breeds with shorter time to attain slaughter weight can outweigh this challenge. The higher return per shilling for cattle farming business observed in this study are in contrast with the findings in a study by Sintayehu et al (2013) who reported relatively lower return for investment of 9.81% among cattle producers in Ethiopia. The Differences between the two findings might be attributed to higher costs of water and feeds by Ethiopian cattle producers which accounted for 10.1% and 27.8% of variable costs respectively. These resources (pastures and water) are owned communally and are not paid for in Tanzania.

Table 3. Costs and return to traditional cattle producers

id.	Costs and revenue items	Monthly costs/ 200 heads	Annual costs/ 200 heads	Annual costs/hea
	Costs			
1	Grazing	300 000	3 600 000	18 000
2	Veterinary services	250 000	3 000 000	15 000
3	Dipping	30 000	360 000	1 800
4	Trekking to markets			
5	Total variable costs (1 -4)	780 000	9 360 000	46 000
6	Cost of producing kg (285000/150) (Tsh/kg)			
	Revenue			
7	Selling price (Tsh/head)			
8	GM (TR – VC i.e. (7) – (5))			
9	Estimated costs /kg (5)/300			
10	% Proportion GM/Sales (7/6)*100			
11	Return per shilling invested (8)/(5)*100			

12 Return per kg of beef (8)/150

Assumptions: *Cattle live weight 300kg, Dressing percentage 50%, Carcass weight/cattle 150kg*

Efficiency of cattle fatteners

Table 4 revealed that cost of purchasing cattle for fattening accounted for 93% of the variable costs incurred by cattle fatteners. The remaining cost items such as transportation, veterinary services and feeds accounted for only 7%. However, if cattle purchase cost would be disregarded to consider only additional cost due to fattening the additional cost would comprise 20% feeds, 38% veterinary services and 42% transportation. Surprisingly, the proportional percentage of feed cost of fattening is significantly lower than what is reported by Mwilawa (2012) and Mlote et al (2012) that feed was the major cost component in cattle fattening, accounting for 78% and 66% of the variable costs in Dodoma and Lake Zone respectively. The differences in the feed cost component between this study and studies by Mwilawa (2012) and Mlote et al (2012) is due to the difference in feeding systems practiced in the two study areas. Studies by Mwilawa (2012) and Mlote et al (2012) were carried out in areas where cattle were totally confined and fed with hays and concentrates; while this study was carried out in areas where cattle were grazed in privately owned paddocks during the day and supplemented with concentrates in the evening.

Table 4. Costs and returns to cattle fatteners

	Costs and revenue items	**TSh/ head**	**TSh/kg**
	Costs		
1	Cattle purchase (Tsh)	514 333	1 714.4
2	Transportation (Tsh)	17 000	56.7
3	Feeds (Tsh)	8 150	27.2
4	Veterinary services (Tsh)	15 700	52.3
5	Total variable costs (1-4) (Tsh)	555 183	1 850
6	The added cost/kg (2+3+4) (Tsh)		233

	Revenue		
7	Sale of cattle (Tsh/head)	610 623.7	2 035.4
8	Gross margin/head (7) – (5) (Tsh)	65 440.7	218.1
9	% proportion GM/sale (8/6)*100	10.5%	
10	Return per shilling invested (8)/(5)*100	11.8%	
11	Return per kg of beef (8)/175 (Tsh)	374	

Assumptions: *Cattle live weight/head 350kg, Dressing percentage50%, Carcass weight 175kg*

According to Table 5, the total cost of producing quality beef was 1 850Tsh/kg. This cost was relatively lower than that of 2 820 Tsh/kg and 3 015 Tsh/kg reported by Mwilawa (2012) among Boran and TSHZ respectively in Dodoma region. Furthermore, the costs of producing quality beef in the study area was less than the costs of producing quality beef in Ilemela and Magu districts which stood at 3 512.41 Tsh/kg as reported by Kadigi et al (2013). Lower cost of producing quality beef in this study can be associated with the difference in feeding systems of fattening cattle as described above.

Added cost per kilo of beef was about 233Tsh (0.13USD) (Table 4). The added cost of producing QB observed in this study is relatively lower than the added cost of producing a kilo of QB reported by Mlote et al (2012) in Lake Zone that stood at 683.43 Tsh/kg (0.41USD/kg); and lower than that reported by Umar et al (2008) in Nigeria which stood at 0.89USD/kg among Nigerians smallholder cattle fatteners. Lower added cost observed during the course of producing QB in the study area can be associated with the economies of scale enjoyed by Ormoti Co. Ltd and Manyara ranch that were involved in fattening of cattle. During field survey Ormoti Co. Ltd and Manyara ranch fattened 250 and 100 cattle per batch respectively, while smallholder cattle fatteners in Mwanza and Shinyanga regions fattened up to 10 cattle per batch; and cattle fatteners in Nigeria rose up to 8 cattle per batch. Moreover, while cattle fatteners in Mwanza region were reported to purchase cattle in weak condition for fattening which takes too long (three months) and require more feeds and time for it to be in good condition (Mlote et al 2012); Ormoti Co. Ltd buy cattle in good conditions (grades A and B) requiring relatively less time (hardly 14 days) and feeds to gain the desired slaughter weight.

As shown in Table 4, the return per kilogram of beef produced was 374 Tsh while the return per shilling invested was 11.8%, implying that every shilling invested in quality cattle production would yield about 12 cents (Table 4). This rate of return in a short period of 14 to 60 days of fattening is substantially higher than the commercial interest rates charged by most banks in Tanzania that range between 18% and 25% per annum. This suggests that cattle fattening is a highly paying business. The returns to cattle fattening observed in this study is different from the returns to cattle fattening of 35% among cattle fatteners in Mwanza and Shinyanga regions reported by Mlote et al (2013 $_a$). Also the returns to cattle fattening in the study area differs from those reported by Sarma and Ahmed

(2011); and Farmer (2010) of 34% and 91% among smallholder cattle fatteners in Bangladesh and Ethiopia respectively. Differences between these observations can be associated with the use of own resources in business like family labour that is not accounted for as a cost in the QB cattle production.

Efficiency at processing node

The costs incurred and the returns obtained by quality beef processors are shown in Table 5. The total variable cost incurred to process a kilo of quality beef was 6 212.5Tsh. If the cost of purchasing fattened cattle is not considered, the costs of processing (slaughtering and chilling) would be astronomical, accounting for almost two thirds of the total variable cost incurred in processing of quality beef. High processing costs were due to high electricity cost of about 1 133 Tsh/kg, accounting for 84% of the total costs of slaughtering cattle and chilling beef. The added cost per unit of quality beef processed was 2 075 Tsh/kg (1.245 USD/kg) (Table 5). The added cost of processing one kilogram of quality beef observed in this study is higher than the added cost of processing a kilogram of quality beef in Ethiopia which is about 0.418ETB/kg (0.0229 USD) and 0.174ETB/kg (0.009USD) in Southern and Northern business routes of Ethiopia respectively (Sintayehu et al 2013).

Table 5. Cost and returns to quality beef processors

Cost item and revenue items	TSh/head	TShs/kg	Percent of t
Costs			
Cattle purchase (350kg) (Tsh)	620 623	4 137	66.6
Slaughtering &chilling (Tsh)	202 580	1 350	21.7
Transport (Tsh)	81 000	600	9.7
Packaging materials (Tsh)	16 875	125	2.0
Total variable costs (40-43)	**920 998**	**6 212**	
Added cost (2+3+4)		2 075	
Revenue estimation			

Beef sale (Tsh)	1 215 000	9 000
Gross margin (TR – TVC) (6)-(5) (Tsh)	294 001	2 787
% proportion GM/sale [(7)/(6)]*100	24.2%	
Returns per shilling invested [(7)/(5)]*100	31.9%	
Returns per kg handled (Tsh)	2 787	

Moreover, Table 5 shows that processors of quality beef earned a return of 2 787 Tsh/kg which is about 32% per shilling invested in quality beef processing. This return per shilling is slightly higher than that of 30% reported by Spies (2011) among South African beef processors.

Efficiency at retailing node

According to Table 6, the cost of retailing quality beef was 1 487 Tsh/kg (0.89USD/kg). The cost of retailing a kilogram of quality beef is relatively higher than the cost of retailing quality beef in Ethiopia that stood at 0.282USD/kg as reported by Addisu et al (2012). With regard to the returns of quality beef retailing, the returns per kilogram of quality beef retailed was 13 080Tsh while the return per shilling invested at supermarket retailing outlets was 83% (Table 6). This return is the highest among all the other preceding upstream beef chain actors. Huge returns in supermarkets might be associated with monopolistic powers enjoyed by high end markets in setting terms and conditions for their suppliers, since the former are a few in numbers However, huge profit might be associated with the exclusion of overhead costs and non food costs incurred at these nodes. These findings contrast to those reported by Funke (2006) who noted a relatively low gross margin ranging from 17% to 33% among high end retailing outlets selling beef prime cuts such as rump, sirloin, topside, brisket and chuck to high income clusters in South Africa.

Table 6. Costs and returns to retailing of quality beef in supermarkets

	Cost and revenue items	**TSh/kg**
	Costs	
1	Beef purchase (Tsh)	14 233

2	Utilities	987
3	Packing materials (Tsh)	500
4	**Total variable cost (TVC) (Tsh)**	**15 720**
5	The added cost/kg (2+3) Tsh	1 487
	Revenue	
6	Beef sale (Tsh)	28 800
7	Gross margin (TR – TVC) (6) – (4) (Tsh)	13 080
8	% proportion (GM/sales) [(7)/(6)]*100	45%
9	Return per shilling invested [(7)/(4)]*100	83%
10	Returns per kg handled (Tsh)	13 080

Summary of costs and returns along the beef supply chain

Efficiency in terms of costs per unit of output and return per unit of input was found to vary among quality beef supply chain actors. The cost per kilo of quality beef incurred by processors was found to be relatively higher (2 075 Tsh/kg) compared to the cost of handling a kilo of quality beef among QB fatteners (233 Tsh/kg); and retailing costs of 1 487 Tsh/kg among QB distributors (Figure 1). The relatively low cost among cattle fatteners can be associated with non use of electrical energy in the production of quality beef. This is because electricity bills formed major (84%) component of costs incurred by processors. Moreover, non food costs incurred by QB distributors can be associated with relatively higher costs of retailing QB compared to the costs incurred QB fatteners. Moreover lower added costs incurred by QB cattle can be explained by the fact that fattening company had a large piece of land to graze cattle in paddocks and supplement them with concentrates in the evening. Feeds have been documented as a major cost item in quality beef production in the country (Mwilawa 2012; Asimwe et al 2012; Mlote et al 2012); and elsewhere in developing countries (Sintayehu et al

2013; Umar et al 2008; Emokaro and Amadasson 2012). The low cost experienced by QB cattle fatteners implies that there should be demarcation and privatization of pastoral land that in turn would reduce environmental degradation in pastoral areas as a result of the current communal ownership of grazing land.

Figure 1. Efficiency measures along QB supply chain

The returns per kilogram of quality beef retailed was 13 080Tsh while the return per shilling invested at supermarket retailing outlets was 83% (Table 8). This return is the highest compared the other preceding upstream beef chain actors. Huge returns in supermarkets might be associated with monopolistic powers enjoyed by high end markets in setting terms and conditions for their suppliers, since they are a few in numbers. However, huge profit might be associated with the exclusion of overhead costs and non food costs incurred by supermarkets. These findings are different from the findings reported by Funke (2006) who noted a relatively low gross margin ranging from 17% to 33% among high end retailing outlets selling beef prime cuts such as rump, sirloin, topside, brisket and chuck to high income clusters in South Africa.

Conclusion and recommendation

Electricity accounted for 84% and 73% of added cost for processing and retailing of quality beef respectively. Gross return/shilling was highest (83%) and lowest (12%) at retailing and production nodes respectively. To promote production and consumption of quality beef this study recommends that: (i) Investors should venture in local quality beef supply because it is profitable. However, efforts should be made to use low cost alternative energy sources such as biogas and solar power to make the venture more profitable. Linkages of major importers of quality beef with local quality beef producers should be made with proper taxation of imported beef to make locally produced QB more competitive.

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