



Effect of Supply Chain Management Training on Milk Production among Small Holder Dairy Farmers in Trans-Nzoia County, Kenya

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Abstract

The increase in the world's population and urbanization across the globe have triggered an elevated demand for dairy products. In the East Africa region, future projections indicate that the demand for milk will have tripled by 2050. However, milk supply is not predicted to increase and match demand indicating an inevitable shortage in the supply. Supply chain management is paramount in enhancing efficient production and supply of products from the farm level to the consumers factoring in the consumers' requirements in terms of reliability, quantity, quality and price. It is therefore critical to do an in-depth analysis on the importance of supply chain management training intervention in the milk supply chains among smallholder dairy farmers to respond to the shortfalls in future demand. This study consequently sought to determine the effect of supply chain management training on milk production among smallholder dairy farmers in Trans-Nzoia County, Kenya. The Rational Choice Theory guided this study. The study adopted a descriptive research design. A sample size of 1875 dairy farmers were selected to participate in the study. Primary data was collected using a questionnaire and analyzed using SPSS. The Standard Poisson model results revealed that age, education, and marital status of the household head, herd size, road condition, milk volume, distance to milk output market, and household size were significant contributors to the use of motorcycle services. The study established that dairy farmers' supply chain management training intervention significantly affected milk production in Trans Nzoia County ($F=39$, $p < 0.05$) and therefore concluded that supply chain management training intervention was paramount in enhancing milk production. Therefore, this study recommends that county governments should set up mechanisms through which interventions will be enacted to help farmers enhance their dairy yields. As such, the government should consider setting up workshops through which farmers will be enlightened on various supply and value chain factors for optimal production.



Introduction

The supply chain includes activities within an industry to deliver a valuable product or service to its market. Each stage of the supply chain adds more value. The supply chain provides a tool to visualize a firm's productivity by identifying the activities and interventions involved (Fernandez-Stark & Gereffi, 2019).

Supply chain analysis aims to increase production efficiency so that the industry can deliver maximum value for the least possible cost (Salehi-Amiri et al., 2022). Supply chain analysis requires the "mapping of the market" to track and analyze the contribution of the different chain actors and their relationships. Understanding the interactions within a supply chain helps identify the factors that influence how well or how badly the chain works and the different cost-effective yet differentiated interventions to engage. The resulting market map defines the supply chain actors, the enabling environment and the service providers. The enabling environment includes critical factors that create the operating conditions within which the supply chain operates, such as infrastructure, policies, and regulations, as well as institutions and processes that shape the market ecosystem. Service providers include extension services that provide support to the supply chain, such as providers of market information, financial services, transport services, research and development facilities, and accreditation services (Liverpool-Tasie et al., 2020). The goal of any supply chain strategy is to identify the most valuable activities and to act on the activities which can be improved upon to create a competitive advantage.

Dairy farming in Kenya is an all-season business and applying efficient management systems to a dairy farm is key to its success. According to Odhiambo et al. (2020) Kenyan economy is supported to a large extent by the agricultural sector, which is a significant contributor to the country's GDP (Gross Domestic Product). Dairy farming is the single largest agriculture sub-sector in Kenya and contributes 4.5 per cent of the GDP. The sector is a livelihood, food and nutritional security source to 1.8 million smallholder dairy farmers and another 750,000 actors engaged along the supply chain, including support services.

According to Odari (2018), Kenya produces an estimated 5.2 billion litres of milk annually, of which over 88% is from cattle while the rest is from other dairy animals. With an estimated 3.5 million exotic and 14.1million indigenous cattle, the dairy industry has been growing at a rate of 3 to 4 per cent annually due to increasing herd size rather than rising productivity levels. Most commercial dairy production is concentrated in Central and Rift Valley regions leaving many other dairy-potential areas, including the coast region, underexploited. Due to the increasing demand for milk and milk products in Kenya, it is projected that milk production will fall short of demand in 2022 unless targeted interventions are implemented to increase productivity, reduce the cost of production, improve quality, and enhance efficiency in marketing (Kirui, 2022).

The agriculture sector supports majority of Kenyans who earn their living directly or indirectly. It is the largest agriculture sub-sector compared to other agricultural farming. The rising urbanization and incomes have triggered increased demand for dairy products in Kenya (Adesogan & Dahl, 2020). The total world production was 659 million tonnes of fresh cow milk, out of which Africa contributed six per cent (Osorio et al., 2021).

East Africa is the leading milk-producing region, representing 68 per cent of the continent's milk output and 43 per cent of cow milk (Parekh, 2019). The dairy sector forms one of the fastest-growing agricultural sub-sectors in East Africa. Though Kenya, the major regional producer, processor, and exporter of dairy products, whose dairy industry is a model being



emulated, in some parts, by dairy development efforts in neighbouring African countries, has established a competitive dairy industry; milk supply remains lower than its potential, and demand still outstrips supply.

Enahoro et al. (2019) stated that by 2050, it is estimated that in sub-Saharan Africa, milk demand will triple, with the most significant increase in East Africa. However, milk supply across the region is not predicted to match the estimated demand. An in-depth consideration of milk supply chains to identify the strengths and weaknesses of the existing systems to estimate how they will respond to the shortfall in supply is critical. From the output side, the dairy supply chain actors in the project counties include smallholder producers; formal and informal milk transporters; milk traders and retailers (mobile traders, vendors, milk bars); cooperatives; and private processors.

Milk production is a crucial source of income for more than two million households across Kenya (DeLay et al., 2020). Dairy farming is a high-value enterprise that presents substantial opportunities for future smallholder development. The Kenyan dairy sector ranks among the most developed in Sub-Sahara Africa, boasting regional market advantages and substantial untapped production potential (Opoola, 2019). With increasing domestic consumption and the harmonization of dairy product specifications by the East African Community (EAC) and the Common Market for East and Southern Africa (COMESA), the Kenyan dairy supply chain needs upgrading to increase productivity, reduce inefficiencies, lower production and processing costs, and improve milk quality to international standards.

The dairy sub-sector in Kenya is rated as one of the fastest growing sub-sectors in Kenya, faster than even tea (Njora & Yilmaz, 2021). It plays an essential role in the national economy and the socioeconomic development of many rural households in Kenya. The industry supports a range of actors, including farmers, milk traders, processors, consumers and several service providers. Munyori (2019) stated that the dairy sector in Kenya is regarded as a successful and vibrant industry due to the increasing domestic milk production, processing capacity, per capita milk consumption and export potential.

Mwangi (2021) stated that given its importance, dairy is among those supply chains prioritized for investment in the Agricultural Sector Transformation and Growth Strategy (ASTGS) and in the County Integrated Development Plans for two-thirds of the country's 47 counties. In addition, the Integrated National Export Development and Promotion Strategy (2017-2022) emphasizes the opportunity for export growth in the dairy sub-sector, particularly in the target destination markets in EAC, COMESA, ECOWAS, ECCAS and Gulf Cooperation Council (Saudi Arabia, UEA, Qatar, Bahrain, and Kuwait) and select Middle East Countries.

The rising demand for dairy products presents a significant market opportunity for small-scale dairy producers who dominate the industry (Wang et al., 2021). However, this requires that, at the minimum, farmers undertake actions to increase productivity and improve economic efficiency. The profitability of dairy farming in Kenya is affected by the high cost of milk production and frequent fluctuations in milk producer prices (Asmara et al., 2017).

Though Kenya is a major regional producer, processor, and exporter of dairy products, whose dairy industry is a model being emulated, in some part, by dairy development efforts in neighbouring African countries, milk supply is still lower than its potential, and demand still outstrips supply. Kiambi et al. (2022) observed that the increased demand for milk consumption coupled with its low supply would pressure existing supply chains triggering the evolution of more milk supply chains. This, they note, will complicate already complex



food systems. A 2012 report by the national livestock production indicated that Nairobi, one of Africa's fastest-growing urban cities, produced approximately 39 million litres of milk.

Otieno et al. (2020) indicated that productivity per animal in Kenya is still far below global leader producers like the European Union, USA, Canada, New Zealand and South Africa, where production per 305 lactation days is above 5000L/cow, with vertically coordinated efficient supply chains. Various studies have been undertaken in this field. Isako and Kimidu (2019) reviewed Kenya's camel milk supply chain. If the dairy sector is developed, factoring in the supply chain factors would present a source of income for smallholders with limited land for crop production and would be a key pillar of food security and nutrition (Gil et al., 2019).

According to Kiambi et al. (2018), interventions like training dairy farmers in Supply Chain Management, including the supply and value chain drivers, production, inventory, location, transportation, and information concerning market and market price, enhance dairy production.

Milk Production in Trans Nzoia County

Trans Nzoia County is one of the forty-seven Counties of Kenya. It covers an area of 2,495.6 square kilometres (Njogu, 2019). To promote dairy farming in Trans Nzoia County, the administration, in partnership with other stakeholders, launched the county supply chain platform for stakeholders in the industry in 2018, which has had concerted efforts of the involvement of different service providers in this field to ensure sustainable milk production. The County Government of Trans Nzoia, in consultation with the farming communities and key stakeholders, has identified and prioritized Dairy farming for investment to increase farm productivity and profitability at all levels of the supply chain (Omwoyo, 2021).

The dairy sector in Trans Nzoia County contributes both to household income and nutrition and provides significant opportunities for self-employment along the supply chain. Production has, however, remained low due to low-quality breeds compounded by poor farming and feeding practices and high incidences of pests and diseases.

Theoretical Framework

Homans (1958) established the foundations of exchange theory based on behaviorist psychology's assumptions. A reasonable choice is made after considering various options based on experience and relevant information gained through training on observation over time (Alaie, 2020). The rational choice theory is based on the concept that people are rational and make decisions based on what they know and believe is the most effective way to achieve their intentions (Chen et al., 2019). The rational choice theory usually starts by looking at the decision-making behavior of one or more individual decision-making units. The rational choice theorist frequently assumes that the decision-making unit represents a larger group, such as buyers or sellers in the supply chain (Wieland, 2021). Rational choice theorists argue that we must view individuals as rational decision-makers in a world of scarcity to understand better how and why they behave in specific ways based on certain conditions, including supply chain conditions, whether individually or socially (Gunessee & Subramanian, 2020). Human beings are purposive and goal-oriented, and a goal or purpose drives every activity according to rational choice. Individuals in the supply chain strive to achieve their objectives by acting rationally based on their knowledge, resources, and circumstances (Ketokivi & Mahoney, 2020).

The rational choice theory guided this study into how Supply Chain Management training intervention affects milk production among smallholder dairy farmers in Trans-Nzoia



County, Kenya. Smallholder dairy farmers are expected to make logical judgments regarding supply chain factors, including production, inventory, output and input market, transportation, and milk price, among other factors, based on their knowledge. The rational choice theory was the most suitable theory to guide this study since it helps explain smallholder dairy farmers' individual and collective behaviours of rational choice in supply chain management based on their knowledge acquired through training. It also aids in determining why people, including dairy farmers, tend to act toward specific decisions based on their understanding of specific costs and benefits.

Methodology

The study was conducted in Trans Nzoia County in western Kenya which borders Uganda to the North west. Trans Nzoia County lies on the western side of Mount Elgon in the former Rift Valley province, some 380 km northwest of Nairobi. The county borders Bungoma to the west, Uasin Gishu and Kakamega to the south, Elgeyo Marakwet to the east, West Pokot to the north, and Uganda's republic to North West. Trans Nzoia County lies between Latitude 1° 3' 24.0012' and Longitude 34° 57' 2.3868" south and Longitude E 34° 57.0398' and Latitude: 1.056667°. Agriculture is the main economic activity characterized by both small- and large-scale farming. Dairy production is practiced for subsistence and commercial purposes. Situated on the mountain's slopes, Trans Nzoia has a cool and temperate climate with average annual temperatures ranging from 10°C to a maximum of 27°C. The county receives annual precipitation between 1000 and 1200mm, with the wettest months experienced between April and October. Trans Nzoia County is home to about 990,341 people, 50% male and 50% female (Kenya Population and Housing Census, 2019). The cool and temperate climate, with a rainfall distribution almost annually, promotes dairy production in Trans Nzoia County (Were, 2017). Friesian, Ayrshire, Jersey, and crosses are the main dairy breeds in Trans Nzoia County (Bii, 2017). The study was conducted in all five sub-counties of Trans Nzoia County (Cherengany, Endebess, Kwanza, Kiminini, and Saboti).

The study adopted a descriptive survey research design. This research design enables descriptive and preliminary studies as it permits one to collect, summarize, and interpret as well as clarify the information (Asenahabi, 2019). The target population comprised dairy farmers in all five sub-counties of Trans Nzoia County (Cherengany, Endebess, Kwanza, Kiminini and Saboti). Multistage sampling procedure was adopted in this study. Trans Nzoia County was purposively selected in the first stage since it has high dairy milk production potential. Finally, in the second stage, simple random sampling was used to select 1875 dairy farmers for interview proportionate to the population of each sub-county with farm households as the sampling unit. The required population sample for each ward was derived by dividing the total population by sub-county divided by the total population into all the five sub-counties, then multiplied by the desired sample estimate of 1875 households arrived at using the formula by Creswell (2007).

Data were obtained from the dairy records kept by the farmers in the project before and after the interventions. The data was then analysed using Statistical Package for Social Science. The study used the F-test to determine the effect of supply chain management training intervention among dairy farmers at a 0.05 significant level. The variance between total milk production before training intervention and total milk production after training intervention was compared to establish if there was a significant difference.

Results and Discussion

The results of the total milk produced in litres before and after the training intervention are indicated in Table 1.

Table 1: Total milk produced in litres before and after the training intervention



Before training intervention				After training intervention			
Months	Total cows in lactation	Total milk produced in litres	milk in	Months	Total cows in lactation	Total milk produced in litres	milk in
Apr-21	1,420	2,232		Jul-21	1,420	10,152	
May-21	735	1,343		Aug-21	735	3,652	
Jun-21	612	1,295		Sep-21	612	3,194	
Totals	2,767	4,870		Totals	2,767	16,998	

The total milk produced in litres before the training intervention in April, May and June 2021 was 4,870 litres, while the total amount produced in litres after the training intervention in July, August and September 2021 was 16,998 litres (Table 1). The results indicate that after training intervention, total milk produced in litres increased from 4,870 to 16,998 litres.

Milk Production Trend Analysis

The study used the total monthly milk production before and after training interventions to establish the trends for milk production. Figure one shows the milk production trend analysis before and after the training intervention for three months.

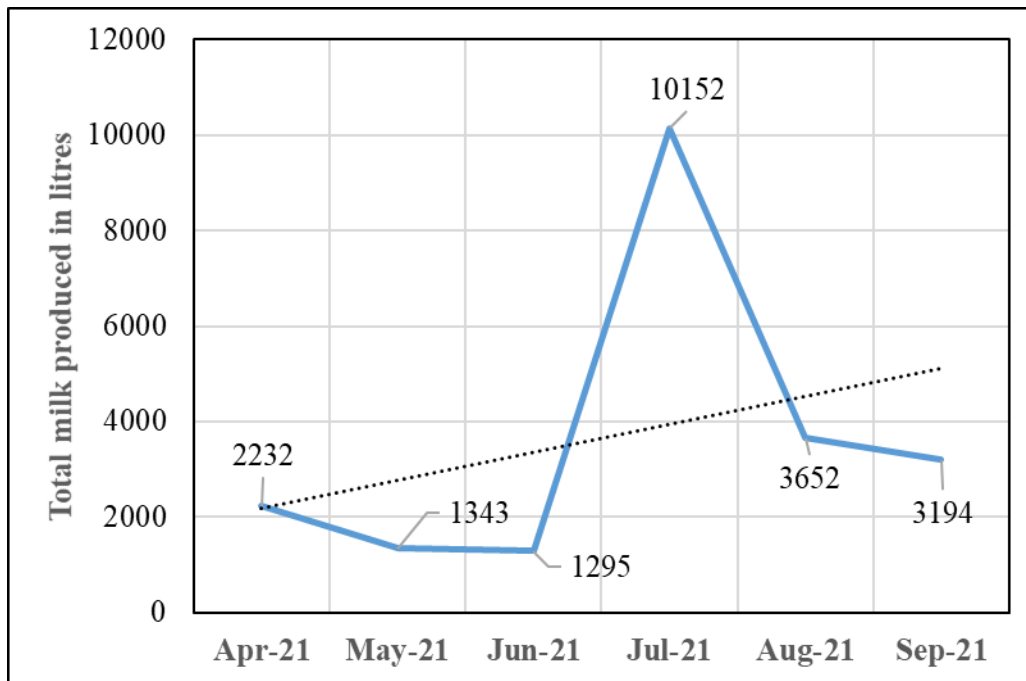


Figure 1: Line graph representation of trend analysis for milk production before and after the training intervention

The study results in Figure 1 indicate that milk production gradually decreased from April to June 2021 (Before the training intervention). The total milk production increased rapidly from July to September 2021 (After the training intervention). The trend line indicates a positive upward trend after the supply chain training intervention.



Further, the study used the Mann-Kendall trend test to determine if there was a significant trend in total milk production before and after the training intervention. Table 2 indicates the Mann-Kendall trend test results for total milk production before and after the training intervention.

Table 2: Mann-Kendall trend test of total milk production before and after the training intervention

Mann-Kendall trend test	
Kendall's tau	0.200
S	3.000
Var(S)	28.333
p-value (Two-tailed)	0.719
alpha	0.05

There was no significant trend in total milk production before and after training intervention from April to September (Table 2). Since the computed p-value in Table 2 is greater than the significance level of $\alpha = 0.05$.

Supply Chain Management Training Intervention and Milk Production

The study used F-test to determine the effect of supply chain management training intervention among dairy farmers on milk production. The total milk production before training intervention and total milk production after training intervention were compared to establish if there was a significant difference. Table three indicates the results of the F-test.

Table 3: F-test results for the effect of supply chain management training intervention on milk production

F-test results	
F (Observed value)	0.018
F (Critical value)	39.000
DF1	2
DF2	2
p-value (Two-tailed)	0.036**
alpha	0.05

The study used the F test at a 0.05 significance level to reveal that the variance in total milk produced before and after training intervention varied significantly ($P < 0.05$). The results suggest that training intervention significantly predicted milk production among dairy farmers in Trans Nzoia County. Hence supply chain management training intervention among dairy farmers significantly affected milk production in Trans Nzoia County. These findings conform with the study by Bórawski et al. (2020) on "Factors shaping cow's milk production in the EU.", who established a significant association between supply chains and milk production in the EU.

Conclusion and Recommendations

The findings from the study demonstrated that training intervention in the supply chain significantly enhances milk production. The study concluded that capacity building for farmers engaged in dairy milk production through supply chain training enhances their milk



productivity. In this regard, training interventions on the supply and value chain drivers, including production, inventory, and logistics/transportation, among other factors aligned to the supply chain, could enhance dairy production. The study, therefore, recommends that county governments should set up mechanisms through which interventions will be enacted to help farmers enhance their dairy yields. As such, the government should consider setting up workshops through which farmers will be enlightened on various supply and value chain factors for optimal production.

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