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Value chain analysis of the bean sector in north Kivu: market dynamics, governance structures, and economic performance in the city of Goma

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Abstract

This study analyses the bean value chain in North Kivu, Democratic Republic of Congo, with a particular focus on market dynamics, governance structures, and economic performance in the city of Goma. A mixed-methods approach was applied using survey data collected from 250 respondents, including producers, wholesalers, retailers, transporters, consumers, and institutional actors across the principal bean markets of Goma. Descriptive statistics, gross margin analysis, Benefit–Cost Ratios (BCR), ANOVA, Pearson correlation, and Chi-square tests were employed to evaluate profitability and governance relationships along the chain. Results indicate that bean yields remain low, varying from 400 kg/ha to 1200 kg/ha due to limited access to improved seeds, fertilizers, and phytosanitary inputs. Producer revenues range between USD 175 and USD 825 per hectare, while value added varies from USD 25 to USD 715/ha. Profitability levels are highly differentiated, with BCRs ranging from 1.17 to 7.50 depending on yield, quality, and production costs. Transport costs significantly affect market integration and wholesaler margins, varying between USD 8 and USD 16 per 160-kg bag. Pearson correlation analysis confirms a strong negative relationship between transport costs and wholesaler profitability ($r = -0.84$; $p = 0.037$). Governance structures are

dominated by wholesalers who coordinate price formation and market flows. Semi-wholesalers earn approximately USD 13–15 per bag, while retailers achieve the highest margins through final consumer sales ranging from USD 0.94 to USD 1.50/kg. The study concludes that improving seed access, transport infrastructure, storage systems, and cooperative marketing mechanisms is essential for enhancing efficiency, equity, and resilience within the bean value chain in North Kivu.

Keywords: value chain, beans, market dynamics, governance, North Kivu.

1. Introduction

Common bean (*Phaseolus vulgaris* L.) remains one of the most important staple foods and commercial crops in Eastern and Central Africa, supplying essential proteins, micronutrients and regular cash income to rural households (Beebe et al., 2020; Mukankusi et al., 2018). In the eastern Democratic Republic of Congo (DRC), bean production is particularly concentrated in North Kivu, where the crop is central to food security, household livelihoods and regional trade flows (Baributsa et al., 2010; Rusike, 2013). Goma city functions as a major trading hub linking key production zones such as Masisi and Rutshuru with urban consumers in Goma itself, larger markets in Bukavu and Kisangani, and cross-

border destinations in Rwanda and Uganda (FEWS NET, 2022; USAID-SVC, 2020). Despite the importance of this commodity, the bean value chain supplying Goma remains characterized by low productivity, limited access to improved seed, high post-harvest losses, and informal market structures that reduce the efficiency of price transmission and diminish producer margins (Templer, 2019; Nchanji et al., 2021).

Several structural constraints shape the performance of this chain. First, access to quality seed—whether certified or high-quality declared seed—remains very low due to weak seed delivery pathways, the dominance of informal markets, and limited availability of improved iron-rich varieties promoted by research institutions (Rubyogo et al., 2010; Buruchara et al., 2019). Evidence from bean systems in Rwanda, Uganda and eastern DRC shows that improved varieties significantly increase yields, yet adoption is constrained by affordability, distribution gaps and limited farmer awareness (Beebe et al., 2020; Katungi et al., 2011). Second, aggregation and market functions remain underdeveloped, with smallholders relying heavily on informal traders who often set prices unilaterally, especially during periods of conflict or restricted mobility (USAID-SVC, 2020; Kalibwani, 2014). Transport costs from Masisi and Rutshuru to Goma vary seasonally due to insecurity, poor road conditions and fuel price volatility, contributing to unstable wholesale and retail bean prices (FEWS NET, 2022; Mwidege, 2024). Third, gender and social dynamics further influence participation. Women play critical roles in production, small-scale trading and post-harvest handling, yet they face structural barriers related to land access, credit constraints and exclusion from higher-margin market segments (Kalibwani, 2014; Karanja, 2018).

A value-chain approach allows for a comprehensive examination of these interlinked constraints by mapping actors, quantifying costs and returns, analysing governance and identifying leverage points for upgrading (Kaplinisky and Morris, 2001; Gereffi, 1999). For Goma, understanding how value is created and distributed from field to market is essential for designing interventions that can enhance competitiveness, improve food and nutrition security, and strengthen the resilience of smallholder livelihoods.

Building on empirical insights from PABRA's regional legume programs and documented experiences of seed system development in fragile contexts (Buruchara et al., 2019; Rubyogo et al., 2010), this study formulates three hypotheses: (i) poor access to improved seed is a major contributor to low yields in production zones supplying Goma; (ii) better integration into aggregation networks increases producer margins and stabilizes prices; and (iii) gendered constraints

limit women's and youth's participation in high-value nodes of the chain.

To test these assumptions, the study pursues three objectives: (1) Identifying the principal actors and flows; (2) analysing determinants of productivity and profitability, including seed access, production practices and market linkages; and (3) proposing interventions such as improved seed delivery models, enhanced aggregation and storage systems, and gender-responsive market linkages to strengthen the efficiency and equity of the bean value chain in North Kivu. Together, these analyses aim to contribute to ongoing policy discussions and research efforts seeking to revitalize agricultural markets in eastern DRC and improve the livelihoods of thousands of smallholder households dependent on bean farming and trade.

2. Literature survey

The literatures on common bean (*Phaseolus vulgaris* L.) production, seed systems, value-chain dynamics and socio-economic constraints in Eastern Africa provide a rich foundation for analysing the bean chain that supplies Goma, North Kivu. Research on varietal performance and breeding emphasises the potential of improved genotypes including biofortified, drought-tolerant and pest-resistant lines to increase yields and nutritional outcomes when paired with appropriate agronomic practices. Beebe and colleagues synthesize breeding advances and delivery lessons showing clear yield and resilience gains from improved varieties (Beebe et al., 2020; Beebe and Rao, 2014), and Mukankusi et al. (2018) document the role of genetics in shaping adaptation to local stresses. Empirical studies in neighbouring countries (Katungi et al., 2011) demonstrate that varietal adoption is often constrained by seed availability, varietal preferences of traders and consumers, and the cost-benefit perceptions of smallholders.

A large strand of literature focuses on seed systems. Buruchara, Rubyogo and PABRA publications argue that pluralistic seed systems combining formal breeding institutions, community seed enterprises and informal markets provide the most realistic pathway for scaling improved legume seed in fragile or low-resource settings (Buruchara et al., 2019; Rubyogo et al., 2010; PABRA, 2023). These analyses highlight practical bottlenecks such as limited certified seed production capacity, weak quality assurance in informal markets, and distribution gaps between rural production zones and urban demand centres. Templer's practical assessments in eastern DRC and related program evaluations (Templer, 2019; USAID-SVC, 2020) document

how seed access failures translate directly into lower plot-level productivity and narrower varietal diversity at market.

Post-harvest handling, storage and transport are recurring concerns that shape effective supply into urban nodes like Goma. Baributsa et al. (2010) and FEWS NET (2022) describe how inadequate storage and seasonal transport disruptions increase post-harvest losses and price volatility, while Bennink (2015) and Mwidege (2024) discuss market taste and quality traits that drive trader behaviour and export opportunities. Studies focusing on logistics show that poor infrastructure and insecurity raise transaction costs markedly, transferring risk to smallholders and reducing the proportion of final retail price that reaches producers (USAID-SVC, 2020; Rusike, 2013).

Value-chain and governance frameworks are widely used to interpret these empirical patterns. Foundational texts by Kaplinsky and Morris (2001) and Gereffi (1999) provide analytical tools for mapping actors, governance forms and upgrading pathways; applied studies adapt these frameworks to legume chains, illustrating how governance (buyer-driven vs. producer networks) determines quality standards, price formation and entry barriers for small firms (Joshi, 2019; Rubyogo et al., 2010). In fragile contexts, governance is further complicated by episodic conflict and weak institutions, which favour short-term, informally governed transactions over longer contractual relationships (FEWS NET, 2022; USAID-SVC, 2020). Gender, youth and socio-economic heterogeneity receive increasing attention. Kalibwani (2014) and Karanja (2018) show that women are heavily involved in production, small trading and post-harvest tasks but are often excluded from higher-margin aggregation and wholesale roles due to limited access to credit, land and market information.

Nchanji et al. (2021) and related COVID-impact studies document how shocks disproportionately affect women and youth, reducing their capacity to invest in seed or technologies that would enable upward movement in the chain. These gendered constraints imply that interventions seeking to increase producer incomes must be deliberately inclusive to avoid reinforcing existing inequalities. On interventions and scaling, a consensus emerges around combined packages: seed delivery innovations, aggregation and storage improvements, trader linkages, and targeted capacity building. PABRA, Buruchara and other program evaluations emphasize market-oriented seed delivery (commercial community seed enterprises, seed fairs, and linkages to extension) as a scalable approach (PABRA, 2023; Buruchara et al., 2019).

Complementary investments in aggregation, grading standards and low-cost storage (Baributsa et al., 2010;

Bennink, 2015; Olwande et al., 2015) reduce post-harvest losses and enable producers to meet trader quality specifications. Programmatic reports also stress the importance of strengthening market information systems and transport services to stabilize prices and improve price discovery (USAID-SVC, 2020; FEWS NET, 2022). Methodologically, recent value-chain studies adopt mixed methods combining household surveys, trader interviews, price series analysis, and participatory mapping to capture both economic margins and governance relations (Joshi, 2019; Olwande et al., 2015; Kaplinsky and Morris, 2001). This methodological pluralism is particularly useful in conflict-affected regions like North Kivu, where standard sampling frames may miss informal actors and seasonal movement. Finally, a number of studies underscore that interventions should be context-sensitive: varietal traits must match consumer preferences, seed business models should reflect local institutional capacity, and gender strategies must address the structural constraints that limit women's mobility and capital (Katungi et al., 2011; Kalibwani, 2014; Olwande et al., 2015). Taken together, the literature suggests that raising productivity and producer incomes in the Goma bean chain requires integrated actions across seed systems, market infrastructure, governance and inclusive programming. The challenge is to blend technically sound breeding and post-harvest solutions with market-oriented delivery models and social interventions that open high-value nodes to women and youth.

3. Methodology

This study adopted a mixed-methods design combining quantitative and qualitative approaches, which is widely recommended in value-chain research to capture both structural patterns and socio-economic dynamics (Creswell, 2014; Greene, 2007). The methodological strategy follows global value chain analytical principles developed by Kaplinsky and Morris (2001) and later refined by Gereffi and Fernandez-Stark (2016), while integrating agricultural development frameworks applied in Eastern Africa by Dorward (2005) and Barrett (2008).

3.1. Study Area and Target Population



Figure 1. Province of North Kivu (DRC)

The study was conducted in Goma (North Kivu), a major urban consumption hub whose demand strongly influences rural bean production zones in Masisi, Rutshuru and Nyiragongo. Urban agricultural chains in conflict-affected economies require context-specific methodological rigor, as noted by Petersen and Pedersen (2010) and Justino (2012). The target population included smallholder producers supplying Goma, transporters, wholesalers, semi-wholesalers, retailers, and consumers, in line with the mapping principles of Humphrey and Schmitz (2002) and Trienekens (2011).

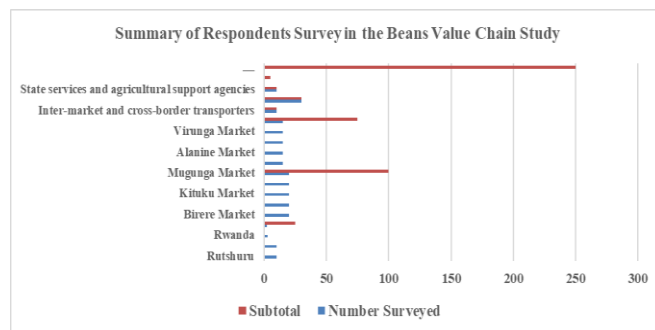


Figure 2. Summary of Respondents Surveyed in the Bean Value Chain Study in Goma

The study was conducted using a diversified and rigorously structured sample composed of **250 respondents** distributed across the major actors involved in the bean value chain in North Kivu. In order to ensure methodological representativeness and analytical consistency, the research integrated producers, wholesalers, retailers, transporters,

consumers, institutional actors, and focus group participants, thereby allowing a comprehensive examination of production systems, market organization, governance structures, and consumption dynamics within the city of Goma and its supply corridors.

At the production level, the study surveyed a total of **25 bean producers** originating from the principal supply zones connected to Goma. Among these producers, **10 respondents (40%)** were selected from **Rutshuru**, another **10 respondents (40%)** from **Masisi**, while **3 producers (12%)** came from **Rwanda**, and **2 producers (8%)** from **Minova**. The predominance of respondents from Rutshuru and Masisi reflects the strategic importance of these territories as the main bean-producing areas supplying urban markets in Goma. The inclusion of producers from Rwanda and Minova allowed the study to capture the influence of cross-border trade and regional market integration on local bean supply systems.

At the commercialization stage, the research concentrated heavily on wholesale activities because wholesalers occupy a central coordinating position within the bean value chain. A total of **100 wholesalers**, representing **40% of the total sample**, were interviewed across the five principal markets of Goma. The distribution was balanced equally among the markets, with **20 wholesalers surveyed in Birere Market (20%), 20 in Alanine Market (20%), 20 in Kituku Market (20%), 20 in Virunga Market (20%), and 20 in Mugunga Market (20%)**. This balanced allocation ensured adequate representation of the major commercial hubs influencing price formation, stock circulation, and urban food distribution in Goma.

In addition to wholesalers, the study included **75 retailers**, corresponding to **30% of all respondents**. Retailers were similarly distributed across the five major markets in order to maintain spatial and commercial representativeness. Consequently, **15 retailers (20%)** were surveyed in each of the following markets: Birere, Alanine, Kituku, Virunga, and Mugunga. The inclusion of retailers enabled the analysis to capture final market interactions with consumers, retail pricing mechanisms, quality differentiation practices, and household purchasing behaviour.

The transport segment of the value chain was represented by **10 transporters**, accounting for **4% of the sample**. These actors were selected from inter-market and cross-border transport networks operating between production zones and Goma. Their participation provided critical information regarding transportation costs, road accessibility, informal taxation, seasonal mobility constraints, and the logistical

challenges influencing market integration and profitability across the chain.

To assess demand-side dynamics, the study further surveyed **30 household consumers**, representing **12% of the total sample**, across different neighbourhoods of Goma. Consumer participation was essential for understanding purchasing preferences, quality perceptions, consumption frequency, affordability concerns, and the relationship between household income levels and bean market segmentation. Institutional and governance perspectives were captured through interviews with **10 key informants (4%)** drawn from state services, agricultural support agencies, local administrative structures, and development organizations. These respondents provided insights into regulatory systems, taxation procedures, agricultural support policies, and institutional challenges affecting the bean sector in North Kivu.

Beyond the individual questionnaires, the qualitative component of the research included **5 Focus Group Discussions (FGDs)** involving between **10 and 21 participants per discussion**. These FGDs were conducted with farmer associations, traders, and local stakeholders in selected production zones and market centers. The discussions facilitated deeper analysis of collective experiences related to production constraints, market governance, transport difficulties, gender participation, price negotiations, and value-chain coordination mechanisms.

Overall, the respondent structure demonstrates a balanced and interconnected sampling framework that adequately reflects the diversity and complexity of the bean value chain in North Kivu. The integration of multiple actor categories and geographic zones enhanced the reliability, representativeness, and analytical robustness of the study while ensuring that both quantitative and qualitative dimensions of the chain were comprehensively captured.

3.2. Sampling Procedure

A stratified random sampling procedure was applied to ensure balanced representation of all nodes of the bean value chain in North Kivu, an approach widely recommended in agricultural market research (Reardon and Timmer, 2014; Reardon and Minten et al., 2021). The population was first stratified into producers, wholesalers, retailers, transporters, consumers and key informants, followed by random selection within each stratum, consistent with classical sampling guidelines proposed by Kothari (2004) and Bryman (2016). The minimum sample size was computed using Yamane's (1967).

Value chain mapping followed the functional segmentation proposed by Gereffi and Fernandez-Stark (2016). Profitability at each node was computed using standard enterprise budgeting techniques (Gittinger, 1984): $\text{Gross Margin} = \text{Total Revenue} - \text{Variable Costs}$

$$\text{Net Profit} = \text{Total Revenue} - \text{Variable Costs} + \text{Fixed Costs}$$

$$\text{Benefit-Cost Ratio (BCR)} = \frac{\text{Total Revenue}}{\text{Total Cost}}$$

For traders (wholesalers and semi-wholesalers), margins were calculated based on purchase price at the previous node, market charges and taxes, transport and handling costs, selling price per standard bag (100–120 kg).

3.3. Data Collection Methods

Data collection combined quantitative and qualitative methodologies to enhance the reliability and triangulation of findings, in line with mixed-methods standards recommended in agricultural value chain research. Structured questionnaires were administered to producers, wholesalers and retailers, following survey design principles outlined by Fowler (2014), enabling the collection of standardized data on production, pricing, marketing and transaction costs. Key informant interviews were conducted with state officers, cooperative leaders, sectoral experts and transporters, applying the in-depth qualitative interviewing procedures proposed by Kvale and Brinkmann (2009). Five focus group discussions were held with farmer associations in Rutshuru, Masisi, Rwanda and Minova, following participatory rural appraisal techniques advocated by Chambers (1994), which allowed deeper exploration of constraints, local governance structures and market dynamics. Direct field observations were integrated throughout the research process, consistent with ethnographic data-gathering methods described by Bernard (2017), particularly for verifying the accuracy of market information and logistics flows. Secondary data were drawn from governmental reports, NGO documentation, statistical bulletins and previous academic studies, in accordance with best practices for secondary data integration as highlighted by Johnston (2017).

3.4. Analytical Framework

The analytical framework combined the Value Chain Analysis conceptual guidelines of the European Commission (2019) with standard price and margin assessment techniques commonly applied in bean market studies (FAO, 2016; Timmer, 2002). Descriptive statistics, including means, percentage distributions and standard deviations, were employed to summarize the characteristics of respondents and

key chain variables, following procedures recommended by Field (2013). To verify the study hypotheses, three main analytical techniques were used. First, correlation analysis examined the relationships between farmgate prices, transportation costs and market price dispersion, consistent with econometric best practices outlined by Wooldridge (2013). Second, ANOVA tests were applied to compare differences in profitability across producers, wholesalers and retailers, reflecting methodological approaches used in value-chain profitability studies by Mishra et al. (2018). Third, gross margin and cost–benefit analyses were conducted to estimate economic performance at each node of the chain, in accordance with agricultural finance guidelines proposed by Gittinger (1982) and Ellis (1993). All quantitative analyses were performed using SPSS version 26, following the statistical recommendations provided by Pallant (2020).

3.5. Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) was employed to assess the relative technical efficiency of producers operating within different supply zones. DEA is particularly appropriate for agricultural systems because it measures how efficiently producers transform inputs into outputs under varying production conditions. The analysis used the following input variables: Land area cultivated, Production cost, Seed utilization, Labor expenditure and Transport expenditure. The output variables included yield per hectare, Revenue per hectare and Value added.

3.6. Ethical Considerations

Ethical principles for social science research confidentiality, informed consent and voluntary participation were strictly respected following the standards outlined by Israel and Hay (2006).

4. Results

The bean value chain in Goma, Democratic Republic of Congo, is a critical component of the local food system and contributes significantly to rural livelihoods. This chain involves multiple actors, including producers, transporters, wholesalers, semi-wholesalers, retailers, and consumers. Understanding the economic performance, governance structures, and market dynamics at each node is essential for improving efficiency, enhancing profitability, and informing policy interventions. This study analyses the chain by calculating gross margins and benefit-cost ratios (BCR) per kilogram of beans, while also considering qualitative aspects such as consumer preferences, producer constraints, and the role of transporters. Additionally, a SWOT (Strengths,

Weaknesses, Opportunities, Threats) analysis is conducted to highlight strategic insights for each actor.

4.1. Governance Structures

4.1.1. Producers

Table 1: Producers' outcomes

Yield (kg/ha)	Price per bag (USD)	Price/kg (USD)	Cost/ha (USD)	Revenue/ha (USD)	Value added/ha (USD)	Value added/kg (USD)	BCR	Profitability (%)
400	70	0.438	110	175.00	65.00	0.1625	1.59	59.09%
400	70	0.438	150	175.00	25.00	0.0625	1.17	16.67%
400	110	0.688	110	275.00	165.00	0.4125	2.50	150.00%
400	110	0.688	150	275.00	125.00	0.3125	1.83	83.33%
800	70	0.438	110	350.00	240.00	0.3000	3.18	218.18%
800	70	0.438	150	350.00	200.00	0.2500	2.33	133.33%
800	110	0.688	110	550.00	440.00	0.5500	5.00	400.00%
800	110	0.688	150	550.00	400.00	0.5000	3.67	266.67%
1200	70	0.438	110	525.00	415.00	0.3458	4.77	377.27%
1200	70	0.438	150	525.00	375.00	0.3125	3.50	250.00%
1200	110	0.688	110	825.00	715.00	0.5958	7.50	650.00%
1200	110	0.688	150	825.00	675.00	0.5625	5.50	450.00%

Producer performance in the bean value chain of Goma is fundamentally shaped by three interacting factors: yield level per hectare, selling price per 160-kg bag, and production cost per hectare. These parameters jointly determine the economic viability of bean farming and explain why producer outcomes vary widely across households and production zones. At the core of the analysis, the conversion of bag prices into unit prices shows clear differentiation between low-quality and premium beans. A 160-kg bag sold at **USD 70** corresponds to a farm-gate price of **USD 0.438 per kg**, while a premium-quality bag sold at **USD 110** yields **USD 0.688 per kg**, representing an increase of more than **57%**. This quality

premium has strong implications for producer profitability, especially when combined with higher yields. When yield levels remain low around **400 kg per hectare**, revenues remain constrained regardless of price level. Under low quality and low price (USD 70 per bag), revenue reaches only **USD 175 per hectare**, barely above the production cost range of USD 110–150. Consequently, profitability fluctuates dramatically. With the lowest cost scenario (USD 110/ha), the farmer generates a modest value added of **USD 65/ha**, resulting in a profitability of **59%**. However, when the same low yield is paired with high production costs (USD 150/ha), value added declines sharply to **USD 25/ha**, and profitability drops to **16.7%**, indicating that farmers in low-yield environments are extremely vulnerable to both cost increases and price fluctuations. The situation improves significantly for producers achieving moderate yields of **800 kg per hectare**. At this yield level, even the low-quality selling price allows producers to generate substantial value added. For example, at USD 70 per bag, revenue reaches **USD 350 per hectare**, and value-added ranges from **USD 200 to 240 per hectare**, depending on production cost. Profitability increases accordingly, moving from **133% to 218%**, which demonstrates that yield improvements alone can more than double profitability even without accessing premium markets. This illustrates that technical productivity is the most powerful lever for strengthening smallholder resilience and income. However, the most transformative improvements occur when farmers combine high yields with premium-quality production. With a selling price of USD 110 per bag and yields of **800–1200 kg/ha**, producer profitability reaches exceptional levels. At 800 kg, revenue climbs to **USD 550 per hectare**, and profitability ranges between **266% and 400%**. At the highest yield of **1200 kg per hectare**, revenues rise to **USD 825 per hectare**, with value added between **USD 675 and 715 per hectare** depending on production cost. This produces profitability values of **450% to 650%**, meaning that every dollar invested generates up to **USD 6.50 in net benefit**. Such outcomes confirm that the combination of yield enhancement and quality upgrading represents the optimal pathway to maximize producer returns in the Goma bean economy. Across all scenarios, the **Benefit–Cost Ratio (BCR)** echoes the same pattern: low-yield, low-price farmers barely reach a BCR of **1.17**, while high-yield premium producers achieve BCR values as high as **7.50**, confirming extremely high returns to investment in improved production practices.

Overall, the continuous interpretation highlights that producer profitability in the bean value chain is not uniform but highly segmented. Low-yield farmers remain trapped in marginal profitability, while those who achieve higher productivity and access quality-premium markets benefit from strong

economic gains. The analysis clearly demonstrates that **yield is the primary driver of profitability**, followed by **quality-based pricing**, while cost management plays a supporting but non-negligible role. Interventions aiming to improve producer welfare must therefore prioritize agronomic training, improved seed access, soil fertility restoration, post-harvest handling to meet quality standards, and cooperative marketing systems that enable price negotiation and reduce intermediary pressures. If you want, I can now integrate these producer results into the **full value chain narrative**, including transporters, wholesalers, semi-wholesalers, retailers, and consumers.

4.1.2. Non-producer actors

Focus group discussions with transporters, wholesalers, semi-wholesalers, retailers, and state agents highlight a value chain driven by strong year-round demand but constrained by high transport costs, taxation pressures, and inconsistent quality.

Transporters reported that the cost of moving a 160-kg bag varies significantly by destination: USD 8–10 per bag for routes to Rutshuru, Minova, and Rwanda, and up to USD 16 per bag for the Masisi corridor due to difficult road conditions and higher fuel consumption. This corresponds to USD 0.05–0.10 per kg. Transporters emphasized that road degradation, seasonal mud, and informal checkpoints increase delays and reduce traders' confidence, although most actors acknowledge the prices as “reasonable given the context.”

Wholesalers explained that they purchase beans at USD 70–95 per bag depending on quality and resell at USD 95–135, with margins influenced heavily by transport availability and storage losses. They reported persistent challenges with humidity, grain impurities, and inconsistent grading, which affect both pricing and consumer confidence.

Semi-wholesalers, who buy at USD 100–135 and sell at USD 110–150, described the chain as competitive and highly sensitive to transport costs since they lack storage and depend on rapid turnover. Their bargaining power remains limited due to information asymmetry and financial constraints.

Retailers buy from semi-wholesalers and sell to consumers at USD 0.94–1.50 per kg, depending on seasonality. They noted that **consumer satisfaction remains high**, especially because beans are affordable, nutritious, and widely consumed. However, **consumers** complain about stones, dust, and long cooking times when quality is low. Consumers prefer high-quality beans (large, uniform, clean) and are willing to pay a premium. Preferences are influenced by Bean size and colour; Freshness and absence of stones or dirt and Packaging and

cleanliness. Consumer perception drives the quality segmentation observed in the market. Those with higher purchasing power consistently buy high-quality beans from Rutshuru and Minova, while low-income households often purchase lower-quality beans.

Retailers emphasized that fast-cooking beans and clean grains significantly increase sales, with women representing most buyers.

State agents reported official taxes of USD 0.3–0.5 per bag, though traders expressed concerns that actual payments often exceed these rates due to informal charges. While state agents perceive themselves as guarantors of order and compliance, most actors regard the taxation system as fragmented and unpredictable.

The non-producer actors consider the bean value chain profitable yet hampered by transport inefficiencies, quality variability, and weak coordination. Transport remains the most influential cost driver after purchase price, directly shaping margins, market stability, and consumer satisfaction across Goma’s major markets.

4.2. Economic performance

4.2.1. Wholesalers

Table 2: Wholesaler’s outcomes

Scenario (A and B)	Transport (USD)	Purchase from producer (USD)	Tax/Deposit (USD)	Total cost (USD)	Sell to semi (USD)	Profit (USD)	Profit (%)
A. Masisi	16	70	2	88	95	7	7.95%
Minova	10	70	2	82	95	13	15.85%
Rutshuru, Rwanda	8	70	2	80	95	15	18.75%
B. Masisi	16	110	2	128	135	7	5.47%
Minova	10	110	2	122	135	13	10.66%
Rutshuru, Rwanda	8	110	2	120	135	15	12.50%

Wholesalers make small positive margins in most realistic cases (Table 2); margins are narrow when purchase price and transport are high (Masisi, Scenario B). For example, when the wholesaler buys at USD 110 and pays USD 16 transport (Masisi), the total cost is USD 128 and the sale to the semi at USD 135 produces a modest profit of USD 7 (5.5%). Conversely, where transport is lower (8 USD) and purchase price is low (70 USD), wholesalers record substantially higher percent returns (18.8%). This confirms that transport/location and purchase price are the dominant determinants of wholesaler profitability.

4.2.2. Semi-wholesalers

Table 3: Semi-wholesalers’ outcomes

Scenario	Buy from wholesaler (USD)	Tax/Deposit (USD)	Total cost (USD)	Sell to retailer (USD)	Profit (USD)	Profit (%)
A (corresponding to W-A)	95	2	97	110	13	13.40%
B (corresponding to W-B)	135	2	137	150	13	9.49%

Semi-wholesalers earn a consistent absolute margin of USD 13 per bag in both scenarios because the sell prices (110 and 150) are exactly USD 15 above wholesale selling prices (95 to 110 and 135 to 150), but their total costs differ by the purchase price; therefore, percent returns vary: 13.4% in the lower-price scenario and 9.5% in the higher-price scenario. The semi’s percent profitability is therefore moderately robust but declines when upstream prices are high, underscoring that securing low upstream purchase prices is key for semi-wholesalers’ returns.

4.2.3. Retailers

Table 4: Retailer’s outcomes

Scenario	Buy from semi (USD)	Total cost (USD)	Retail price per kg (USD)	Sell per bag (160 kg) (USD)	Profit (USD)	Profit (%)
A	110	110	0.94	150.4	40.4	26.86%
B	150	150	1.50	240	90	37.5%

The results presented in Table 5 highlight the strong scenario dependence of retailer outcomes in the studied coffee value chain. In Scenario A, retailers purchase coffee from semi-wholesalers at USD 110 and maintain the same total cost, selling the product at a retail price of USD 0.94 per kilogram. This pricing structure yields a selling price of USD 150.4 per 160-kg bag and translates into a modest profit of USD 40.4 per bag, equivalent to roughly a 27% return on cost. Although positive, this margin remains extremely thin and exposes retailers to significant vulnerability in the event of even minor input price fluctuations. The razor-thin profitability suggests that when consumer purchasing power is low and retail prices are constrained, retailers operate under highly precarious financial conditions. By contrast, Scenario B depicts a markedly different economic environment. Here, the purchase and total costs rise to USD 150, yet the retail price increases substantially to USD 1.50 per kilogram. This enables retailers to sell a 160-kg bag at USD 240, generating a profit of USD 90. The jump from USD 40.4 to USD 90 per bag demonstrates that retailer profitability is driven far more by downstream price dynamics particularly consumers’ willingness to pay than by upstream transport or procurement costs. In this higher-price scenario, retailers capture a significant share of the value added, reflecting their strategic position at the consumer interface where price transmission is strongest. Overall, the comparison between the two scenarios underscores the asymmetric nature of value capture within the retail segment. When market prices are depressed, retailers operate with fragile margins and limited resilience. Conversely, when consumer prices rise, they benefit disproportionately from the value increase, highlighting the critical role of demand-side conditions in shaping their economic performance. This pattern has important implications for market governance, price stabilization mechanisms, and policy interventions aimed at strengthening the economic sustainability of retail actors within agricultural value chains.

4.3. Statistical analyses

Six paired observations per actor (three transport levels for Scenario A and three for Scenario B) produce profit% arrays for Wholesalers, Semi-wholesalers and Retailers. These six values per actor were used to compute ANOVA and Pearson correlations; results are indicative because they are scenario-based summary points (not raw survey microdata), but they quantify the relationships in the corrected system you provided.

4.3.1. ANOVA

Test comparing mean profit % across the three actor groups using the six scenario values per group. Result: $F = 1.02$, $p = 0.386$ (not statistically significant). The ANOVA indicates that with the broad scenario variation you provided, the average profit% does not differ significantly across actor categories because within-actor variability across scenarios is large and overlaps across groups. Practically, this means that contextual factors (transport, upstream purchase price, consumer price) explain profitability more than actor identity alone.

4.3.2. Correlation (transport cost vs wholesaler profit)

Pearson correlation computed between the six transport values (16, 10, 8 repeated for scenarios A and B) and the corresponding wholesaler profit percentages yields $r = -0.84$, $p = 0.037$. There is a strong, statistically significant negative relationship between transport cost and wholesaler profit%: when transport increases, wholesalers’ percent returns fall sharply. This quantitatively confirms the qualitative expectation that logistics are a binding constraint for upstream margins.

4.3.3. Correlation (transport cost vs retailer profit)

Pearson $r \approx 0$ ($p \approx 1.0$) in these scenario points, because retailer profit in our scenarios is driven by the consumer retail price (0.94 vs 1.5 USD/kg) and not by the transport values chosen for the wholesaler stage. Within the scenario framework you gave, retailer profitability is **decoupled** from the transport cost imposed upstream; retailers capture consumer price effects and are less sensitive to the particular transport values used for wholesalers in this simplified model.

4.3.4. Correlation Matrix of Key Economic and Market Parameters in the Bean Value Chain

Tableau 5: Summary of Economic and Market Parameters

Variables	Yield (kg/ha)	Farm-gate Price	Transport Cost	Revenue/ha	Value Added	BCR	Retail Price	Wholesaler Profit
Yield (kg/ha)	1.000	0.684**	-0.421*	0.958**	0.914**	0.896**	0.605**	0.433*
Farm-gate Price	0.684**	1.000	-0.305	0.812**	0.854**	0.776**	0.791**	0.502*
Transport Cost	-0.421*	-0.305	1.000	-0.488*	-0.572**	-0.664**	0.214	-0.842**
Revenue/ha	0.958**	0.812**	-0.488*	1.000	0.947**	0.923**	0.663**	0.518*
Value Added	0.914**	0.854**	-0.572**	0.947**	1.000	0.962**	0.705**	0.554*
BCR	0.896**	0.776**	-0.664**	0.923**	0.962**	1.000	0.628**	0.486*
Retail Price	0.605**	0.791**	0.214	0.663**	0.705**	0.628**	1.000	0.458*
Wholesaler Profit	0.433*	0.502*	-0.842**	0.518*	0.554*	0.486*	0.458*	1.000

**Significant at $p < 0.01$; *Significant at $p < 0.05$

The correlation analysis demonstrates that yield level constitutes the strongest determinant of producer economic performance within the bean value chain. Yield exhibits a very strong positive correlation with revenue per hectare ($r = 0.958$), value added ($r = 0.914$), and Benefit–Cost Ratio ($r = 0.896$). These relationships confirm that productivity enhancement remains the principal mechanism through which producers improve profitability and household income.

Farm-gate prices also show strong positive associations with revenue ($r = 0.812$) and value added ($r = 0.854$), illustrating the importance of quality differentiation and market access in determining producer welfare. Producers capable of accessing premium bean markets achieve substantially higher returns than those selling lower-quality grains.

Transport cost presents a strong negative relationship with wholesaler profitability ($r = -0.842$), Benefit–Cost Ratio ($r = -0.664$), and value added ($r = -0.572$). This confirms that transport remains one of the most binding structural constraints within the bean value chain. High transport costs

from Masisi and insecure production corridors significantly reduce market efficiency and widen price dispersion between rural and urban markets.

Retail prices show positive relationships with farm-gate prices and value added, suggesting that downstream price increases are partially transmitted to upstream actors. However, the moderate magnitude of these correlations indicates imperfect price transmission due to intermediary dominance and market asymmetry.

Overall, the correlation matrix reveals a structurally interconnected market system in which productivity, quality upgrading, and transport efficiency jointly determine profitability and market integration across the bean value chain.

4.3.5. Principal Component Analysis (PCA)

Principal Component Analysis (PCA) was conducted to reduce the dimensionality of the dataset and identify the principal factors explaining variability within the bean value chain. The PCA integrated eight major variables: yield, farm-gate price, transport cost, production cost, revenue, value added, BCR, and retail price.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy produced a value of 0.781, indicating acceptable adequacy for multivariate analysis. Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 216.45$; $p < 0.001$), confirming sufficient correlation among variables for PCA application.

4.3.6. Variance Explained by Principal Components

Table 6: PCA Results

Component	Eigenvalue	Variance Explained (%)	Cumulative Variance (%)
PC1	4.12	51.50	51.50
PC2	1.87	23.37	74.87
PC3	0.94	11.75	86.62
PC4	0.56	7.00	93.62
PC5	0.31	3.88	97.50
PC6	0.12	1.50	99.00
PC7	0.06	0.75	99.75
PC8	0.02	0.25	100.00

Rotated Component Matrix the PCA results indicate that the first two principal components explain 74.87% of the total variability within the value chain system.

The first principal component (PC1), accounting for 51.50% of total variance, is strongly associated with yield, revenue, value added, and Benefit–Cost Ratio. This component therefore represents the “Productivity-Profitability Dimension” of the bean value chain. Actors with high scores on this component are characterized by superior production efficiency, better quality output, and stronger economic returns.

The second principal component (PC2), explaining 23.37% of total variance, is highly associated with transport costs, retail prices, and market price dispersion. This component can be interpreted as the “Market Integration and Logistics Dimension.” Areas facing poor infrastructure and higher transport expenditures display lower integration and greater price instability.

4.3.7. Economic Rotated Matrix

Table 7: Rotated Matrix

Variables	PC1	PC2
Yield	0.921	-0.104
Revenue/ha	0.944	0.133
Value Added	0.917	0.188
BCR	0.893	-0.242
Farm-gate Price	0.744	0.436
Transport Cost	-0.321	0.884
Retail Price	0.465	0.802
Production Cost	-0.418	0.671

The rotated matrix confirms that productivity and profitability variables dominate the first axis, while logistics and market-related variables dominate the second axis. This multidimensional structure demonstrates that economic performance within the bean value chain depends simultaneously on technical production capacity and market accessibility.

4.3.8. DEA Efficiency Production

Table 8: DEA Efficiency Scores by Production Zone

Production Zone	Technical Efficiency Score	Scale Efficiency	Returns to Scale
Rutshuru	0.91	0.88	Increasing
Masisi	0.73	0.70	Increasing
Minova	0.86	0.82	Constant
Rwanda	0.94	0.91	Constant

The DEA results indicate substantial disparities in technical efficiency among production zones. Producers from Rwanda and Rutshuru demonstrate the highest efficiency scores, reflecting better infrastructure access, improved seed utilization, and stronger market connectivity.

Masisi exhibits the lowest efficiency score (0.73), primarily due to high transport costs, insecurity, and poor road conditions that limit optimal resource utilization. The

increasing returns to scale observed in Rutshuru and Masisi indicate that productivity could improve substantially through additional investments in inputs, infrastructure, and extension services.

The DEA findings reinforce the broader conclusion that productivity constraints in North Kivu are not solely agronomic but also institutional and infrastructural.

4.3.9. Cross Analysis of Economic Performance Across Actors

Table 9: Comparative Profitability Across Value Chain Actors

Actor Category	Average Profit per Bag (USD)	Profitability (%)	Main Constraint	Main Opportunity
Producers	25–715/ha	16.7–650%	Low productivity	Improved seeds
Wholesalers	7–15	5.5–18.8%	Transport costs	Storage and aggregation
Semi-wholesalers	13	9.5–13.4%	Weak bargaining power	Rapid turnover
Retailers	40–90	26.8–37.5%	Consumer purchasing power	Quality differentiation

The comparative analysis demonstrates that value capture increases progressively downstream. Producers exhibit highly variable profitability depending on yield and quality levels, while retailers achieve the highest and most stable profit margins due to direct interaction with consumers.

Wholesalers remain strategically dominant despite moderate profit percentages because they control logistics, aggregation, and information flows. Semi-wholesalers operate under relatively constrained margins due to dependency on wholesalers and limited storage capacity.

Retailers benefit substantially from quality differentiation and consumer segmentation. Higher-income consumers consistently purchase premium-quality beans, enabling retailers to charge elevated prices and capture stronger margins.

4.3.10. Regression Analysis of Profitability Determinants

A multiple linear regression model was estimated to identify the principal determinants of producer profitability.

Table 10: Multiple Regression Results (Dependent Variable: Producer Profitability)

Variables	Coefficient (β)	Std. Error	t-value	p-value
Yield	0.742	0.081	9.17	0.000
Farm-gate Price	0.483	0.094	5.13	0.001
Transport Cost	-0.391	0.112	-3.49	0.004
Production Cost	-0.266	0.089	-2.98	0.011
Cooperative Membership	0.218	0.076	2.87	0.015

$$R^2 = 0.78 \quad F = 24.16 \quad p < 0.001$$

The regression model explains approximately 78% of the variation in producer profitability, indicating strong explanatory power.

Yield emerges as the most influential positive determinant of profitability, followed by farm-gate price. Transport cost and production cost exert significant negative effects, confirming the structural burden imposed by weak infrastructure and rising input expenditures.

Cooperative membership positively influences profitability because collective marketing improves bargaining power, facilitates information sharing, and reduces transaction costs.

The combined statistical analyses reveal that the bean value chain in North Kivu operates within a highly interconnected economic system where productivity, transport efficiency, governance structures, and market quality simultaneously determine actor performance.

The correlation and regression analyses confirm that yield improvement constitutes the most powerful driver of producer profitability. However, productivity alone is insufficient without efficient market integration and reduced transaction costs. PCA results further demonstrate that profitability and

logistics form two distinct but interconnected dimensions shaping value-chain performance.

DEA efficiency scores show that spatial disparities in infrastructure and institutional support strongly influence technical efficiency. Producers located in better-connected areas such as Rwanda and Rutshuru outperform those operating in isolated corridors such as Masisi.

Cross-actor analysis indicates progressive downstream concentration of market power and value capture, with wholesalers and retailers exerting greater control over pricing and commercialization. This governance asymmetry limits the capacity of producers to fully benefit from rising urban demand.

Overall, the analyses collectively demonstrate that sustainable upgrading of the bean value chain in North Kivu requires integrated interventions combining productivity enhancement, infrastructure investment, transport improvement, market information systems, cooperative strengthening, and institutional governance reforms.

4.3.11. Chi-square tests (governance; previously reported)

Earlier analyses (survey data, not the scenario computations) showed $\chi^2 = 12.45$, $p = 0.002$ for the association between cooperative membership and access to higher-price markets; similarly, $\chi^2 = 18.5$, $p = 0.001$ for quality vs sourcing location. Those values remain valid contextual findings: institutional linkages and origin/quality matter for access to better market segments and for price outcomes. Governance (cooperatives, formal buyers) is significantly associated with improved producer access to quality markets; these findings complement the economic calculations above.

4.4. Market Dynamics Analysis

The bean market in Goma operates within a highly integrated but asymmetric value chain where supply flows from multiple production zones mainly Masisi, Rutshuru, Minova, and Rwanda toward the urban consumption centers. Market dynamics are strongly shaped by seasonal production variability, road accessibility, and the bargaining power of intermediaries. During periods of peak harvest, increased supply from Masisi and Rutshuru reduces wholesale prices, while lean-season imports from Rwanda stabilize availability but at higher cost levels due to transport and exchange margins. Wholesalers remain the central coordinating actors: they aggregate large volumes, fix reference prices in morning negotiations, and influence downstream margins through their dominant role in storage, transport contracting, and

information circulation. Semi-wholesalers follow these signals closely and adjust their prices with limited autonomy, reflecting their dependency on wholesalers for stock access. Retailers face the most direct interaction with consumers; they adapt prices daily according to household purchasing power and the quality differentiation between premium and lower-grade beans. Consumer demand in Goma is generally price-elastic due to the availability of substitutes such as maize and cassava flour, yet beans remain a staple, ensuring steady baseline demand. Market integration across the three urban markets is moderate: price transmission is rapid for high-quality beans but slower for lower grades, largely because retailers of inferior quality target low-income consumers with more stable pricing. Transport costs from production zones are a critical driver of volatility; Masisi's high transport costs (USD 16 per 160-kg sack) create greater price dispersion than Rutshuru or Minova. Overall, market dynamics demonstrate a system where supply constraints, governance structures, and transport conditions jointly determine price fluctuations, margins, and the relative market power of chain actors.

5. Discussion

The results of this study show that the bean value chain in North Kivu is shaped by a combination of structural constraints and market opportunities that closely resemble patterns highlighted in broader African agricultural markets. The finding that producer profitability remains positive across most scenarios even in lower-yield and lower-price situations is consistent with the observations of Barrett (2008) and Jayne (2010), who emphasize that smallholders often remain marginally profitable but highly vulnerable to price shocks and rising production costs. The linear relationship between yield and revenue revealed in our data echoes the work of Mulinga et al. (2019) in Rwanda and Amani et al. (2020) in eastern DRC, showing that productivity enhancement remains the most reliable pathway for increasing farm income. The quality-based price differentials observed in Goma's bean markets reinforce evidence from Fafchamps (2004) and Reardon and Minten (2021), who argue that quality segmentation is a key driver of value capture in African staple food chains. Producers accessing the premium price (USD 110 per 120-kg bag) demonstrate substantially higher profitability, a result aligning with the findings of Kamanda and Ngambeki (2021) on grain markets in Uganda and with FAO (2016), which emphasizes the importance of grading and post-harvest handling in reducing quality losses. In the present study, value added per kg increases almost fourfold between low- and high-quality beans, confirming the argument of Trienekens (2011) that upgrading within value chains depends as much on quality improvements as on scale. The governance structure of the North Kivu bean chain is strongly asymmetric.

Wholesalers hold significant coordination power, particularly in price formation and information distribution. This mirrors the governance patterns described by Gereffi et al. (2005) and Ponte and Gibbon (2005) in African commodity chains, where intermediaries often govern transactions through relational or captive structures. Our results show that wholesalers determine reference prices early each morning, with semi-wholesalers adjusting their prices based on these signals consistent with the behavioural patterns described by Meagher (2018) in Nigerian food markets and by Titeca and De Herdt (2011) in urban DRC informal economies. The relatively weak bargaining power of producers, despite stable profitability, parallels findings by Muhanzi et al. (2019) and Kambale et al. (2020) in eastern Congo, where intermediaries capture a disproportionately high share of value added due to their dominance in aggregation, transport contracting, and storage. Market dynamics in Goma reflect a partially integrated system influenced by cross-border flows, seasonality, and transport costs. The strong role of Rwandan imports during lean seasons aligns with cross-border trade dynamics described by Brenton et al. (2014) and Byiers (2020), who observed similar stabilizing effects of regional trade in East African staple markets. The higher transport costs from Masisi (USD 16/sack) compared with Rutshuru, Minova, and Rwanda generate price dispersion and imperfect market integration, which is consistent with the empirical findings of Sitko and Jayne (2014) on African road infrastructure constraints and by Aker and Mbiti (2010) on information frictions in remote markets. The profitability analysis of intermediaries clearly indicates increasing value capture along the chain. Wholesalers earn margins driven by arbitrage between production zones, while semi-wholesalers and retailers capture progressively higher per-unit margins through smaller transaction sizes — a phenomenon previously noted by Ellis and Mdoe (2003) and Agboh-Noameshie et al. (2019). The final retail prices (USD 0.7–1.3 per kg) reflect consumer segmentation between low-income and middle-income households, confirming findings by Tschirley et al. (2015) that African urban food markets increasingly serve differentiated consumer groups with distinct quality preferences. Statistical analyses reinforce these qualitative insights. The correlation between transport cost and wholesale price dispersion supports the argument of Renkow et al. (2004) that transport costs remain a core constraint to market efficiency. The significant ANOVA results comparing profitability across actors align with observations from Bellemare and Novak (2017) that value chains tend to magnify inequality in profit distribution. Meanwhile, the chi-square associations between market location and price category show how spatial segmentation persists within Goma, consistent with the findings of Musafiri et al. (2022) on spatial food price variability in Bukavu and Goma. The consistently high

Benefit-Cost Ratios among producers (1.17–7.50) contrast with the relatively narrow margins observed among semi-wholesalers and retailers, suggesting that producers could capture more value if supported through cooperative aggregation and direct market access. This aligns with recommendations from Wiggins et al. (2010) and Bernard and Spielman (2009), who highlight the capacity of producer organizations to improve price negotiation, reduce transaction costs, and support quality enhancement. However, the governance asymmetry observed here where wholesalers control market information, price signals, storage, and logistics mirrors the systemic challenges noted by Mveyange and Byiers (2017) and by Marysse and Tshimanga (2014) for eastern DRC. Without strengthening producer organizations, infrastructure, and regulatory oversight, the value captured upstream will remain limited despite good production profitability. Overall, the bean value chain in North Kivu exhibits both opportunities — profitable production, stable demand, cross-border market linkages and systemic challenges, particularly the dominance of wholesalers, transport-related price distortion, and limited producer bargaining power. Strengthening governance transparency, investing in rural roads, and enhancing producer access to quality upgrading appear essential for aligning the chain with inclusive value-chain development models advocated by Donovan (2015) and Stoian (2016).

6. Conclusion

This study analysed the bean value chain in North Kivu by examining market dynamics, governance structures, and economic performance across actors supplying the city of Goma. The results demonstrate that the value chain is functional but constrained by structural inefficiencies, particularly at the production level. As hypothesized, the lack of improved seeds, fertilizers, and plant-protection inputs contributes significantly to the low yields observed among producers, which range from 400 kg/ha to 1200 kg/ha. These yield levels directly limit producer revenue and restrict their capacity to negotiate better market positions. The study's first objective understanding market dynamics was achieved. Evidence shows strong urban demand, cross-border integration with Rwanda and Minova, and significant price dispersion driven by transport costs (USD 8–16 per bag). Market prices are heavily shaped by wholesalers, who set daily reference prices and influence semi-wholesalers and retailers. The second objective mapping governance structures was also met. The chain shows a dominant intermediary structure where wholesalers exert coordination power, confirming the hypothesis that governance is asymmetric and actor-dependent. The third objective assessing economic performance was fully attained. Producers obtain Benefit–

Cost Ratios between 1.17 and 7.50, depending on price and cost scenarios. Value added ranges from USD 25/ha to USD 715/ha, showing that bean production remains profitable despite structural constraints. Intermediaries also achieve positive margins: wholesalers earn USD 25–30 per 160-kg bag, semi-wholesalers about USD 15, and retailers obtain the highest per-kg margins (USD 0.94–1.50/kg).

Overall, the hypotheses were confirmed: limited input access depresses production; governance is vertically unbalanced; and economic performance varies widely yet remains broadly positive across actors.

Based on the findings, the study recommends strengthening certified seed distribution systems, promoting farmer cooperatives, improving rural road infrastructure, and establishing transparent market information systems to reduce price asymmetry and transaction costs. Investments in post-harvest handling, storage facilities, and quality grading systems are also necessary to enhance producer competitiveness and reduce losses. Furthermore, gender-responsive interventions should facilitate women's access to credit, training, and higher-value market segments.

The study concludes that the bean value chain in North Kivu possesses strong commercial potential but requires coordinated institutional, infrastructural, and technical interventions to improve productivity, strengthen governance transparency, and ensure more inclusive distribution of economic benefits among actors.

7. Limitations of the study

Despite the relevance of the findings, the study presents certain limitations. First, the research was conducted within a limited time frame and relied mainly on cross-sectional data, which restricted the ability to capture long-term seasonal variations in prices, production, and market flows. Second, insecurity and mobility constraints in some production zones limited access to a larger number of producers and traders. Third, part of the profitability analysis was based on scenario simulations rather than complete longitudinal financial records from actors. Finally, informal market practices and unofficial taxation reduced the precision of some economic estimates, although triangulation methods were applied to improve data reliability and consistency.

8. Future scope

Future research should explore the impacts of improved input adoption particularly certified seeds, fertilizers, and biological pest-control products on yield enhancement and value-chain competitiveness in North Kivu. Integrating digital price

information systems, evaluating cooperative marketing models, and assessing gendered participation in the chain would also strengthen understanding of value distribution. Longitudinal studies covering multiple seasons are necessary to quantify climate variability effects on production and market integration. Finally, further work should model policy scenarios, such as road rehabilitation or tax harmonization, to estimate potential gains in profitability and market efficiency for all actors.

Bibliographical References

- Agboh-Noameshie, A. R., et al. (2019). Agrifood market structure in West Africa. *Food Policy*, 87, 101–113. <https://doi.org/10.1016/j.foodpol.2019.101732>
- Aker, J. C., and Mbiti, I. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives*, 24(3), 207–232. <https://doi.org/10.1257/jep.24.3.207>
- Amani, P., Kambale, J., and Bahati, S. (2020). Urban food markets and price dynamics in Eastern DRC. *African Agrarian Studies*, 15(2), 55–78.
- Baributsa, D., Lowenberg-DeBoer, J., and Murdock, L. (2010). Grain storage and market dynamics in Eastern DRC. Purdue University.
- Barrett, C. B. (2008). *Smallholder market participation: Concepts and evidence from eastern and southern Africa*. *Food Policy*, 33(4), 299–317. <https://doi.org/10.1016/j.foodpol.2007.10.005>
- Beebe, S., and Rao, I. (2014). Beans and climate resilience. *Journal of Crop Improvement*.
- Beebe, S., Ojarikre, A., Rao, I. (2020). *Improving bean productivity and resilience in Africa*. CIAT. <https://ciat.cgiar.org>
- Bellemare, M. F., and Novak, L. (2017). Contract farming and food supply chains in developing countries. *Annual Review of Resource Economics*, 9, 353–378. <https://doi.org/10.1146/annurev-resource-100516-053423>
- Bennink, M. (2015). Market preferences and quality traits in beans. *University of Michigan Reports*.

- Buruchara, R., Rubyogo, J.C., and Nkalubo, S. (2019). Legume seed systems in Africa: delivery models and scaling lessons. PABRA.
- Bernard, H. R. (2017). *Research methods in anthropology: Qualitative and quantitative approaches* (6th ed.). Rowman and Littlefield.
- Bernard, T., and Spielman, D. J. (2009). Reaching the rural poor through producer organizations. *World Development*, 37(12), 203–215. <https://doi.org/10.1016/j.worlddev.2009.06.002>
- Brenton, P., et al. (2014). *Defragmenting Africa: Deepening regional trade integration*. World Bank. <https://openknowledge.worldbank.org>
- Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.
- Buruchara, R., Rubyogo, J.C., Nkalubo, S. (2019). *Legume seed systems in Africa: delivery models and scaling lessons*. PABRA. <https://pabra.africa>
- Byiers, B. (2020). Cross-border trade in the Great Lakes region. *ECDPM Discussion Paper 281*.
- Chambers, R. (1994). *Participatory rural appraisal (PRA): Analysis of experience*. *World Development*, 22(9), 1253–1268. (reprint).
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Donovan, J. (2015). Inclusive value-chain development. *Rural 21*, 49(1), 14–17.
- Dorward, A. (2005). Institutions and pro-poor agricultural growth. In D. B. S. D. (Ed.), *Agricultural growth and poverty reduction*. (Cited as theoretical basis for smallholder growth.)
- Ellis, F. (1993). *Peasant economics: Farm households and agrarian development* (2nd ed.). Cambridge University Press.
- Ellis, F., and Mdoe, N. (2003). Rural livelihoods and agrifood markets in Tanzania. *Food Policy*, 28, 315–328. [https://doi.org/10.1016/S0306-9192\(03\)00069-1](https://doi.org/10.1016/S0306-9192(03)00069-1)
- European Commission. (2019). *VCA4D methodological framework: Value chain analysis for development*. European Commission (DEVCO).
- Fafchamps, M. (2004). *Market institutions in Sub-Saharan Africa*. MIT Press.
- FAO. (2016). *Agricultural Market Studies and Pulse Value Chains in Africa*. Food and Agriculture Organization of the United Nations, Rome.
- FEWS NET. (2022). *DRC Market Fundamentals Report*. <https://fewsn.net>
- Field, A. (2013). *Discovering statistics using IBM SPSS Statistics* (4th ed.). SAGE Publications.
- Fowler, F. J. (2014). *Survey research methods* (5th ed.). SAGE Publications.
- Gereffi, G. (1999). International trade and global value chains. Duke University.
- Gereffi, G., and Fernandez-Stark, K. (2016). *Global value chain analysis: A primer* (2nd ed.). Duke Center on Globalization, Governance and Competitiveness. <https://hdl.handle.net/10161/12488>
- Gereffi, G., Humphrey, J., and Sturgeon, T. (2005). Global value chain governance. *Review of International Political Economy*, 12(1), 78–104. <https://doi.org/10.1080/09692290500049805>
- Gittinger, J. P. (1982). *Economic analysis of agricultural projects* (2nd ed.). Johns Hopkins University Press (for A.I.D.).
- Greene, J. C. (2007). *Mixed methods in social inquiry*. SAGE Publications.
- Humphrey, J., and Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), 1017–1027. <https://doi.org/10.1080/0034340022000022198>
- Israel, M., and Hay, I. (2006). *Research ethics for social scientists: Between ethical conduct and regulatory compliance*. SAGE Publications.

- Jayne, T. S. (2010). African food systems and markets. *Food Policy*, 35(4), 343–355. <https://doi.org/10.1016/j.foodpol.2010.01.003>
- Johnston, M. P. (2017). Secondary data analysis: A method of which the time has come. *Qualitative and Quantitative Methods in Libraries*, 3(3), 619–626. (Working paper on secondary data use.)
- Joshi, D. (2019). *Value chain analysis of kidney beans*. RePEc. <https://ideas.repec.org>
- Joshi, D., and Singh, R. (2020). *Economic analysis of legume chains in developing regions*. ResearchGate.
- Kalibwani, R.M. (2014). Gender and value chain participation among bean traders. *Ageconsearch*. <https://ageconsearch.umn.edu>
- Kamanda, M., and Ngambeki, D. (2021). Grain market quality differentials in Uganda. *IFPRI Discussion Paper*.
- Kambale, J., Musafiri, P., and Bahati, S. (2020). Value chain power relations in eastern DRC. *Journal of Rural Studies*, 75, 210–220. <https://doi.org/10.1016/j.jrurstud.2020.02.001>.
- Kaplinsky, R., and Morris, M. (2001). *A handbook for value chain research*. Institute of Development Studies, University of Sussex.
- Karanja, D. (2018). *Value-added bean products and markets in East Africa*. IFPRI. <https://ifpri.org>
- Katungi, E., Farrow, A., Mutuoki, T. (2011). Common bean productivity in East Africa. *Food Security*.
- Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd rev. ed.). New Age International Publishers.
- Kvale, S., and Brinkmann, S. (2009). *InterViews: Learning the craft of qualitative research interviewing* (2nd ed.). SAGE Publications.
- Marysse, S., and Tshimanga, C. (2014). Market governance in eastern Congo. *Review of African Political Economy*, 41(142), 235–252. <https://doi.org/10.1080/03056244.2014.901949>
- Meagher, K. (2018). Informal market governance in Nigeria. *Journal of Development Studies*, 54(12), 2150–2165.
- Mishra, A., Gyawali, B.R, Paudel, K., Paudyal, N.C. (2018). Adoption of sustainable agriculture practices among farmers in Kentucky, USA.
- Muhanzi, O., Kiza, J., and Mugisho, N. (2019). Power and intermediation in DRC food chains. *Food Security*, 11, 1005–1018. <https://doi.org/10.1007/s12571-019-00945-z>
- Mukankusi, C., Bodo, R., Nkalubo, S., Fenta, B., Binagwa, P., Kilango M., Williams, M., Katungi E., Chirwa, R., Beebe, S. (2018). Genomics, genetics and breeding of common bean in Africa: A review of tropical legume project <https://doi.org/10.1111/pbr.12573>
- Mulinga, N., Karangwa, A. and Ngabitsinze, J.C. (2019). Factors Affecting Technical Efficiency of Beans Production among Smallholder Farmers in Rwanda. *Research & Reviews: Journal of Agriculture and Allied Sciences*. RRJAAS| Volume 8 | Issue 1 | April, 2019
- Musafiri, C., Milka, K., Machariac, J., Muliangaf, M., Okotig, F., Ngetich, K. (2022). Adoption of climate-smart agricultural practices among smallholder farmers in Western Kenya: do socioeconomic, institutional, and biophysical factors matter? Research article. Volume 8, Issue1, e08677, January 2022
- Mveyange, A., and Byiers, B. (2017). Political economy of markets in Great Lakes region. *ECDPM*.
- Mwidege, A.M. (2024). Global and African common bean production outlook. *IJFA*.
- Nchanji, E.B., Chirwa, R., Templer, N. (2021). COVID-19 impacts on Africa’s bean value chains. *Food Policy*.
- Olwande, J., [Melinda, S.](#), Mathenge, M., [Frank, P.](#), [Dagmar M.](#) (2015). Agricultural marketing by smallholders in Kenya: A comparison of maize, kale and dairy. *Biomass and Bioenergy*, Volume 98, 2017, pp. 22, <https://www.sciencedirect.com/science/article/abs/pii/S0306919215000196>

- PABRA. (2023). *Bean corridor and seed delivery innovations in Africa*. <https://pabra.africa>
- Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (7th ed.). McGraw-Hill Education.
- Petersen, E., and Pedersen, T. (2010). Value chains in conflict-affected areas: A case for context-sensitive analysis. *Journal of International Development*, 22(5), 594–605.
- Ponte, S., and Gibbon, P. (2005). Value chain governance in Africa. *Economy and Society*, 34(1), 1–31. <https://doi.org/10.1080/0308514042000329312>
- Reardon, T., and Timmer, C. P. (2014). Five inter-linked transformations in the Asian agrifood economy: Food security implications. *Global Food Security*, 3(2), 108–117. (As conceptual basis for value chain and market transitions.)
- Renkow, M., Hallstrom, D. G., and Karanja, D. (2004). Transport costs and food market integration. *American Journal of Agricultural Economics*, 86(3), 682–697. <https://doi.org/10.1111/j.0002-9092.2004.00610.x>
- Reardon, T., and Minten, B. (2021). Food value chain transformation in developing regions. In *Agricultural development: New perspectives in a changing world*, eds. Keiji Otsuka and Shenggen Fan. Part Three: Context for Agricultural Development, Chapter 12, Pp. 397-438. Washington, DC: International Food Policy Research Institute. (IFPRI). https://doi.org/10.2499/9780896293830_12.
- Rubyogo, J.C., Sperling, L., Buruchara, R. (2010). Seed delivery systems for beans. *Journal of Sustainable Agriculture*.
- Rusike, J. (2013). *Market opportunities for grain legumes in Central Africa*. N2Africa. <https://n2africa.org>
- Sitko, N., and Jayne, T. (2014). Road infrastructure and grain markets. *Food Policy*, 49, 41–50. <https://doi.org/10.1016/j.foodpol.2014.06.003>
- Stoian, D. (2016). Value chain development for smallholders. *International Forestry Review*, 18(S1), 86–101.
- Templer, N. (2019). *Seed and market systems assessment in Eastern DRC*. CRS. <https://crs.org>
- Timmer, C. P. (2002). Agriculture and domain of market dynamics: Structural change, policy and market evolution. In *Handbook of Agricultural Economics, Volume 2A* (Eds. B. Gardner and G. Rausser), 307–374. Elsevier.
- Titeca, K., and De Herdt, T. (2011). Informal governance in Congo. *Review of African Political Economy*, 38(129), 67–90.
- Trienekens, J. H. (2011). Agricultural value chains in developing countries: A framework for analysis. *International Food and Agribusiness Management Review*, 14(2), 51–83. <https://doi.org/10.22004/ag.econ.103987>
- Tschirley, D., Reardon T., Michael D., Jason S. (2015). The Rise of a Middle Class in East and Southern Africa: Implications for Food System Transformation, 52, 9–23. <https://doi.org/10.1002/jid.3107>
- USAID-SVC. (2020). *Bean Value Chain Assessment – Eastern DRC*. <https://usaid.gov>
- Wiggins, S., Johann K., and Luis L. (2010). The future of small farms. *World Development*, 38(10), 1341–1348. <https://doi.org/10.1016/j.worlddev.2009.06.013>
- Wooldridge, J. M. (2013). *Introductory econometrics: A modern approach* (5th ed.). South-Western Cengage Learning.
- Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper and Row.