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Research Paper

Analysis of the transport chain for perishable goods: the case of tomatoes (*Lycopersicon esculentum* Mill) in the city of Gbadolite in the Democratic Republic of Congo

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Abstract
The purpose of this study is to analyze the supply chain for perishable goods in the municipality of Gbadolite in the Democratic Republic of Congo, focusing on tomatoes. In the municipality of Gbadolite, agriculture plays a central role in the economy. Among the crops grown, tomatoes stand out due to their high local consumption and their contribution to the income of many households. However, despite their importance, the supply chain remains poorly structured, inadequate, and inefficient, resulting in significant economic losses for both sellers and producers. The implementation of appropriate logistics and equipment or infrastructure for the product is the only means of overcoming the obstacles that cause losses in the tomato supply chain.

Keywords: *Analysis, Supply chain, Perishable goods, Tomatoes, Gbadolite*

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I. Introduction

The interaction between economic development and international trade policy has never been more apparent than it is today. With the expansion of the "world system" across continents, liberalization through the opening up of national economies and their integration with international markets has continued at a steady pace since the early 1980s. The creation of regional geo-economic blocs only accentuates this economic, social, and political globalization (Tazanli, 2007; Ato, 2008).

Only those localities, territories, and economies that successfully integrate into these regional blocs are able to maintain an acceptable level of socioeconomic development. It is certainly this threat that is pushing developing countries to implement upgrading policies to better meet the expectations of international bodies (Tazanli, op. cit.; Chanforan, 2010).

Local industries are increasingly integrated into the supply chains of large companies that are constantly reconfiguring their areas of activity. By establishing and applying their own rules and standards, these large companies are extending their sphere of influence beyond their national borders and thus emerging as key players in global value chains (Tazanli, 2007).

Furthermore, in tropical and subtropical climates, it will be difficult to preserve tomatoes without cold storage. Sometimes rapid marketing is the only solution. When tomatoes are sold fresh for direct consumption, storage periods must be very short (Shankara et al., 2005).

When tomatoes are processed, for example into purée or tomato juice, or when they have been dried or preserved in vinegar, the storage period can last several months or even a few years (Davies and Hobson, 1981; Degrou, 2013; Cotte, 2000).

In general, in the DRC, and particularly in the municipality of Gbadolite, agriculture plays a central role in the economy. Among the products grown, tomatoes stand out due to their high local consumption and their

contribution to the income of many households. However, despite their importance, the supply chain remains poorly structured, inadequate, and inefficient, resulting in huge economic losses.

There is a lack of protective equipment and appropriate storage systems. Added to this are dilapidated roads, a lack of suitable packaging, and a lack of coordination between producers, transporters, and sellers. This situation leads to rapid deterioration in the quality of tomatoes, a loss of market value, and significant economic losses for sellers, as in other parts of the world (FAO, 2014).

In addition, the lack of logistical planning for well-located collection points and training for stakeholders exacerbates the problem. While tomatoes are a perishable commodity that requires rapid and appropriate transport conditions, current practices do not meet cold chain requirements or minimum storage standards.

This is why it is important to analyze and improve the transport chain for perishable goods in the city of Gbadolite: the case of tomatoes, with a view to addressing the real problem observed in the field of agricultural logistics. Specifically, to analyze the means of transport used by tomato sellers at the time of supply.

II. Materials and methods

Setting

This survey was conducted in the city of Gbadolite, capital of North Ubangi Province, particularly in the neighborhoods of Lite, Kaya, Mbanza, Modernité, Camp fonctionnaire, Maman Mobutu, Tabac Congo, Pangoma, Moanda, and Mangundu over a two-month period from July to September 2025 in the municipality of Gbadolite.

The geographical coordinates are between 4° 16' 41'' North Latitude and 21° 00' 18" East Longitude, 300 m and 500 m above sea level. The city of Gbadolite has a tropical climate with an average rainfall of 200 mm per month; and annual rainfall can reach 1,500 mm (Ngbangu et al, 2024).

The city of Gbadolite has a hot and humid climate characterized by alternating heat throughout the year. Rainfall is unevenly distributed throughout the year, with an annual average of 1,600 mm (Molongo et al, 2022).

The city enjoys a tropical climate, with two alternating seasons: the dry season, which lasts from mid-November to mid-March of the following year, and the rainy season, which lasts from mid-March to mid-November of the same year. The soil covering the town hall of Gbadolite is generally sandy clay and very fertile for all crops, both industrial and food crops. The terrain consists of plateaus, hills, and wooded savannas to the south, with a large virgin forest known as the equatorial forest forming its border with Mobayi Mbongo, whose lowlands are occupied by rivers (Molongo, 2022).

Materials

The materials used in this study consisted of interview guide questionnaires, pens, A4 carbonless paper, rulers, notebooks, Excel software, LiveGap-Chart software, and IBM SPSS Statistics 20 software.

Methods

The methodological approach adopted in this study was sampling, which used survey, documentary, and interview techniques (Atakpama et al., 2018).

This method was useful in that it allowed us to gather the views of tomato sellers. In the context of this study, we used individual or personal interviews, which mainly targeted spice sellers (Mataboro et al., 2016). Taking into account the demographic size of the municipality of Gbadolite and the logistical and financial resources available, 60 people were selected as samples using the non-probability sampling technique (PAM and FAO, 2019).

The interviews took place in the participants' homes. Spice sellers were given the opportunity to participate, as the subject was the tomato supply chain (Mataboro et al., op. cit.; WFP and FAO, op. cit.).

Statistical analysis

The data from this study were analyzed using IBM SPSS Statistics 20 software. One-way analysis of variance without sampling and Fisher's F-test were used to identify significant differences between

III. Results and discussion

Results

Gender of respondents

In this section, we will present the results of our study relating to gender, as shown in Figure 1.

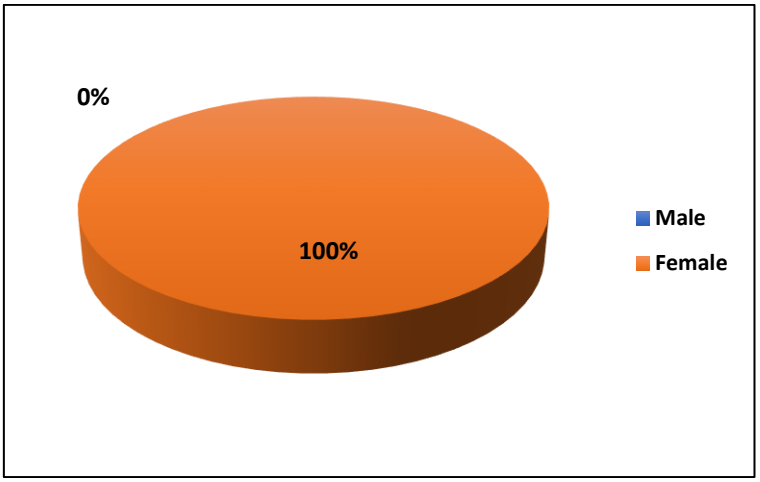

Figure 1: Breakdown of respondents by gender

Looking at Figure 1, we see that 100% of tomato sellers are women.

Age of respondents

Information on the age groups of respondents is available in Figure 2.

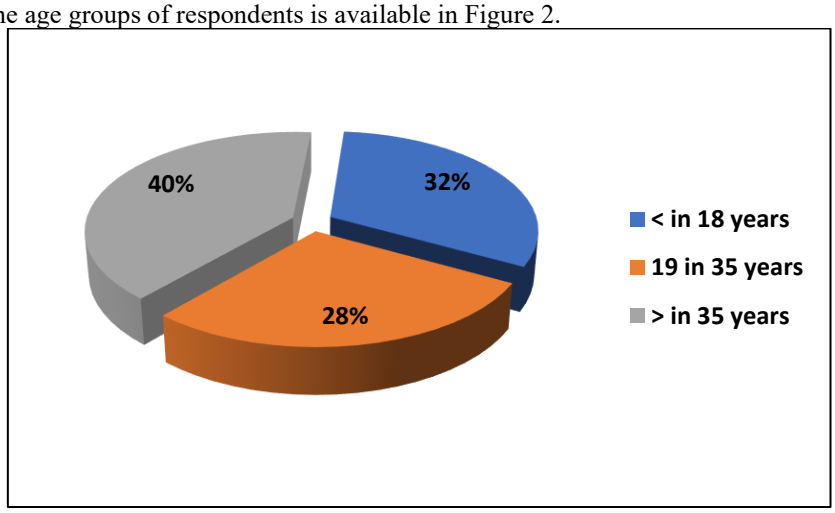

Figure 2: Distribution of respondents by age group

Looking at Figure 2, we see that 40% of female vendors are in the over-35 age group.

Level of education

The results relating to the respondents' level of education were recorded and entered in Figure 3.

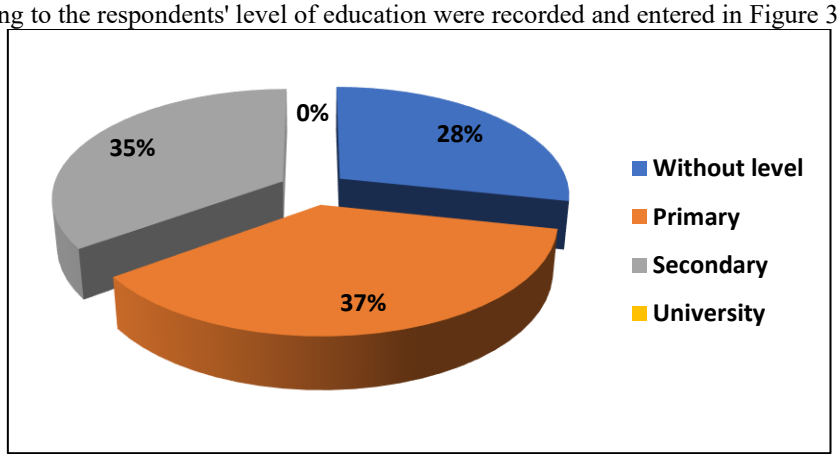

Figure 3: Distribution of respondents by level of education

Looking at Figure 3, we see that 37% of female vendors have a primary school education, while 35% have a secondary school education, 28% have no education, and finally, we recorded no vendors with a university education.

Origin of tomatoes

Figure 4 provides information on the place of origin of tomato sellers.

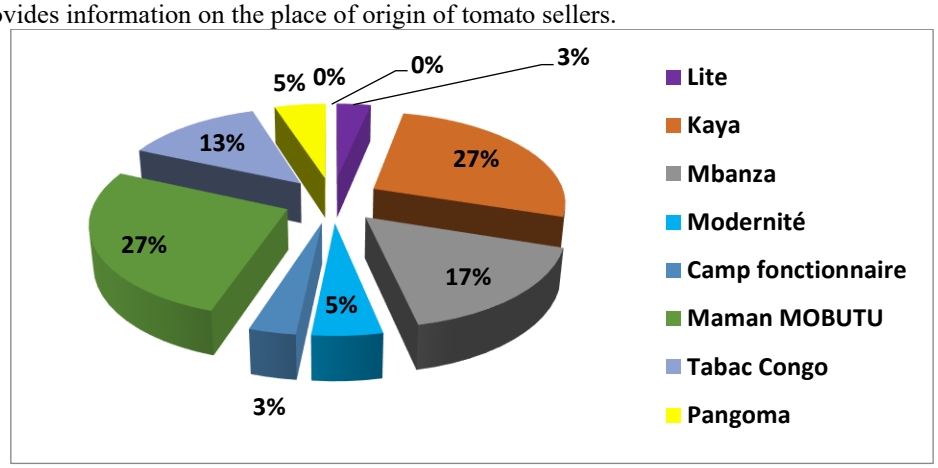

Figure 4: Distribution of respondents according to the place of origin of female vendors

Based on the results in Figure 4, we see that 27% of female vendors are residents of the KAYA and Maman Mobutu neighborhoods, followed closely by MBANZA with 17%, the Tabac-Congo neighborhood with 13%, the Modernité and Pangome neighborhoods with 5% of respondents, and then 3% from the Lite and Camp Fonctionnaires neighborhoods.

Source of supply

The results obtained relating to the source of supply were collected and recorded in Figure 5.

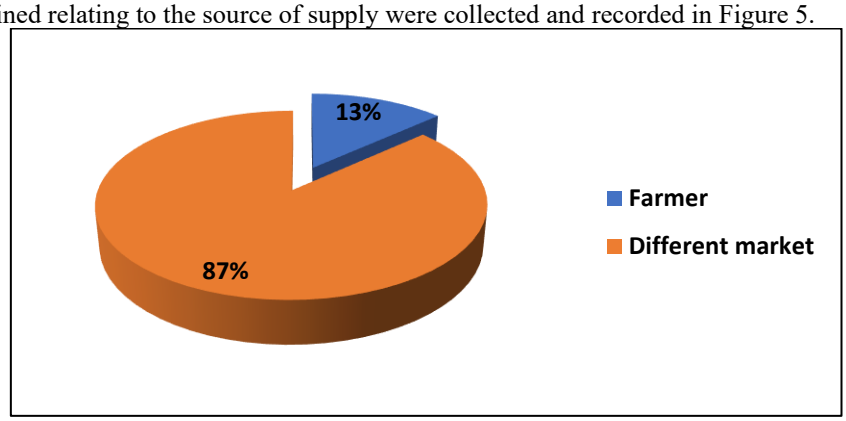

Figure 5. Distribution of respondents according to source of supply

In light of Figure 5, we note that 87% of female vendors source their tomatoes from various markets in the city and 13% source them directly from farmers.

Awareness of the risks of poor storage

The distribution of respondents according to their awareness of the risks of poor storage is shown in Figure 6.

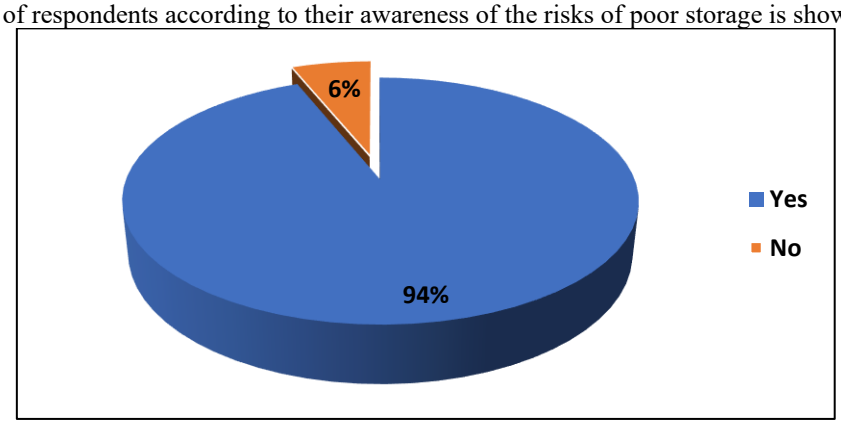

Figure 6: Distribution of respondents according to their knowledge of the risks of poor storage

The results in Figure 6 show that 82% of female vendors are aware of the risks associated with poor tomato storage, while 18% are completely unaware of any risks.

Storage methods
Information on the distribution of respondents according to tomato storage methods is shown in Figure 7.

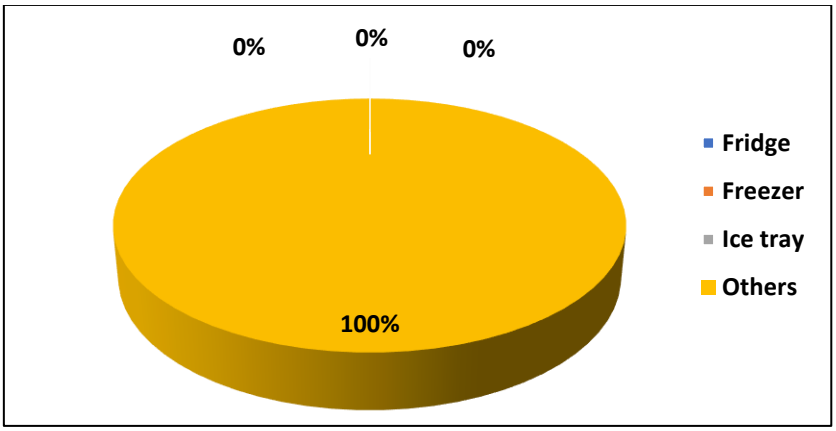

Figure 7: Distribution of respondents according to preservation methods

Looking at Figure 7, we see that all female vendors use other methods to preserve their tomatoes.
Types of packaging used during supply

During our research, we investigated the type of packaging used during supply, and the results are shown in Figure 8.

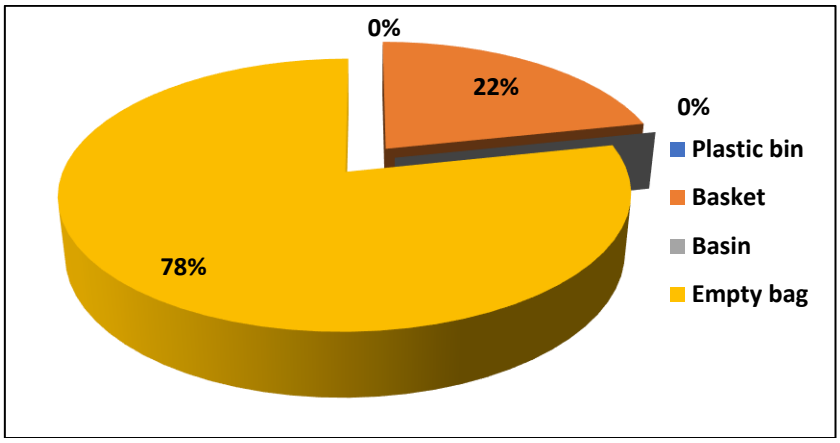

Figure 8: Types of packaging used during procurement

Figure 8 clearly shows that 78% of female vendors use empty bags as packaging when procuring tomatoes, compared to 22% who use baskets.
Means of transport used during procurement
The means of transport used by respondents during procurement are shown in Figure 9.

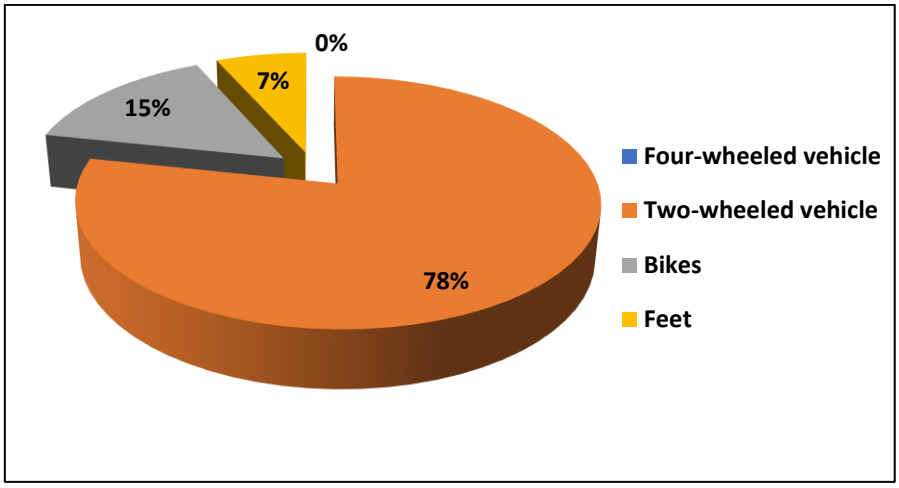

Figure 9: Means of transport for plantain supplies

The results in Figure 9 show that 78% of female vendors use motorized two-wheelers to obtain tomato supplies, followed by non-motorized two-wheelers at 15% and then walking at 7%.

IV. Discussion

The results of this study showed that women's participation was 100% compared to 0% for men. In light of these results, it was observed that men were unnoticed and that women were dominant during this study.

In relation to this parameter, our results contrast with the 41% of men and 59% of women obtained by Atakpama et al. (2018). This situation is justified by the fact that the majority of sellers and users are women.

In view of this result, it is confirmed that the educational level of the respondents is low. With regard to the highest level of education, the largest proportion was that of primary level, representing 37%; 35% had secondary education; 28% had no education; and 0% had university education. Strategies are needed to reverse this trend, as sustainable natural resource management requires a minimum level of education in order to receive or contribute to education on sustainable resource management (FAO, 2019).

It has been confirmed that many of the female vendors come from the Kaya and Maman Mobutu neighborhoods, which accounted for 27% of those surveyed, followed by vendors from the Mbanza neighborhood with 17% and those from the Taba-Congo neighborhood with 13%. These results were confirmed when compared with those of Elombe (2020). We believe that this is due to the high population density in these neighborhoods compared to others.

In addition, the source of supply has a very significant impact on different markets, with 87% sourcing from agriculture compared to 13% sourcing from other sources. We confirm the hypothesis of Tingu & Mathunabo (2019) that, depending on the activity, market gardening crops are produced in lowland farming conditions. We can justify our result in the sense that Gbadolite is a city with a high population density, so market garden products could only come from peripheral markets.

The risks of spice spoilage are well known. Our research findings show that nearly 82% of female vendors are aware of the risks of improper tomato storage, while 18% are completely unaware of the consequences of improper storage.

This situation can be explained by the fact that these female vendors are aware of the risks of poor storage thanks to their experience with this commodity, especially older women. In addition, younger women do not have this knowledge, partly because they do not use tomatoes regularly, and partly because young women sometimes engage in these activities solely to obtain school supplies, as noted by Laborde (2020).

We observe that all female vendors apply other means of storage based on their own ideas. This situation is justified by the interruption of electricity supply by the national electricity company following a power failure at the power station in the city of Gbadolite.

Based on the results of our field survey, it can be observed that most tomato sellers package their products in empty bags, with 78.33% of respondents doing so, compared to 21.67% of those who transport them in baskets, contrary to the assertion that market garden produce needs to be well harvested and must always be aired by being exposed to the open air in the shade in order to be preserved for a long time (Laborde, op. cit).

FAO (2016) notes that poor handling, overloading, poor road conditions, inappropriate packaging and packaging techniques, sun, and rain in Cameroon.

V. CONCLUSION

The overall objective of this research is to evaluate the transport chain for perishable goods in the city of Gbadolite, using tomatoes as a case study, and specifically to identify the main logistical problems related to the transport of tomatoes, analyze current transport conditions (means used, delays, infrastructure, etc.) and to assess post-harvest losses caused by poor transport and storage practices in the city of Gbadolite.

Based on the assumptions, the results suggest the following:

- All (100%) of our respondents use other aquatic means to preserve tomatoes rather than refrigerators (fridges and freezers) and ice boxes. 78% of respondents pack their tomatoes in empty bags for transport,
- The means of transport used by sellers to transport tomatoes were recorded and show that the majority of our respondents use two-wheeled vehicles (78%), while those who use bicycles account for 15%.

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