



# Dynamics of Losses in Tomato Commodity Chain (Estimates based on experimental design in Cameroon).

**Mr. Tolly L. Desire Emmanuel** | Open Markets Ltd | Cameroon

**Mr. Kamtchouing P.** | Faculty of Agronomic Sciences of Dschang | Cameroon

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## ABSTRACT

In order to improve food security in Cameroon, a diagnostic study for the reduction of Post-Harvest Losses (PHL) in tomato supply chain was carried out in 2013, by a team of two FAO consultants, for the Ministry of Agriculture and Rural Development (MINADER). The study was conducted in the West (main production area), and Littoral (urban markets) regions of the country. The methodology was based on four main stages: (i) preliminary diagnosis of the situation of PHL throughout the supply chain, (ii) field work with various actors of the sub-sector, (iii) synthesis of the results obtained, and finally (iv) the development a strategy and the relevant work plan and for a significant reduction of these losses over a period of 10 years.

With an average consumption of 30.05 kg/person/year and 35% of all vegetables consumed in the country, fresh tomato occupies a prominent place in the country's food security. About 329 033 small farmers are involved in the sub-sector with a potential of 1 645 165 jobs. Tomato produced locally is mainly marketed fresh, without any significant processing after harvest. For reasons related to logistics and time constraints, the western production area and urban market of Douala were selected for further analysis in the field. Moreover, we also considered financial resources available for the study and the following criteria, defined by the FAO guide: (i) be part of an organization of small farmers producers of tomato, (ii) final products are intended for human consumption, (iii) have their end markets in villages, urban areas or abroad, (iv) create value added by small and medium sized farms in the supply chain; (5i) to be integrated into a support program underway in the tomato subsector. Preliminary investigations revealed that Pre-harvest, Transport and Marketing were the highest Food Losses stages. Even though the production of fresh tomato was about 932 530 tons in 2012, and the consumption estimated at 605 054 tons, the country still faced huge deficit which were partly filled by concentrated tomato imports; This is due to high losses along the supply chain. Interviews with different actors of the supply chain, and a study conducted in markets, allowed us to compare the preliminary information obtained during the screening phase, with the results of measurements of losses at critical points. Hence, losses in tomato supply chain are both quantitative (reduction of mass) and qualitative (reduction of market and nutritional value). Causes of these losses depend on several factors: technological, managerial, infrastructural, etc. Origin of these losses is diverse and include among others: climate, soil, variety, physiology, mechanical damage, diseases, pests, and agricultural processing practices. Field analysis revealed the steps where tomato losses (quantitative and qualitative) were most significant: Pre-harvest/harvesting (28.30%; # %), Transport (7.70%; 5.15%), and Retail sale (#%; 25.85%) of production. The synthesis of results helped us to identify the following solutions: (i) improve access to agricultural inputs (quantity, cost, regulation, certification, etc.) and adequate knowledge of the usage; (ii) drive an inclusive research-development action to improve traditional containers used for tomato transportation; (iii) develop farmer's capacities in farm management practices, and market access; (iv) improve market infrastructure, (v) Facilitate access to innovative packaging and handling techniques. Finally, a strategy for the reduction of losses in the tomato sub-sector over a period of 10 years was proposed to Cameroonian Government. Keywords: supply chain, critical stages, quantitative losses, qualitative losses

**Keywords:** SOC content, Hierarchical modelling, Multi-scale, Spatial statistics

## PAPER

### 1. Introduction

According to FAO statistics, the current energy consumption which is about 2300 kcal/ person/day in Cameroon remains below the average of developing countries (2600 Kcal/day/ person). The State of Cameroon in its strategy for growth and jobs (agriculture and rural development component) had set a goal to reach a level of 3100 Kcal/day/person in 2015. To achieve this objective, it was necessary to combine the growth of agricultural production initiatives, with the reduction PHL. These losses account for about 20 to 50% of production or more for some crops in Cameroon, including fruits and vegetables. Indeed,

a significant reduction in losses is not only beneficial to all stakeholders of the various agricultural and food sectors but is also conducive to food security in its different dimensions (availability, accessibility, stability of market supplies, sanitary quality and nutritional food) and preservation of the environment. No previous study had been conducted for the assessment of post-harvest losses on the tomato supply chain in Cameroon.

Although these estimates come from the Ministry of Agriculture in Cameroon, they are not confirmed by reliable field analysis.

From the Ministry of Agriculture data in Cameroon (not confirmed by reliable field analysis), although estimates are available on the level of food losses, there is always the need to identify the most critical determinants at different points of the food supply chain in order to achieve profitable and sustainable socio-economic and environmental solutions. Studies are needed as a prerequisite for setting priorities for the implementation of specific interventions for reducing losses and obtaining a maximum desired effect. It is in this context that MINADER requested a diagnostic study for reducing PHL of three crops (cassava, potato and tomato) with FAO support. This was evidenced by project MINADER/FAO-TCP/CMR/3402: "Diagnostic study of post-harvest losses in cassava tomato and potato value chains in Cameroon". This report covers only the work done in the context of tomato in Cameroon. For FAO, the study is part of a series of case studies from the global initiative to reduce food losses and waste (Save Food).

The main objective of this study is to make an inventory of PHL and critical stages in the tomato supply chain in order to propose a strategy for better control of losses. The fieldwork was conducted in 2013 and was subject to a detailed report and validated during a national workshop held in Yaoundé in April 2014.

## 2. Intermediate sections

### 2.1 Methodological approach

The methodological approach used is that developed by FAO for the case studies as part of the Save Food initiative. It consists of the implementation of the main steps and actions summarized below:

- Preliminary diagnosis of the sub-sector. It brought out general situation of losses on the tomato sector in Cameroon, identify key critical steps and reveals the levels of qualitative and quantitative losses as perceived by experts and other resource-persons in the sector;
- Field surveys for evaluation of losses. In the production area (western region), they were made via field measurements in farms, and semi-structured interviews with groups of stakeholders (producers, processors), completed by field observations. In consumption areas (Douala markets), specific questionnaires were administered to transporters, wholesalers and retailers.
- Monitoring of tomato shipments from the fields through the rural markets (or assembly markets), to urban consumer markets (wholesale and retail);
- Analysis of data collected in the production areas and markets in order to establish a detailed statement of the causes of food losses, estimate their size and the possibilities of their reduction to the different critical stages of the supply chain;
- Preparation of the study report and validation via a national workshop. Based on the findings, interventions are proposed, aiming for a significant reduction in losses over a period of ten years in the tomato supply chain.

The fieldwork was made in 2013 in the following areas: (i) Production area and rural markets (West) and (ii) urban-consumption markets: Douala (Littoral). The choice of supply chains for the field work was done at the end of the preliminary phase, in regard of the following criteria: creation of added value, contribution to income generation, ability to generate non-family labor, importance of the export market (generation currency), and contribution to food security. It is also based on the following criteria: (i) size of the food chain operations; (ii) creating added value for small and medium farms in the supply chain; (iii) nature of the products obtained in the supply chain; (iv) existence of markets in villages, urban areas and opportunities to sell abroad; (v) sector/ study is included in an ongoing program of support for the sector.

A team including two national experts (an economist and a food technologist) conducted the field study under the supervision of FAO.

### 2.2 Status and importance of the tomato subsector in Cameroon

With an estimated production of 889,800 tons and annual growth rate of 9.4% in 2012, tomato sector occupy about 329,000 producers in Cameroon. Based on FAO estimates, 150 000 hectares were planted in 2012, with an average yield of 11.3 tons/ha, still well below the value of 20 tons/ha referred. The production is still artisanal, largely carried out by small producers operating in a context of family farming, and organized into cooperatives. Moreover, tomato is grown mostly by men who typically exploit an area of 0.25 hectare each where they practice monoculture. An estimate conducted by MINADER between 2007

and 2008 shows that current consumption of tomato in Cameroon is about 30 kg per capita. Tomato is firstly produced for marketing and it contains a potential of 1,645,200 jobs. The tomato processing is almost non-existent in Cameroon yet. There is a significant demand for derivatives products such as concentrate and sauces, covered by imports. Moreover, this sector also has enormous export potential in the CEMAC sub-region unfortunately; this opportunity is not used because of the high volume of PHL recorded throughout the supply chain, aggravated by poor organization of the sector, the isolation of production areas and the instability of marketing channels.

Table 1 summarizes the essential information on the national tomato production. It shows that this production is greater than consumption of the country that would amount to 605 054 tons, valued at 148.5 billion CFA francs. However, it is only an apparent surplus because if one takes into account all the losses suffered by the product after its harvest, the supply of fresh tomato in Cameroon would be negative. This significant gap is filled in part by imports of tomato paste which constitutes an offer of 6,000 tons for a demand about 60 390 tons.

**Table 1 - Information on production and by-products of the tomato sector**

| Item  | Data                               | Observations  |
|---|------------------------------------|---|
| Annual volume of production (tons / year)             | 889 800                            | Data for 2012 (FAOSTAT, 2015)   |
| Area (ha)   | 150 000                            | Data for 2012 (FAOSTAT, 2015)   |
| Average yield (tons/ ha)                              | 5,9                                | Production volume/area  |
| Average rate of increase over the last 10 years (%)   | 9,4                                | Data for 2012 (FAOSTAT 2015)  |
| Average production cost (FCFA /ton)                   | 221 240<br>(434 USD/ ton)          | Average production costs of tomato growers organizations in the targeted regions.   |
| % Of production consumed                              | 2                                  | Almost all family farmers which cultivate tomato consume a small amount (less than 1 Kg/day), the rest going to the market  |
| % Of production marketed                              | 98                                 | Interview with Experts  |
| Estimate% sold wholesale / retail sold by producers   | 90<br>10                           | Interview with experts; Field confirmation  |
| Output value (FCFA / year)                            | 166 billion<br>(325.5 million USD) | Turnover for 2012 (FAOSTAT 2015)  |
| Number of producers                                   | 600 000                            | The majority of farms in the studied production areas have an area of 0.25 hectares. Number of producers/ 0.25 = area.  |
| Market size of fresh tomatoes (request) (tons / year) | 867 000                            | In 2007, the consumption of fresh tomatoes in Cameroon was 27.5 kg per capita (MINADER, 2009). It is assumed that it evolves with the same trend as production (average annual growth rate: 9.4%); so, it is of 43 kg per capita in 2012.                                 |
| Market value of fresh tomatoes (FCFA / year)          | 213 billion<br>(417 million USD)   | Average price/kg = 245.5 FCFA (\$ 0.48), value calculated from measurements of the market.  |
| Size concentrated tomato market (tons/ year)          | 60 400                             | Tomato paste consumption is about 3 kg/person/year in some African countries, including Benin, Nigeria and Niger (LARES and IRAM 2002). The consumption of 3 kg/person/year is extrapolated to that of Cameroon's population has almost the same diet as that of Nigeria. |
| Market value of concentrated tomato (FCFA/ year)      | 69 billion<br>(135 million USD)    | minimum average price/kg = 1142 FCFA (\$ 2.24) calculated from the imported brands on the market  |

Source: Results of the study; 1 USD = 510 FCFA

### 2.3 Description of studied areas, actors involved and stages along the supply chain

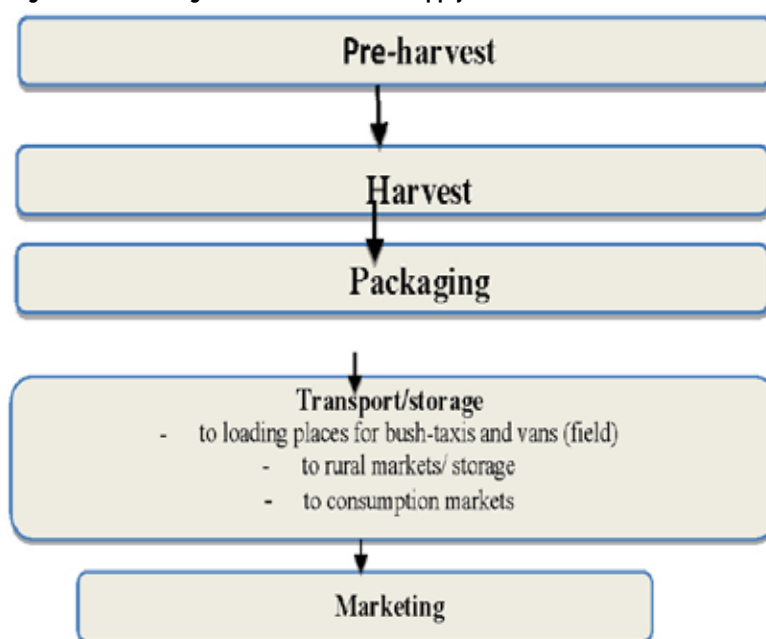
Two fresh tomato supply chains were selected for detailed study on PHL: Mbouda-Bafoussam-Douala and Foubot-Bafoussam-Douala, with exports opportunities in neighboring countries namely Gabon and Equatorial Guinea. The following criteria were taken into consideration: (i) value added, (ii) contribution to revenue generation of each operator, (iii) ability to generate non-family jobs and ease to organize and track shipments and, (iv) ability to sell in the CEMAC zone.

The selected communities are located within a radius of about 70 km around the towns of Mbouda and Foubot. The production of fresh tomato is done in two seasons: (i) dry (February-April) and (ii) rainy (August-October), where it reaches its peak. Women are almost absent in this sub-sector. There are carriers, wholesalers and retailers. Rio variety is the most cultivated in Cameroon and is characterized by its resistance to disease, its pear-shaped size of fruit, deep red, with a diameter of  $4.9 \pm 2$  cm and an average weight of about 150g. The production cycle takes around 80 days. Several harvests take place on the same field of tomato [4-6] with one week interval between two successive harvests. The production facilities consist of rudimentary tools. Fresh tomatoes could be left non-cropped days after the maturity of fruit to meet the uncertainties of the market demand and lack of markets information.

Basic constraints such as (i) lack of electricity in rural areas, (ii) poor organization, (iii) limited volume of tomato per farmer, (iv) lack of maintenance, etc., cooling facilities seems not to be appropriate for the moment.

After harvest, the ripe or half-ripe fruit are packed in baskets (crates), made by local craftsmen from raffia bamboo. The full crate is covered by a bunch of grass or banana leaf. With a volume that varies between 20 to 25 liters, the average empty crate weighs 400 g and sold between 250 and 300 FCFA per unit is the most requested format. In the case of fresh tomatoes packed for export the conditioning is done in plastic boxes brought by the customer. Once packed in the field, crates are then transported on the heads, in wheelbarrows or on motorcycles to the nearest rural track where they can be stored by the roadside in full air (for maximum a day), until the arrival of the conveyance. A second storage takes place in the rural markets, in preparation of loading for high consumption areas. The transporters usually travel at night, with an average temperature of 20 to 25°C. Night trip reduces the perishability of the product that keeps certain level of freshness, while facilitating early arrival to consumption markets. Storage or exposure of the product to the sale is to put tomato in the open. Wholesalers and retailers do not have the means to create the ideal conditions for the conservation of fresh tomato for three days or more, in Douala where average temperature varies between 25 and 30 °c.

**Figure1 - Flow Diagram of fresh tomato supply chain**



#### 2.4 Alleged losses in selected supply chains

With its high water content (about 90%), tomato is a particularly fragile vegetable. Should harvesting, transportation and marketing standards not achieved, they can cause huge PHL. Preliminary analysis revealed that pre-harvesting, transport and retail sales are the critical points where food losses (quantitative and qualitative) are the most significant. Qualitative losses appear at harvest and increase with process steps (transport, marketing). Quantitative loss is mainly expressed during the pre-harvest phase (because of the fruit growing or ripe rotting up especially when they are placed on the floor or fall), or during transport (as a result of mechanical factors such as shocks that cause the crushing of fruit and water loss). Thus in the first stream (Mbouda - Douala market), the level of fresh tomatoes loss was estimated at 27% during the pre-harvest phase, 5.3% at harvest, 8.8% in transport and 1.4% in marketing. The second stream (Foumbot - Douala market), gives an estimate of 31.7% during pre-harvest/harvest stage, 5.9% in transport and 0.65% for marketing. These low values of quantitative losses in marketing could be justified by poor practices observed on retail markets. Indeed, injured, crushed or sometimes even rotten tomatoes, are rarely discarded; rather they are collected, crushed and re-sold to pig breeder or small restaurants. Hence, qualitative losses (25,85%) are important losses during marketing; and low quality tomatoes are even sold half price.

#### 2.5 Post-Harvest Losses along the supply chain: Results of study

At each stage of the supply chain, detailed description considered the following aspects: location, time of the year, number of players involved, intermediates, quantities produced, location, facilities used, duration/distance, required inputs and services, cost of production and the cost of products at sale. Results of analysis show that losses of fresh tomatoes which are both quantitative (mass or volume

reduction), and qualitative (reduced market value, nutritional value and food safety) have various origins: physiological, mechanical, microbiological and pests action. Furthermore, the identified critical points are pre-harvesting, transportation and marketing.

**Table 2 - Critical points and levels of PHL along fresh tomato supply chains (average)**

| Supply chain steps | Qualitative losses (%) | Quantitative losses (%)                       |                            |
|--------------------|------------------------|---|----------------------------|
|                    |                        | Losses at critical point (% ingoing quantity) | Losses (% total harvested) |
| Pre-harvest        |                        | 28.3  | 28.3                       |
| Transport          | 5.15                   | 10.85   | 7.7                        |
| Marketing          | 25.85                  | -   | -                          |
| <b>Total</b>       | -                      | -   | <b>36.0%</b>               |

Source: Results of the study

Qualitative losses are primarily valued as depreciation in the market value of the product at retail. Product quality decreases, it loses its economic value and is sold at a lower price. It will still be consumed. Monitoring of tomato shipments shows that most losses are obtained during transport.

A synthesis matrix of the results of semi-structured interviews, shipments tracking and market research on food has been developed. The main aspects taken into consideration were: (i) cause of losses, (ii) % of loss relative to the initial amount, (3i) affected people, (4i) impact of losses, (5i) loss of market value in FCFA (6i) trends, (7i) time / season (8i) perception of actors and, (9i) solutions suggested by stakeholders. All actors in the tomato supply chain are affected by PHL: producers, distributors, consumers and their families. Causes of losses appearing at all stages, potential solutions should therefore involve all actors in the supply chain. Summary tables allowed us to have an overview of interventions that can be performed at critical points to sustainably reduce the loss of fresh tomato. The economic feasibility, social acceptability, environmental impact and management of the practical implementation of these interventions should be carefully studied beforehand. Their formulation and implementation should be inclusive and involve stakeholders from the public and private sectors.

At each critical stage identified, the following aspects were considered: (i) extent of losses (qualitative and quantitative), (ii) economic loss, (iii) causes of losses, (iv) intervention proposed to reduce these losses, (5i) impact of reducing losses, (6i) intervention costs over 10 years and (7i) risks.

A rapid calculation of economic feasibility (cost-benefit analysis) of loss reduction interventions shows that the total cost of implementation is estimated at USD 10.4 million over 10 years. PHL can thus be reduced gradually to 50% over 10 years (5% per year) with a mid-term review. Quantitative losses in the supply chains amounted to 35%. After ten years, they are expected to be about 17.5%. If we assume that the losses are reduced by 5% a year, therefore the level of economic loss estimated at USD 110 809 000 per year will also be reduced by 5% per year (or USD 5 540 500 per year); yet the annual cost of interventions is only estimated about USD 1 million.

To achieve the objectives of reducing PHL it would be appropriate to develop an intervention program, which will be implemented at the national level through one or more institutional actors. During the implementation and monitoring/evaluation activities, other relevant partners such as Unions of Cooperatives, research organizations, NGOs and actors in the public and private sector should be involved. Hence, in order to reduce PHL in the tomato sector, three main axes should guide the implementation of an operational strategy:

- Core axe effect: (i) organization of the supply of agricultural inputs through improvement of availability, accessibility and quality; (ii) capacity development in management and marketing, especially for producer organizations, to better manage market supply; (iii) facilitating access to rural financing (acquisition of transport and packaging equipment); (iv) implement a national network for tomato actor's chain;
- Relay axe effect: inclusive Research and Development on packaging practices of fresh products for the improvement and/or substitution of traditional containers;
- Result axe effect: strengthening of technical capacities of actors (producer organizations and other) on management (including logistics), marketing, hygiene and food safety.

A national strategy for the reduction of post-production losses was adopted in December 2015 by the Cameroonian government with FAO support, but the implementation of activities is still to be launch.

### 3. Conclusion

The quantitative and qualitative losses are present at all stages of the tomato supply chain with consequences on the income of actors and lower product availability in markets.

The critical stages where losses are most significant are: the pre-harvest, harvest, transport and marketing. The production stage, with at least 2/3 of losses identified on the entire supply chain, is the main critical point that should be a priority in loss reduction strategies. The losses represent approximately 39.5% in quantitative terms including: 28.3% for the pre-harvest stage and 10.9% during transport from the main production areas (Mbouda, Foubot) to the marketing town (Douala); Qualitative losses are estimated at 31%, of which 5.2% for transport and 25.6% in marketing.

The poor chain organization impacts on transport (low professionalization), fragile packaging, lack of information on the product label, low mastery of conditioning techniques necessary for good conservation, etc. In addition, the poor state of roads prevents the product to arrive on time in the market, with a live effect on transport costs, increasing market prices. The level of losses for delayed shipments is reflected in its low price in the consumption market. Despite these constraints, there is a significant potential for the extension of production in different areas for the cultivation and development of marketing both at national and sub-regional level.

Reducing losses in the harvesting and processing greatly benefit from targeted actions such as: improving access to quality inputs, strengthening of technical and organizational capacities of stakeholders, the use of suitable agricultural and processing facilities, etc. To sustainably reduce product losses at the marketing stage, actions to be taken should have a direct effect on the transport, storage and display on retail. While the use of more robust and suitable packaging would greatly reduce mechanical losses, storage in the appropriate conditions would drastically drop the level of losses caused by the physiological deterioration of the product as a result of its conservation outdoors, under the sun or rain.

Control and reduction of losses throughout the tomato supply chain, and mainly at critical points will increase the income of the actors involved, increase the availability of goods and improve the level of professionalism in the sector. The results of this study recommend the development and implementation of an intervention program for reducing PHL, which would be implemented by the Government, in partnership with the Unions of Cooperatives, local councils, and other key stakeholders in the public and private sectors. At the level of the proposed measures, it will ensure that any implemented action benefits women, in particular actions facilitating access to finance and micro-finance structures will be relevant in this area.

Finally, the establishment of a sustainable system of monitoring/evaluation of PHL, especially in collaboration with relevant technical and financial partners, is important because it will measure, manage and know different performance of targeted value chains, through the levels of PHL performance indicators. It will also contribute to the evaluation of the implementation of PHL reduction solutions by 50% by 2025, target set in the Declaration of Heads of State and Governments of Africa in Malabo in June 2014.

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