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Factors Affecting Fresh Fruit Loss and Waste at Retail: A Focus on the Thiaroye, Pikine, and Sandiniéry Markets in the Dakar Region, Senegal

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ABSTRACT

Senegal faces a severe food crisis that is exacerbated by significant fruit waste and loss at retail. This study seeks to achieve the following objectives: (i) estimate the extent of fruit waste and loss at retail; (ii) identify the factors contributing to such waste and loss; and (iii) propose actionable strategies to reduce these waste and loss. Conducted in winter 2024 (February-March) in three major markets of the Dakar region, Thiaroye, Pikine, and Sandiniéry, the study aimed to lay the foundation for adopting good practices in fresh fruit preservation within an improved and hygienic environment. The survey involved 75 fruit retailers, focusing on socioeconomic characteristics (age, gender, education, and experience), access to information/training, types and percentages of fruits sold, handling practices (transportation, packaging, storage, displaying), and estimated waste and loss. Data were collected through semi-structured questionnaires and direct interviews, supplemented by field observations. Analysis included descriptive statistics and thematic analysis of qualitative data. The study revealed significant fruit waste and loss at the retail level in the three markets, with estimates ranging from 25% to 40% depending on the fruit type. Despite improvements in transportation and storage over the past decade, packaging, handling, and displaying practices remain major risk factors, mainly due to inadequate training and poor operational methods. Notably, while efforts to boost daily fresh fruit consumption are encouraged, policies and public investments should strengthen market infrastructure, including clean water supply, toilets, sewage disposal systems, municipal waste management, and urban planning.

Keywords: Fruit Waste, Fruit Loss, Market Infrastructure, Handling Practices, Senegal Markets.

INTRODUCTION

Senegal, like many sub-Saharan African countries, is facing a severe food crisis due to a combination of factors including inadequate access to food, inappropriate infant and young

childcare and feeding practices, poor hygiene and sanitation practices, insufficient access to drinking water and health services and substantial post-harvest losses. The World Food Program (2023) reports that approximately 1.3 million people faced acute food insecurity during the lean season in 2023. Senegal has been one of the first African countries living the "westernization" of traditional diets and the associated nutrition transition (Frazzoli and Mantovani, 2021). The combination of food crisis and nutrition transition call the local scientists and research to find out workable waste and loss reducing strategies and good practices along the whole food chain, from agricultural production (growing, harvesting), post-harvest handling and storage (washing, sorting, grading, temperature-controlled storage), post-harvest packaging and distribution. In 2010, a consumer safari in the region of Dakar, Thiès, and Diourbel, fruit was not part of the traditional meal (Frazzoli, 2020); it was poorly consumed, relatively expensive and especially consumed as canned juice. The benefit and protective effect of consuming fresh fruit was poorly known (Frazzoli, 2020). In 2018, a survey on 6,328 rural and urban households in Senegal confirmed how the consumer intake of fruit is well below the internationally recommended threshold. According to Faye et al. (2023), urban consumers eat two times more fruit than rural consumers perhaps indicating easier access in bigger urban areas even if rural-rural and urban-rural supply chains work well: rural households depend a lot (76%) on them, and only 24% of rural fruit consumption is own-produced (Faye et al., 2023). In Senegal, consumed fruit has transformed from traditional, indigenous to non-indigenous, non-traditional products like melon, papaya, apples, pears (Faye et al., 2023). The "semi-traditional" mango, associated partly with backyard production, is only a quarter of fruit consumption in urban areas and half in rural areas. Diversification in the fruit markets has seen the rise of watermelons, bananas and citrus over time. Urban consumption is nearly entirely from purchases. Only mangoes are widely (50%) home-produced (backyard trees), followed by citrus and watermelon (39%).

Low intake of fruit is associated with an increased risk of various non-communicable diseases. Research by Kouadio et al. (2020) highlights significant post-harvest waste and losses in West Africa, with figures reaching up to 50% for highly perishable fruits. Food wastage is particularly problematic for perishable items such as fruits, where waste and loss at retail are notably high. According to Gustavsson et al. (2011), global food losses and waste in the supply chain amount to 40-50% of fresh products, with perishable items like fruits facing the greatest levels of waste. This wastage occurs at multiple stages of the supply chain from production to retail, and is driven by various factors including inadequate or insufficient infrastructure, limited technical knowledge among farmers and retailers, and unfavorable environmental and climatic conditions that accelerate spoilage. Indeed, the understanding of local specific scenarios is crucial to highlight, design and implement context-specific solutions. Noticeably, in Senegal there is a notable lack of detailed studies focusing specifically on Senegalese markets. This study aims to contribute addressing this gap and support private and public decision-makers by evaluating waste and loss of fresh fruits at post-harvest distribution and retail in three major Senegalese markets: Thiaroye, Pikine, and Sandiniéry. The study seeks to achieve the following objectives: (i) estimate the extent of fruit waste and loss at retail; (ii) identify the factors contributing to such waste and loss; and (iii) propose actionable strategies to reduce these waste and loss.

MATERIALS AND METHODS

Study Area

The Dakar region is a fast-growing *conurbation* that includes the cities of Dakar, Guédiawaye, *Pikine*, and Rufisque. The study was conducted in three prominent fruit markets in Senegal: Thiaroye, Pikine, and Sandiniéry. Thiaroye is a bustling market located in the suburbs of Dakar, known for its large-scale fruit trade. Pikine, situated northeast of Dakar in the Pikine conurbation, is another major market with a high turnover of perishable goods. Sandiniéry, located in the southern part of Dakar, serves as a key regional market for fruits. According to Faye et al. (2023), purchases constitute 99% of urban fruit consumption. In fact, each of these markets was selected due to its significance in the local fruit supply chain and its potential to provide insights into post-harvest waste and loss dynamics in Senegal.



Figure 1: Localisation of the markets (Syndicat in Pikine, Sandiniéry in Sandaga and Thiaroye)

Sampling Procedures and Data Collection

A total of 75 fruit retailers from the Thiaroye, Pikine, and Sandiniéry markets were randomly selected for this study. The selection was based on a stratified random sampling method to ensure representation from different market sections and types of fruits sold. Data collection involved a semi-structured questionnaire designed to gather information on socioeconomic characteristics (age, gender, education, and experience), sources of information/training, types and percentage of fruits sold, handling practices (transportation, packaging, storage, displaying), and estimated waste and loss. The questionnaire included both closed and open-ended questions to capture quantitative data and qualitative insights. In addition, direct observations and informal interviews were conducted with market vendors to gain a deeper understanding of the challenges faced.

Data Analysis

The collected data were analyzed using descriptive statistics to determine the extent of post-harvest waste and loss and identify key contributing factors. Frequency distributions, percentages, and mean values were calculated and presented in tables and graphs. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 23.0.

Qualitative data from interviews and observations were analyzed thematically to highlight common issues and potential solutions.

RESULTS

Socioeconomic Characteristics of Retailers

The Table 1 outlines the socioeconomic profile of fruit retailers across the markets of Thiaroye, Pikine, and Sandiniéry. A significant majority of respondents, 89%, are under 50 years old, with an average age of 34 years. Most retailers (80%) have over 5 years of experience in fruit trading, averaging between 8 to 16 years. Women dominate the market, constituting 89,3% of the respondents, while men make up only 10,7%. Educationally, 12% of retailers have no formal education, 48% have completed primary education, 28% have secondary education, and 12% have attained tertiary education.

Notably, none of the retailers has received formal training in fruit management. Results reveals that 80% of retailers obtain information on good practices from other retailers, while 90% have never received such information through extension agents or traditional media.

Table 1: Socioeconomic characteristics of retailers

Characteristic	Frequency	Percentage
Age (years)		
Less than 20	5	6.7%
21–30	20	26.7%
31–40	30	40.0%
41–50	12	16.0%
Above 50	8	10.7%
Gender		
Male	8	10.7%
Female	67	89.3%
Education		
No formal education	9	12.0%
Primary education	36	48.0%
Secondary education	21	28.0%
Tertiary education	9	12.0%
Experience (years)		
Less than 5	15	20.0%
5–10	27	36.0%
Above 10	33	44.0%
Training in post-harvest management		
Yes	0	0%
No	75	100%

Distribution of Fruit Species

According to Table 2, during winter retailers sell a variety of fruits, with all participants offering at least two types. Among the 15 fruit species identified, the most sold include bananas (100%), apples (96%), oranges and limes (90% each), pears (76%), avocados (69%), lemons (60%),

and papayas (52%). Other fruits such as mangoes, apples, grapes, strawberries, pineapples, guavas, and soursops are less sold.

Table 2: Distribution of fruit species sold by the respondents (winter season)

Type of Fruit	Frequency	Percentage
bananas	75	100%
apples	72	96.0%
oranges	67	89.3%
Limes	67	89.3%
pears	57	76.0%
Avocadoes	52	69.3%
Lemons	45	60.0%
Papayas	39	52.0%
Mangoes	32	42.7%
watermelon	24	32.0%
Grapes	24	32.0%
Pineapples	15	20.0%
Strawberries	8	10.7%
Guavas	4	5.3%
Soursops	4	5.3%

Factors Affecting Fresh Fruit Loss and Waste at Retail

Most fruits have short shelf life due to high water content and easy damage during picking, transportation, and storage. Mechanical damage can favor the contamination with microorganisms, which increase the risk of spoilage. Indeed, transport by pick-up trucks or public transportation or wheelbarrow is widespread, depending on the distance, thus exposing fruit to the risk of microbiological, chemical and physical contamination. Results show that 76% of retailers use cars for transporting fruits from the main market to their shops, 24% use motorcycles, and 6% use pickup vans (Figure 2&3).



Figure 2: Transporting fruits from the main market to shops. Sandiniéry (Sandaga) market.

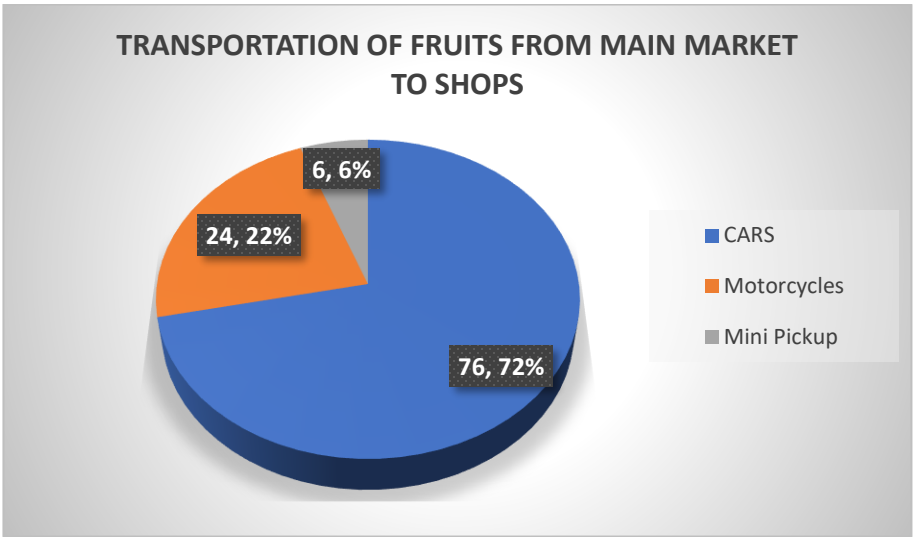


Figure 3: Distribution based on transportation system (n=75).

Inadequate transportation management, distance travelled from logistic centers to points of sale, storage and cold-chain facilities, poor operational performance including temperature control, low prices that do not cover transportation costs or unavailability of buyers are all factors affecting fruit waste and loss.

Avoiding mechanical damage during storage (at home or at the market's stand overnight) and displaying of fruit are additional main factor avoiding waste and loss. Condition (temperature, ventilation, light) and duration of storage affect fruit ripening and wilting, i.e. its shelf life and quality. Water and weight loss, changes in the pulp, texture, and colors could be monitored to quantify the ripeness level of fruits. The majority of vendors keep fresh fruits on cartons or straw, under trees, on the ground or on the wet sand roadside. Climate and sunlight are hazards for fresh fruits, due to rapid bacterial growth. Cleaning and physical sorting to remove spoiled pieces significantly reduce fungal infection and mycotoxin contamination. Hygienic practices are crucial when handling fruit. Good practices include personal hygiene like: correct hand washing after using the toilet and after touching contaminated surfaces or deteriorated food; hand drying; avoid contamination by sneezing, spitting, coughing, blowing nose, manipulating money; use personal protective equipment when sick or injured (Figure 5).



Figure 4: Storing fruits at the Sandiniéry market



Figure 5: Displaying fruits from the main market to shops. Pikine market

Proper displaying protect fruit from mechanical and biological disruption. In few days, fruits change their organoleptic properties. Fruit sold in bad conditions obviously negatively affect the market in terms of number of fruit consumers and fruit waste (Figure 6).



Figure 6: Displaying fruits from the main market to shops. Thiaroye market



Figure 7: Displaying fruits from the main market to shops. Pikine market

Hygiene practices include the environment as well, like: cleaning and care of contact materials and surfaces; protection from dust (e.g., displaying stands should be separated from the floor at least 1m); protection from vehicular traffic; use of safe packaging; collection and disposal of garbage to avoid bad smell and attraction of insects and animals; paying attention to the safety

and quality of water sources (e.g. avoid water from boreholes or artisanal sources). Vendors should be aware that investing in good hygiene practices will lead to less waste and more sales.

Figure 8 shows that 36% of retailers use perforated plastic buckets, 20% use plaited baskets and 20% jute bags, and 12% use cartons.

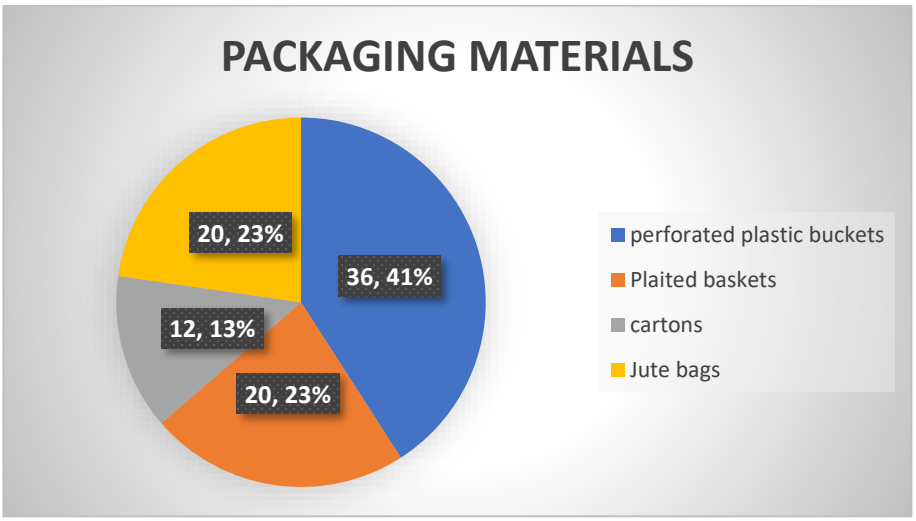


Figure 8: Distribution of respondents according to the types of packaging materials (n=75).

Estimated Waste and Loss

The study revealed significant waste and loss at retail level in the three markets, with estimates ranging from 25% to 40% for different types of fruits. Retailers estimate fruit waste and loss as 20% for limes and lemons, 40% for mangoes and watermelons, and 50% for papayas (Figure 9). Fruits like mangoes, watermelons and papayas, are the most perishable fruit among the retailers surveyed.

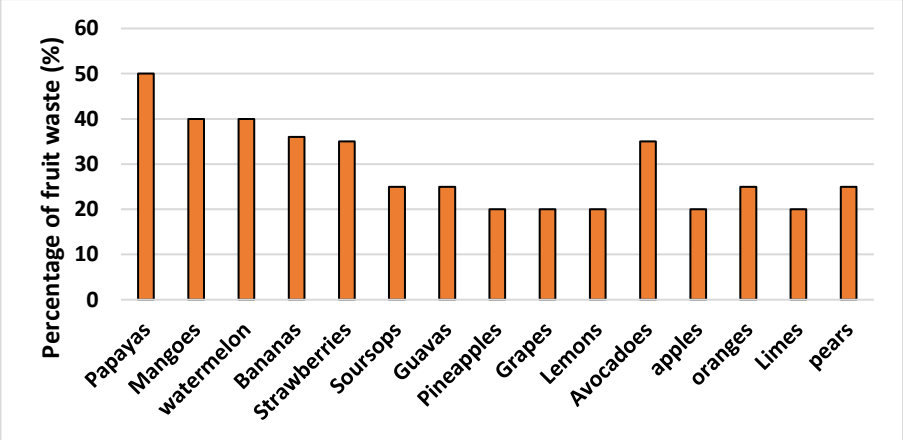


Figure 9: Estimation of fruit waste at the retailer level (n=75)

These estimated fruit waste and loss at retail turned out to be similar to those obtained by Kamda *et al*. (2021) in the same period (2017). The waste and loss of fresh fruits estimated at retail level in the study markets motivate efforts to identify avoidable causes and relevant good

cost-effective practices for the empowerment of retailers. Key factors contributing to these waste and loss at retail included inadequate storage facilities, poor handling practices, and high ambient temperatures that accelerate spoilage. Specific issues identified included insufficient refrigeration, substandard packaging materials, and limited knowledge about proper handling techniques. Main causes of fruit waste were failure to sell, mechanical damage during transport, and storage conditions. Defective or ill-suited packaging packaging materials and poor hygiene were also observed, and about 40–50% of fruits did not reach the consumers' table in Cameroon (Kamda *et al*., 2021). In Thiaroye, for instance, the lack of cold storage facilities was a major contributor to spoilage. In Pikine, handling practices during transportation were found to be inadequate, leading to increased damage and waste. Sandiniéry faced challenges related to both storage and packaging, which compounded the waste and loss. The findings suggest that targeted interventions are needed, such as improving market infrastructure, providing training for retailers on best practices, and investing in better storage solutions. Training and empowerment of retailers represent the main measure to decrease fruit waste and loss. In addition, nutritional education programs for the general population on the health protective choice and habit of daily consumption of fruits will decrease the unsold.

DISCUSSION

The diversity of fruits available in markets such as Thiaroye, Pikine, and Sandiniéry reflects Senegal's favorable climatic conditions and fertile soils, which support fruit cultivation. This variety, complemented by imported fruits, ensures a year-round supply of products like apples, oranges, bananas, limes, and mangos, meeting high consumer demand (Ndiaye et al., 2019). This trend mirrors other West African regions, such as Côte d'Ivoire, where similar climatic and agricultural conditions influence the fruit market (Ndiaye et al., 2019). According to Faye et al. (2023), only 12% of national fruit is from imports and the 76% of rural fruit consumption is from domestic sources even into and among rural areas. The supply chains of imports operate all over Senegal, with import penetration in urban settings twice that of rural areas (16 versus 8%). While in urban areas the import (bananas, apples, pears) are seen as luxury and purchase rises with income and education, in rural areas higher income reduces the import share and education has no significant effect (Faye et al., 2023). In 2017-2018 (march-may), fruits (bananas, citrus, mangoes and watermelons) formed 28.3% of fruit consumption in urban areas and 16.3% in rural areas in Senegal (Faye et al., 2023). In particular, bananas (5.2% of urban, 2.5% of rural), citrus (6.6% of urban, 4.4% of rural), mangoes (6.6% of urban, 8.1% of rural), and watermelons (9.9% of urban, 1.3% of rural (Faye et al., 2023).

This study provides insights into the demographics and professional characteristics of fruit retailers in the Thiaroye, Pikine, and Sandiniéry markets. Dominant figure in the fruit market are 34-aged women in Kamda *et al*. (2021). Despite significant professional experience, none of retailers received formal training.

The average age of these retailers, primarily under 50 years, aligns with a period of life marked by significant economic engagement, consistent with findings in sub-Saharan Africa (Doe et al., 2018; Smith & Kone, 2020). For instance, Diop et al. (2020) reported that 60% of fruit retailers in Dakar are between 30 and 40 years old, emphasizing the youthful nature of this sector. Additionally, research from Mali indicates a similar trend, with younger individuals,

particularly women, engaging in the fruit trade due to its flexibility and accessibility (Kouadio & Koffi, 2021). The predominance of women among these retailers (89%) reflects a broader regional trend where women play a significant role in food trading activities (Akinyi, 2017; Osei, 2019). Women are typically most knowledgeable about food sourcing and consumption in Senegalese households. Furthermore, the fact that 80% of the retailers have over five years of experience highlights the importance of practical expertise in managing fruit sales. However, the lack of formal training in post-harvest management is notable (Faye & Ndiaye, 2022). The reliance on informal knowledge, coupled with the widespread use of non-refrigerated vehicles for transportation, significantly contributes to waste and loss at retail. This issue is well documented in Senegal (Gueye & Diop, 2018) and is similarly prevalent in Ghana (Gueye et al., 2018).

The rural fruit consumption is strongly correlated with education, the number of women in the family, and own production (Faye et al., 2023). Education does not have much effect on fruit consumption in urban areas except at university level. Richer urban consumers ask for a more varied and higher quality fruit, while rural consumers and the poor in general use income gains to "catch up" and add more of the staples (Faye et al., 2023). Fruits are vital for nutrition due to their high content of dietary fiber, vitamins, and minerals. However, their health benefits are often compromised by significant post-harvest losses. Studies in Senegal indicate that these losses are exacerbated by inadequate post-harvest management practices, including non-ventilated vehicles and poor packaging materials, which result in substantial fruit damage and spoilage (Gueye & Diop, 2018; Faye & Ndiaye, 2022). These challenges are akin to those observed in other West African countries, including Ghana and Mali (Gueye *et al*., 2018; Kouadio & Koffi, 2021).

The study reveals significant post-harvest losses, ranging from 20% to 50%, primarily due to inadequate management practices and poor transportation methods (Sow & Gueye, 2021). The lack of formal training in post-harvest fruit management exacerbates these waste and loss at retail. Ineffective transport methods and substandard packaging materials, such as perforated plastic buckets and jute bags, contribute to fruit damage and spoilage. High temperatures and insufficient ventilation during transportation further exacerbate fruit decay (Sow & Gueye, 2021). In Senegal, post-harvest losses for fruits range from 30% to 60%, particularly during periods of heat and due to the absence of refrigeration (Sow & Gueye, 2021). Similarly, in East Africa, research highlights that climatic conditions and rudimentary storage methods exacerbate post-harvest losses (Karanja & Odhiambo, 2019).

Fresh fruit is a food category with one of the highest wastes and loss rates. The perishability of fresh fruits as well recurring pests, diseases and contamination events are primary reasons for fruit wastage, but external events (e.g. weather variability and extreme weather events) and internal strategies and practices (washing, sorting, grading, temperature-controlled storage) in both management and distribution contribute to waste and loss along the supply chains. To address these challenges, targeted interventions are essential. Enhancing retailer education on post-harvest management can significantly improve fruit shelf life and reduce waste. Upgrading transportation methods and packaging materials is also critical. For instance, employing well-ventilated containers and advanced packaging techniques can help minimize mechanical

damage and spoilage. Additionally, adopting cost-effective preservation methods, such as wax coatings or plant-based fungicides, could extend fruit shelf life and reduce losses (Sow & Gueye, 2021; Karanja & Odhiambo, 2019).

The study also identifies systemic challenges faced by fruit retailers, including inadequate infrastructure and limited access to refrigeration. The lack of proper storage facilities and poor road conditions further exacerbates post-harvest losses (Sow & Gueye, 2021). Addressing these issues requires a coordinated approach involving government agencies, NGOs, and other stakeholders. This approach should focus on improving infrastructure, enhancing training programs, and supporting retailers in adopting better post-harvest practices (Karanja & Odhiambo, 2019).

Finally, the study points to a broader issue of consumer awareness regarding the nutritional value of fruits. Despite their low cost and accessibility, consumer demand for fresh fruits remains low (Kamda et al., 2021). Increasing public awareness about the health benefits of fruits and encouraging higher consumption could significantly reduce post-harvest waste and improve overall nutritional outcomes (Mabhaudhi et al., 2018; Miller et al., 2020).

Local scientific research should engage more on safe natural storage and food packaging. Gaining knowledge on fruit physiological and biochemical change (e.g. change in shape, size, color of pulp and skin, texture, and nutritional properties) during ripening as well as on characteristics and technological abilities will anticipate attacks by fruit flies, guarantee a better controlled ripening for fresh consumption, and enhance the nutritional and economic potential of local fruit varieties. Research should assess the effectiveness of interventions, examine context-specific risk factors, and characterize indicators. Addressing the post-harvest challenges in Thiaroye, Pikine, and Sandiniéry requires a multifaceted approach that includes improving retailer education, upgrading infrastructure, and enhancing consumer awareness. By implementing these measures, it is possible to reduce post-harvest losses, improve fruit quality, and exploit the value of fruit varieties in nutrition security (Sow & Gueye, 2021; Karanja & Odhiambo, 2019; Njeru *et al*., 2022). As already stated by Kimassoum et al. (2024), primordial and primary prevention should be combined and for effective development and implementation. Primordial (or primal) prevention aims at establishing and maintaining conditions that prevent risk factors and allow the implementation of good practices (Frazzoli, 2021). Under the scheme of primordial prevention, a prerequisite program controlled by health agencies should include, e.g., clean water supply (running water and well-connected sewage connections without infiltrations, well-preserved, protected, and sanitized reservoirs and water facilities; analysis to verify water quality), toilets, sewage disposal system, municipal solid waste management (segregated and protected waste, stored in a place isolated from the food marketing area; proper sanitation of dumps and collectors, sufficient and adequate collectors and dumps), and urban/village planning (e.g. dumps and high traffic routes separated from market area) (Figure 10). With the provision of toilets, cleaning and sanitation of toilets should be assured; stakeholders should regularly collect trash and clean the market before opening to the public. Measures to control pests should be applied. In the context of primordial prevention, primary prevention, i.e. prevention based on individual good practices to avoid risk factors, becomes feasible (Figure 10).

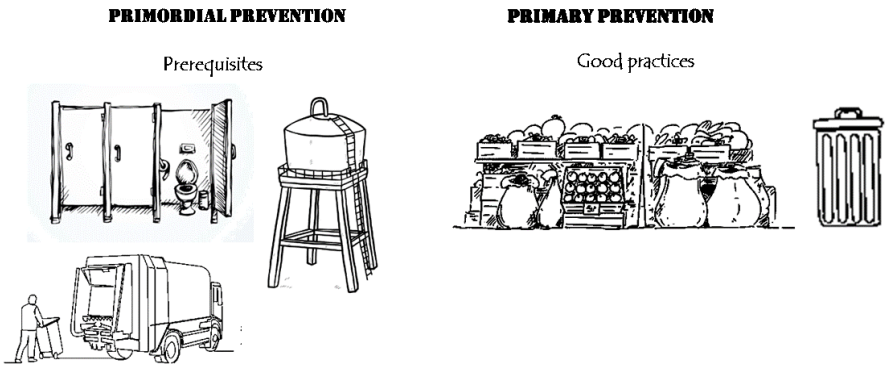


Figure 10: Good practices (primary prevention) is feasible in a context primordial prevention.

CONCLUSION

Waste and loss of fresh fruits at retail is considerable. Although many advances have occurred in the last decade in transportation and storage, packaging, handling and displaying methods are still a great source of risk factors primarily due to inadequate training on best handling practices and wrong operational practices. Fruit sold in bad conditions obviously negatively affect the market in terms of number of fruit consumers and fruit waste. Noticeably, an important process of rise in fruit consumption is happening in Senegal and it should be tracked and sustained over time. Exploring consumer behavior and demand patterns could provide insights into reducing unsold products and improving economic outcomes for retailers. This study underscores the necessity of implementing comprehensive strategies to address the underlying causes of waste and loss at retail. Boosting awareness among market stakeholders is essential. Policies and public investments should reinforce the market's prerequisites including, e.g., clean water supply, toilets, sewage disposal system, municipal solid waste management and urban planning.

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Competing interests: Authors have declared that no competing interests exist.

References

[1]. Akinyi, L. (2017). *The Role of Women in Food Trading in Sub-Saharan Africa*. African Journal of Economic Development, 15(2), 78-89.

[2]. Dieye M, N Diop Ndiaye, J Bassama, C Mertz, C Bugaud, P Diatta, M Cissé (2022). *Storage Time as an Index for Varietal Prediction of Mango Ripening: A Systemic Approach Validated on Five Senegalese Varieties*. *Foods*, *11*(23), 3759.

[3]. Diop, M., Ndiaye, M., & Sow, M. (2020). *Analyse des caractéristiques socio-économiques des détaillants de fruits à Dakar*. Journal of Agricultural Research, 58(3), 123-135.

[4]. Doe, J., Smith, A., & Kone, B. (2018). *Demographic Trends in Sub-Saharan Africa's Food Trade Sector*. African Economic Review, 22(4), 210-225.

[5]. Faye NF, T Fall, T Reardon, V Theriault, Y Ngom, MB Barry, M Rassoul Sy. (2023). *Consumption of fruits and vegetables by types and sources across urban and rural Senegal*. Journal of Agribusiness in Developing and Emerging Economies.

[6]. Faye, I., & Ndiaye, A. (2022). *Formation et gestion post-récolte des fruits au Sénégal*. Senegalese Journal of Training and Development, *15*(1), 56-70.

[7]. Frazzoli C. (2020). *Field anthropological research for context-effective risk analysis science in traditional cultures: the case of Senegal*. Journal of Global Health Reports: e2020043.

[8]. Frazzoli C. & Mantovani A. (2020). *Toxicological risk factors in the burden of malnutrition: the case of nutrition (and risk) transition in sub-Saharan Africa*. Food and Chemical Toxicology, 146:111789.

[9]. Gueye, M., & Diop, S. (2018). *Analyse des méthodes de transport des fruits dans la région de Dakar*. Dakar Journal of Agricultural Studies, 16(4), 120-132.

[10]. Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). Global food losses and food waste: Extent, causes and prevention. FAO.

[11]. Kamda Silapeux, A.G., Ponka, R.; Frazzoli, C., Fokou, E. (2021). *Waste of Fresh Fruits in Yaoundé, Cameroon: Challenges for Retailers and Impacts on Consumer Health*. Agriculture, 11:89. https:// doi.org/10.3390/agriculture11020089.

[12]. Karanja, S., & Odhiambo, E. (2019). *Évaluation des pertes post-récolte de fruits en Afrique de l'Est*. East African Journal of Food Security, 11(3), 67-80.

[13]. Kimassoum D, M Solange, K Barnabas, A Tidjani, C Frazzoli. (2024). *Fruit preservation at the Dembé market, N'Djamena, Chad: steps towards good hygiene practices*. HSOA Journal of Food Science and Nutrition, 10: 190.

[14]. Kouadio, G., & Koffi, K. (2021). *Analyse des pratiques de vente de fruits au Mali*. West African Journal of Agricultural Economics, 12(1), 45-58.

[15]. Mabhaudhi, T., Chibarabada, M., & Modi, A. T. (2018). *Nutritional value of traditional African fruits and vegetables and their potential in improving food security*. South African Journal of Botany, 119, 138-146.

[16]. Miller, V., Callahan, D., & Sullivan, T. (2020). Enhancing consumer knowledge of fruit nutrition: A systematic review. *Journal of Nutrition Education and Behavior*, 52(5), 473-485.

[17]. Ndiaye, M., Diop, S., & Sow, A. (2019). Étude sur la diversité des fruits vendus dans les marchés sénégalais. *African Journal of Food Science, 13*(2), 56-68.

[18]. Njeru, E., Wambua, P., & Mwaura, F. (2022). Post-harvest losses in fruit supply chains: A review of interventions and outcomes. *African Journal of Food Science and Technology*, 13(1), 45-60.

[19]. Osei, K. (2019). *Gender Dynamics in West African Markets*. Journal of Gender Studies, 27(1), 34-45.

[20]. Sow, A., & Gueye, M. (2021). Impact des conditions climatiques sur les pertes post-récolte des fruits au Sénégal. *Senegalese Journal of Agronomy*, 14(4), 78-89.