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Fruit and vegetables loss and waste in Uruguay, a high-income Latin American country: Causes and reduction strategies from a multi-stakeholder perspective

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ABSTRACT

Fruits and vegetables are a cornerstone of healthy and sustainable diets. Paradoxically, despite global consumption levels falling below recommendations worldwide, they are among the most lost and wasted food groups along the agri-food supply chain. The aim of this study was to qualitively explore the loss and waste of fruits and vegetables in Uruguay, a high-income Latin American country, from the perspective of diverse stakeholders. Semi-structured interviews were conducted with 20 key informants. Results suggest that most fruit and vegetable losses and waste occur at the production stage. Key causes identified include the commercial quality standards based on aesthetic criteria, overproduction resulting from uncoordinated planning, technological limitations in post-harvest handling, and the limited capacity of the national industry to absorb surpluses and suboptimal products. These structural factors are compounded by cultural dimensions, such as reluctance to consume imperfect-looking products or non-traditional edible parts. Interviewees proposed multiple strategies to reduce losses and waste, including awareness campaigns to revalue aesthetically imperfect products; strengthening coordination and planning within the production sector; investment in infrastructure and technology for appropriate product handling; implementation of recovery and redistribution processes; and the valorization of surplus and off-grade products through industrial processing. The central role of consumers was emphasized in reshaping demand patterns to foster more inclusive quality standards. These findings highlight the need for a systemic and cross-sectoral approach to reduce fruit and vegetable loss and waste in the country and to advance towards more sustainable, equitable, and resilient food systems.

1. Introduction

Fruits and vegetables are a fundamental pillar of a healthy and sustainable diet (Willett et al., 2019). Paradoxically, although consumption levels remain below recommendations across the globe (Micha et al., 2015; Mason-D'Croz et al., 2019), fruits and vegetables are the most frequently lost or wasted food items along the agri-food chain (Bartezzaghi et al., 2022; FAO, 2019; Ishangulyyev et al., 2019). Fruit and vegetable waste has far-reaching impacts across three key dimensions: environmental, economic, and social. Environmentally, it entails inefficient use of valuable natural resources such as water, soil, and energy, while also contributing unnecessarily to greenhouse gas emissions (Amicarelli et al., 2021; Poore and Nemecek, 2018). Economically, losses across various stages of the supply chain increase production and distribution costs, which in turn result in higher prices for consumers, further limiting economic access to these foods (FAO, 2019). Socially, the volume of wasted fruits and vegetables is particularly concerning in light of the levels of food insecurity affecting a significant portion of the global population, deepening inequities in access to healthy food (FAO, IFAD, UNICEF, WFP, & WHO., 2024).

This situation requires governmental action to implement strategies to reduce fruit and vegetable loss and waste, and contribute to more sustainable food systems (Reynolds, 2022). Developing effective strategies to minimize fruit and vegetable losses and waste requires a thorough understanding of their underlying causes, grounded in the perspectives of local stakeholders involved across the different stages of

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the supply chain (Alamar et al., 2018; Aschemann-Witzel et al., 2017; Thyberg and Tonjes, 2016). This stakeholder-informed approach provides valuable insights into the real-world functioning of supply chains, helps identify critical loss points and areas for intervention, and supports the design of contextually appropriate, feasible strategies (Aschemann-Witzel et al., 2017; Herzberg et al., 2023a).

Several studies have adopted a stakeholder perspective to identify viable approaches to reducing fruit and vegetable loss and waste (Beausang et al., 2017; de Moraes et al., 2022; Gillman et al., 2019; Herzberg et al., 2023a; Jun et al., 2022; Petrescu-Mag et al., 2024; Surucu-Balci and Tuna, 2022). However, significant gaps remain in the literature, as most existing studies have focused on specific segments of the supply chain and have been conducted in high-income countries outside of Latin America, with limited research addressing the regional context (Ambuko et al., 2025). In this context, the present study contributes to the field by examining stakeholders' perspectives on fruit and vegetable loss and waste across the entire supply chain in Uruguay, a high-income Latin American country. It provides an in-depth analysis of a national setting that remains underrepresented in the international literature on food loss and waste. By documenting how diverse actors perceive the magnitude, drivers, and potential solutions to fruit and vegetable loss and waste within a predominantly domestic supply chain and an emerging policy framework, the study generates insights that extend beyond the specific case study. The findings may offer analytically transferable lessons for other countries in Latin America and comparable developing countries seeking to design context-sensitive strategies to reduce food loss and waste.

1.1. Aims of the study and context

This case study aimed to qualitatively explore fruit and vegetable loss and waste in Uruguay from the perspective of diverse stakeholders involved in the agri-food chain. Specifically, the following objectives were proposed: i) to analyze the perceptions of key stakeholders regarding the magnitude of fruit and vegetable loss and waste; ii) to identify the main causes contributing to losses and waste at different stages of the supply chain; iii) to explore strategies and proposals aimed at mitigating fruit and vegetable loss and waste, taking into account the specific features of the national context.

Uruguay is a small country located in the southeastern region of South America, with a land area of approximately 176,000 km^2 and a population of around 3.4 million inhabitants (Uruguay XXI, 2024b). The country has a temperate climate that favors a wide variety of agricultural activities. Agriculture is one of the most important sectors of the national economy, with beef and soy being the main commodities contributing to the country exports and economy (Uruguay XXI, 2024a).

The fruit and vegetable supply chain in Uruguay is largely based on domestic production, with local producers supplying the vast majority of the national market, while imported products account for only a small share of total supply (Unidad Agroalimentaria Metropolitana, & Ministerio de Ganadería Agricultura y Pesca, 2025). The country has a strict regulatory framework that governs imports, the Phytosanitary Entry (Autorización Fitosanitaria de Ingreso, AFIDI), established in the late 1990s, during a period marked by competitive disadvantages for Uruguayan producers (Parlamento del Uruguay, 1991). The AFIDI is managed by the Advisory Commission on Internal Market Supply (Comisión Asesora de Abastecimiento del Mercado Interno, CAAMI), which meets four to six times per year, particularly during periods of local supply shortages or consumer price fluctuations, to assess and manage domestic market conditions and grant authorizations to import fruits and vegetables (CPA Ferrere, 2023).

Local evidence indicates that fruit and vegetables account for a significant share of food loss and waste, both at the initial stages of the supply chain and at the consumer level, particularly in households. One preliminary estimate suggests that approximately 12% of total fruit and vegetable production is lost before reaching the retail sector (Lema et al., 2017). At the household level, fruit and vegetables represent 42.2% of all food wasted (Giménez et al., 2023). These figures highlight the inefficient and costly use of foods that are essential to healthy and sustainable diets. In 2023, Uruguay adopted a National Strategy for the Prevention and Reduction of Food Loss and Waste, which sets concrete targets to reduce food losses by at least 20% in production, retail, and consumer stages by 2027, with the goal of achieving a 50% reduction by 2032 (Ministerio de Ambiente, 2023). However, no concrete actions have yet been implemented under this strategy. In this context, developing an in-depth understanding of the drivers of fruit and vegetable food loss and waste is critical for designing effective, context-sensitive strategies that support progress toward national and international sustainability targets. As a small country with a well-defined institutional framework and recent policy commitments to reduce food loss and waste, Uruguay offers a coherent setting in which stakeholder perspectives can be explored across the entire supply chain.

2. Methods

A qualitative approach was adopted to gain an in-depth understanding of the perceptions, experiences, and proposals of key actors involved in fruit and vegetable production and retail, as well as in research and public policy development in Uruguay. This methodological perspective was chosen for its ability to capture the complexity of food waste from the viewpoint of those directly engaged in the issue. The research protocol was approved by the (blinded for review).

2.1. Participants

Semi-structured interviews were conducted with key informants involved in various stages of the fruit and vegetable supply chain, including production, distribution and retail, academia, government, and non-governmental organizations focused on the recovery of suboptimal fruits and vegetables. Participants were selected based on their expertise and experience in the sector. A snowball sampling strategy was employed, beginning with initial contacts identified through institutional websites and expanding the network progressively to ensure a broad range of perspectives.

In total, 20 interviews were completed: 6 with actors involved in primary production, 7 in distribution and retail, 3 with academics specializing in production systems, 3 with representatives from government institutions linked to fruit and vegetable production, environmental policy, and rural development, and 1 with a representative from a non-governmental organization (NGO) focused on food waste. Producers represented a range of operational scales (from family-based farms to export-oriented companies) and covered diverse products, including both fruits and vegetables. Participants from the distribution and retail segment reflected different types of commercial operations, including supermarkets, small grocery stores, wholesalers, and street markets, thereby capturing heterogeneity within this stage of the supply chain.

The number of interviews was determined based on saturation. During the data collection process, the research team regularly discussed their impressions and the main themes emerging from the interviews. After analyzing the fifteenth interview, they concluded that no new relevant information was being generated, suggesting that thematic saturation had been reached. Nonetheless, five additional interviews were conducted to further diversify the sample, though they did not yield substantially new insights regarding the core themes of the study.

2.2. Data collection

The interviews took place between June and September 2024, conducted in person, by phone, or virtually (via Zoom), depending on participants' availability and preferences. All interviews were conducted by two researchers, one female and one male, with background in

consumer science and experienced in qualitative methods. A semi-structured interview guide was developed based on a review of previous studies and key themes related to fruit and vegetable losses and waste (Table 1). It included open-ended questions aimed at eliciting both general overviews and detailed narratives from participants. Interviewers used follow-up prompts to encourage clarification, elaboration, or the exploration of emerging topics. No definition of fruit and vegetable loss and waste was provided to participants. The guide was piloted during the first two interviews to evaluate its clarity and relevance. As no issues with comprehension or flow were identified, no modifications were made. The guide remained unchanged for the rest of the study, ensuring consistency in data collection.

Interviews lasted between 23 and 72 min, with an average duration of 41.5 min. All interviews were audio-recorded with participants' written informed consent. Transcriptions were generated using Whisper voice recognition software. Each of the transcripts was subsequently reviewed for accuracy against the audio by one of the authors. Transcripts were not returned to participants for comment or correction.

2.3. Data analysis

Data were analyzed using qualitative content analysis, combining both inductive and deductive approaches to ensure a comprehensive exploration of the topic. The analytical process was supported by Taguette, an open-source software for qualitative data analysis, which facilitated systematic coding and organization of the data. The coding framework incorporated emergent categories derived directly from participants' narratives, as well as predefined analytical axes that were informed by the study's objectives and existing literature.

Initially, transcripts were read in full to ensure familiarity with the content. One author conducted the primary coding, while another reviewed and discussed the emerging coding scheme and thematic structure to enhance consistency and credibility. Discrepancies were resolved through discussion and consensus among the research team. No independent reviewer or third party outside the research team participated in the coding or performed an external validation.

This iterative process enabled the identification of key themes related to three main themes: i) participants' perceptions of the magnitude of fruit and vegetable waste, ii) the underlying factors contributing to these losses, and iii) potential strategies for mitigation. Data saturation was considered to have been reached after the analysis of the tenth interview, as no new themes or relevant insights emerged from subsequent interviews. This indicated that the central categories had been sufficiently explored and additional data were unlikely to contribute substantially to the development of new concepts.

To support transparency and trustworthiness, analytic categories are illustrated with selected verbatim quotes from participants. These excerpts are identified by a numerical code and the sectoral affiliation of the interviewee (e.g., production, retail, research).

3. Results

The interview analysis allowed for the identification of perceptions regarding three main themes: i) magnitude of the problem, ii) the causes of fruit and vegetable loss and waste, and iii) proposals of mitigation strategies. The findings for each of the three thematic areas are presented in the following sections.

3.1. Perceptions of the magnitude of fruit and vegetable loss and waste

Interviewees unanimously agreed that fruit and vegetable waste represents a relevant issue in the country, with several participants describing it as a "major" problem. However, one participant offered a more nuanced view, noting that while it is indeed important, the scale may be smaller compared to larger countries or those with more complex agri-food systems. A common concern was the lack of precise national estimates regarding fruit and vegetable loss and waste.

> "It's big. We think it's around that estimate of 125 million kilos per year of fruits and vegetables, which again is just an estimate. There's no definitive data on the real volume or the internal breakdown of that number." (ID3, NGO)

> "Here in Uruguay, given our particular context, I believe it's much lower [than in other countries]. That said, it doesn't mean there's no room for significant improvement." (ID1, retail)

> "Look, 25% is like an average. Some years you see less [losses and waste], and others you easily reach 40% like nothing. And that fluctuates a lot between sectors. Not all sectors are the same, and not all quantifications give you the same results. What we have is more of a rough estimate, right? Because we've never done a precise study to see how much is lost at each stage" (ID13, government)

The production stage was identified by all interviewees as the most critical phase in terms of fruit and vegetable loss and waste. Interviewees from the production sector noted that the magnitude of losses varies significantly by crop and harvest season, with weather conditions being the main driver of this variability. Despite such fluctuations, they estimated that the percentage of loss during the production stage ranges from 5% to 20%, with an approximate average of 10%.

> "The issue of losses at the initial production stage is overwhelming." (ID11, government)

> "I think, in my humble opinion, that the volume of products left behind before even leaving the farm is greater than what ends up in dumpsters, in markets, or gets collected by Redalco [NGO organization in charge of recovering fruits and vegetables] or any other organization." (ID7, production)

> "It can reach up to half the production depending on the year and the harvest. It can be 20%, or more steadily, around 10%." (ID8, research)

> "It mostly depends on the weather. Last year, it was around 10–15%." (ID9, production)

At the commercialization stage, the magnitude of fruit and vegetable waste was also regarded as highly variable. Estimates provided by interviewees ranged from 4% to 20%. Those involved in supermarket retail tended to place their estimates at the lower end of this range, while those linked to farmers' markets reported higher percentages, closer to the upper end.

> "Generally, we're at about a 4 or 5% ratio. That's from what enters our stores." (ID14, retail)

Table 1
Interview guide used to explore participants' perspectives on fruit and vegetable losses and waste.

Question
What is your involvement in the production and commercialization of fruits and vegetables?
What is your opinion about fruit and vegetable losses and waste in the country?
Based on your experience, what are the main causes of fruit and vegetable waste in the country?
What strategies could be implemented in the country to reduce the losses and waste of fruits and vegetables across the whole supply chain?
What do you think would be the impacts of such strategies across different points in the supply chain?

Table 2
Causes of fruit and vegetable loss and waste along the supply chain in Uruguay identified by the interviewees (n = 20).

Stage of the supply chain	Cause	Quotes
Production	Inadequate production planning	"When production exceeds demand, which happens quite often and more and more due to the climate … more and more … and all of that is volume that gets lost, right?" (ID6, production) "Sometimes it's simply decided to discard the product, because, well, there's too much supply, and demand isn't enough—prices drop too much, and at that point, harvesting and everything that follows is just not worth it." (ID10, government) "If we have relatively good weather where production isn't affected, there will surely be moments of overproduction. For example, when the northern and southern harvests overlap. That's key. For instance, what signals this in strawberries is when the southern region starts producing. If we've had good weather, production overlaps and there's an oversupply, which in the end means that in Salto they stop producing and abandon crops due to cost. The same with tomatoes—if we've had favorable weather, we get overproduction … But again, these are situational, though very dependent on the weather. The problem is that a lot of volume comes all at once." (ID12, production) "There's this kind of disconnection in the agricultural sector—like one year there are no sweet potatoes, so that year prices skyrocket. Then the next year, everyone plants sweet potatoes, there's overproduction, and prices crash. So there's very little coordination, partly because this is small-scale family farming. It's a sector that's not very connected or technologically advanced. There's still that strong price incentive, but they're always chasing the carrot—too late, from what we see in terms of how food prices and availability behave from year to year." (ID3, NGO) "[In horticulture] there's no one guiding them, they haven't been able to organize … Just look at how many producer associations there are in Salto alone—small producers, but they're not united. They haven't been brought together." (ID9, production) "And what often happens is that even though we provide information and say, 'Look folks, the trend is heading this way,' producers still make poor decisions." (ID13, government)
	Adverse weather events	"Sometimes frost really damages the fruit, making it unmarketable, and it has to be discarded. You have to remove it from the tree; otherwise, it will have even worse consequences later on." (ID2, research) "Last year we lost about 50 bins of apples due to hail." (ID19, production)
	Critical defects during the production stage	"There may be defects that are later considered serious, for example in fruit trees like apples, or in tomatoes, associated with poor irrigation during cultivation. This results in a kind of internal black rot in the fruit, what's called blossom-end rot in tomatoes, and bitter pit in apples, and the fruit ends up completely devalued." (ID4, research) "Parrots are fatal. A lot of the loss happens before harvest … tons of discarded fruit ends up pecked or on the ground." (ID9, production)
Post-harvest handling and distribution	Inadequate post-harvest handling	"In fruit and vegetable production, I'd say there isn't a single product in Uruguay today … that has a complete cold chain. Cold storage is used, but only for specific stages. For instance—and it's not due to a lack of technology, because practices are very refined in apple conservation—but once the fruit leaves storage, the cold chain is broken … There's definitely room for improving practices here to reduce both direct and indirect losses in terms of reduced product value." (ID1, retail) "Globally, strawberries are harvested like blueberries here—with direct harvest into clamshells and a little bin for rejects. In Uruguay, strawberries are harvested into buckets, dumped into huge containers, and transported that way … in open trucks—one of the fruits most prone to dehydration being transported for five or 6 h at an average of 80 km/h" (ID8, research) "As long as the producer and intermediary see that the raw material holds up, they'll go for the faster or more efficient method—not the one that takes more time." (ID8, research) "One factor I think affects this is that it's a relatively expensive technology. Refrigerated trucks raise the cost of the supply chain." (ID2, research)
Retail	Deterioration during the commercialization stage	"A product may require specific handling based on its condition, and if people get it wrong, it's like malpractice." (ID5, retail) "Things in crates can get damaged, or it could be something like a bell pepper getting bruised from one crate bumping into another, some kind of physical damage, not microbiological." (ID15, retail) "It can change overnight, what goes bad on the truck. Peaches, for example, get moldy and a whole crate can spoil in a day. Strawberries are the same—if you don't have refrigeration, you have to work with exact quantities to avoid spoilage." (ID16, retail)
	Purchase planning based on expected demand	"There are certain circumstances that make a product move more or less. Internally, when we stock our stores, we use a calculation system that's basically automatic. And at the same time, local staff can let us know if the forecasted order is accurate or not." (ID14, retail) "I buy just enough too. I try to … well, you more or less know how much sells at each market." (ID16, retail)
Consumption	Lack of consumption of certain edible parts of fruits and vegetables	"We're not used to cooking with certain types of foods (…) I think there are things we don't cook with because we weren't taught, because people don't know (.) I don't know where this idea of not using beet leaves, or certain other edible leaves, or the broccoli stem or squash seeds comes from." (ID3, NGO) "I see it as a minor aspect [referring to edible parts] compared to a whole bunch of other losses. I mean, without having the numbers, but from a feeling, from a perception point of view, I see it as a minor issue. It's like we've culturally accepted that, well, we have a certain level of waste, that some of the production doesn't get sold and is thrown away, and that's just accepted across the entire chain." (ID12, Production) "The carrot top goes nowhere. The carrot top is left behind; the machine harvests the root, and the top stays in the field." (ID7, Production) "I'm thinking about leaves, like beet greens, for example, which are generally not consumed. They're not even offered in good condition because they're left to wilt. I mean, they're not valued—not even by the person selling them—because they're not taken care of as if they're going to be eaten." (ID2, Research)

(*continued on next page*)

Table 2 (*continued*)

Stage of the supply chain	Cause	Quotes
	Household waste	"From the moment the product arrives at retail onwards, that's where I believe there are significant opportunities, because that's where I observe more substantial losses, including in people's homes." (ID1, retail) "And then there's when the consumer buys the product—well, how they handle it, how it's stored in their home." (ID4, Research)
Transversal	Quality standards for marketing fruits and vegetables	"In the production phase, a big initial issue is meeting what's called 'adequate commercial quality,' which in many sectors is defined by a certain size, or by defects. Each sector has its own standard quality regulations that are often enforced." (ID4, research) "As producers, we have to adapt. If a round zucchini has excellent quality but is a little darker or not shiny, we already know not to send it to market, because if we do, it won't sell. So, what happens? Since we don't want to add extra costs to our supply chain, we just discard it before it generates more costs." (ID7, production) "At the farm level, there's a lot of waste that, for some reason, never even enters the commercial channel. I imagine the dominant factor here is the market's quality demands. Some products, from a nutritional, quality, or even sensory perspective, are totally fine, but they're not sent to market because it's known they probably won't sell." (ID1, retail) "We have the large [retail] chains in Montevideo … which are more demanding than the vendors who pick up crates to distribute in Montevideo neighborhoods." (ID9, production) "It depends on the supply available, because [during the drought], since there wasn't anything else, those [imperfect] products were visible and even sold at a decent price." (ID10, government) "If, due to certain circumstances—like weather conditions—we know there are issues with size, we adjust our tolerance levels." (ID14, retail) "In the end, it's the consumer who sets the standard … a carrot with two tips … the customer won't take it because they're used to long, straight carrots. So the customer sets that rule … Products with deformities end up being discarded because typical customers don't consume or choose them." (ID14, retail) "One thing leads to another. First came the need to achieve higher agricultural yields, and that search for better yields meant selecting things that looked better and were easier to sell. People got more options and got them more stringent. It's like if you have a black-and-white TV and someone offers you a color TV—you're going to want the color one. People keep demanding more and more perfection." (ID5, retail) "This happens because when there's an abundance of supply, the consumer becomes more demanding, wanting more and more perfection. They don't want big fruit, they don't want small fruit, they don't want blemished fruit. They're increasingly picky in their choices. And that leads to more and more leftovers." (ID6, production)
	Inadequate import planning	"Let me give you the example of apples. Last year, around August, there was a meeting with all the apple producers to assess the upcoming harvest. They estimated that they would make it to the end of the year with the apples in cold storage, but that the next harvest wouldn't be so good, so imports might be necessary. Since that time of year imports usually come from outside the region, everything was set in motion, imports were authorized, there were logistics issues … Shipments started arriving in December and kept coming into January. And it turned out that the harvest estimate wasn't that accurate. In the end, the current year's production was good, very good, in fact … What happened is that many people didn't report what they were supposed to and speculated a bit, thinking, 'If I say there'll be less, I can influence a price increase.'" (ID13, government) "I finished selling products at the supermarket in January and still haven't been able to start again because they haven't cleared out the imported ones … I ended up dumping apples … All the smaller calibers that go to the UAM (wholesale market) were discarded because, of course, the imported apples started going bad and lost all value. You'd go to any stall at the UAM and find imported apples at whatever price you were willing to pay." (ID20, production)
Industrialization	Limitations of the national industry	"The industry doesn't have the capacity to absorb all the excess food produced because it's underdeveloped." (ID3, NGO) "Imported products have driven the national agroindustry to near extinction because of the high costs involved." (ID7, production) "The lack of competitiveness in the industry is due to several things. First, it's essentially a local consumption industry, so scale is already a major issue … That's the first limitation when it comes to making investments, acquiring machinery and technologies that help reduce costs, and so on. That's a big barrier. We do have the environmental conditions to produce raw materials—they're not ideal, but acceptable. Still, industries often seek efficiency by locating in areas with more favorable environments. That allows them to produce at a much larger scale … Then there's the issue of competitiveness tied to direct competition with large industries in the region." (ID4, research)

"Roughly speaking, I'd say it could be between 10% and 20%." (ID5, retail)

"Out of 100% of the goods you bring in, maybe you lose about 8% to 10%." (ID18, retail)

3.2. Causes of fruit and vegetable loss and waste along the supply chain

Interviewees mentioned a wide range of causes contributing to fruit and vegetable loss and waste across the supply chain. Some drivers were specific to particular stages, while others operated transversally across multiple stages of the supply chain. Participants' acconts on each of the factors are presented below, whereas the quotes related to each of the causes are presented in Table 2.

3.2.1. Causes operating at the production stage

Three main causes were identified at the production stage: inadequate production planning, adverse weather events, and critical defects during the production stage. The most frequently mentioned cause was inadequate production planning, which often leads to supply significantly exceeding demand. Several interviewees pointed out that productivity has increased due to genetic improvement and mechanization,

yet consumption levels remain low in the country. As a result, and following market logic, excess supply at certain times causes prices to drop to the point where harvesting is no longer profitable, leading many products to be left unharvested and abandoned in the field. In other cases, overproduction results in stockpiling of products, which then deteriorate during postharvest storage, especially those that are highly perishable.

Producers mainly attributed overproduction to climate variability and the resulting difficulty in predicting production volumes. Meanwhile, participants from other sectors noted that losses also stem from a lack of coordination and collaboration among producers, who often make decisions individually based mainly on market prices. One government-affiliated interviewee highlighted that, while data exists on the number of producers and cultivated area, it is not effectively used to guide decision-making.

Adverse weather conditions, such as wind, frost, hail, and sun damage, also contribute to the loss of fruits and vegetables. Several interviewees noted that in many cases, the damage caused by these events does not affect the nutritional quality or safety of the products. However, these items are still discarded for failing to meet commercial or aesthetic standards.

Finally, Interviewees involved in production and research also identified the presence of critical defects, mainly related to physiological damage or pest attacks, as a cause of fruit and vegetable losses.

3.2.2. Causes operating in post-harvest handling and distribution

Post-harvest handling was identified as a key factor contributing to fruit and vegetable waste. Several interviewees pointed to shortcomings in areas such as infrastructure, storage, and product handling, which negatively affect quality, especially during transport from the north of the country to Montevideo, and from there to the rest of the territory. In this context, they highlighted the use of oversized containers, lack of proper refrigeration systems, and the use of open trucks as factors that accelerate product deterioration and, consequently, food waste.

Several interviewees noted that there are major barriers to implementing changes in post-harvest handling. These include resistance to changing established practices, prioritizing convenience in daily operations, and, in the case of refrigeration, the need for significant financial investment.

3.2.3. Causes operating at the retail stage

During the commercialization stage, fruit and vegetable waste was attributed both to the natural deterioration of the products and to accelerated spoilage caused by improper handling. Participants involved in sales at local street markets noted that this type of waste is more frequent in the summer due to high temperatures, whereas in winter products tend to last longer and spoil at a slower rate.

In addition, planning purchases according to expected demand was identified as a key factor in preventing waste during the commercialization stage, regardless of the type of sales outlet.

3.2.4. Causes operating at the consumption stage

The lack of habit in consuming certain edible parts of fruits and vegetables, such as peels, stems, and leaves, was also identified as a factor contributing to food loss and waste, although to a lesser extent. This practice was mainly attributed to cultural eating patterns in Uruguay. However, some interviewees also mentioned fears related to the possible presence of agrochemicals in these parts of the products.

Some interviewees pointed to market factors as one of the causes for the low consumption of certain edible parts of vegetables in the diet. In particular, they mentioned that the lack of consumption of products like carrot tops is partly due to technological limitations that make their preservation and commercialization difficult. Likewise, they noted that in other cases, like beet leaves, these parts are either not offered for sale or do not receive proper post-harvest handling, which prevents their use.

Another issue raised by the interviewees was related to food waste occurring in households, mainly attributed to the length of storage time and inadequate storage conditions for the products.

3.2.5. Causes operating transversally across multiple stages of the supply chain

Participants identified two causes of fruit of vegetable waste that operate across multiple stages of the supply chain: quality standards and inadequate import planning.

Participants widely agreed that market-imposed quality standards, primarily based on appearance and size, are among the main causes of fruit and vegetable loss and waste. These standards were identified as a cross-cutting factor influencing the entire supply chain and affecting most production sectors. Supermarkets, in particular, were noted for applying stricter quality criteria than other retail outlets, leading to the rejection of products that are fit for consumption but do not meet the required aesthetic standards.

In contexts of overproduction, quality standards tend to become more stringent, leading to a larger proportion of products being excluded from the commercial circuit for failing to meet those requirements. In contrast, during times of scarcity or adverse weather events these standards are often relaxed, allowing the commercialization of products that under normal conditions would be discarded. This dynamic highlights the relative and conditional nature of quality standards, which are not based on technical considerations but primarily driven by market logic.

Consumer preferences were identified as the main factor driving the quality standards applied in the market. According to interviewees, consumers tend to favor visually “perfect” products, which pushes the production system to supply fruits and vegetables that meet specific aesthetic parameters. This dynamic contributes to the generation of surplus products that, although suitable for consumption, are discarded for not conforming to those standards. Some interviewees noted that the historic abundance of produce on the market, coupled with consumer habituation to seeing only items with specific physical traits, has reinforced this level of demand, consolidating a culture of visual selection that encourages waste.

Another cause of fruit and vegetable loss and waste operating at multiple stages of the supply chain was the management of import authorizations, particularly in contexts marked by market speculation. Three interviewees indicated that, in certain situations, some producers tend to underestimate the expected harvest volume in order to create an appearance of scarcity and thus secure higher prices. This practice can lead to unnecessary import authorizations, which ultimately result in an oversupply in the domestic market. This market saturation, in turn, leads to avoidable waste during post-harvest handling and commercialization, especially of local products that lose competitiveness against imported ones.

3.2.6. Causes operating at the industrialization stage

Another theme that emerged in the discussion of the causes of fruit and vegetable losses was the lack of a robust industry capable of absorbing surplus or substandard products that do not meet the quality standards for the fresh market. While a few specific examples were mentioned, such as the citrus juice industry and the production of strawberry pulp, interviewees generally agreed that the national industry lacks the competitiveness to stand up to imported products. Producers noted that prices offered by the local industry do not cover production costs, and that imported goods, with lower production costs, represent difficult competition. Factors cited as contributing to the industry's lack of competitiveness included high production costs, the limited size of the Uruguayan market, and the high cost of importing technology.

3.3. Strategies to reduce fruit and vegetable loss and waste in the country

Interviewees identified a diverse array of strategies that could help

reduce the loss and waste of fruits and vegetables in the country. As shown in Table 3, most of the strategies focused on reducing food waste, whereas only two strategies referred to re-using foods. Strategies involving recyclying fruit and vegetable waste or transforming them into non-edible products did not emerge from participants' accounts.

Among the identified strategies, particular emphasis was placed on the need to promote a cultural shift aimed at challenging prevailing quality standards and revaluing products currently considered imperfect. In this process, consumers were identified as key actors, with the ability to influence the rest of the supply chain through their choices, as exemplified in the following quote: "I think it's clearly the end consumer who has to lead the way, but it's also true that the end consumer, in some way, shapes their expectations [referring to the rest of the actors of the supply chain] and opinions based on a whole range of factors." (ID1, retail).

3.3.1. Communication and education campaigns

Mass communication campaigns were considered essential for transforming social perceptions of suboptimal products. Several interviewees stressed the importance of informing people about the reasons behind imperfections, emphasizing that these do not affect sensory or nutritional quality. Two interviewees highlighted the value of experiential campaigns that allow people to see for themselves that so-called imperfect products have no differences in taste, texture, or nutritional value compared to "perfect" ones.

Communication campaigns and educational strategies, especially in schools, were also seen as essential to encourage the consumption of edible parts of fruits and vegetables that are currently discarded. In this regard, one interviewee emphasized the importance of promoting culinary skills that make it easier to creatively incorporate these parts into daily meals.

3.3.2. Genetic improvement

At the production level, genetic improvement was recognized as a key tool for obtaining plant materials that yield more uniform products with characteristics aligned with consumer demands. Other benefits associated with genetic improvement were also highlighted, such as increased disease resistance and improved post-harvest storage tolerance.

3.3.3. Flexibility in quality standards

Relaxing the current quality standards used in commercial circuits was proposed as a relevant strategy to reduce fruit and vegetable loss and waste. Two interviewees indicated that this shift should be primarily driven by a change in consumer preferences toward greater acceptance of products with cosmetic imperfections. They also emphasized the strategic role of wholesalers and commission agents as key players in bringing about rapid changes in applied quality standards by starting to offer products that are currently discarded. In this context, environmental impact and corporate social responsibility were mentioned as potential drivers of change within the sector.

3.3.4. Improvements in production planning

Several interviewees pointed out the need to improve production planning based on expected consumption. In this vein, they stressed the importance of having more accurate and accessible information, as well as promoting greater coordination among producers, particularly in the horticultural sector, in order to avoid overproduction and prevent avoidable losses.

One of the interviewees involved in production warned that the implementation of this strategy presents several complexities. Firstly, they pointed out the difficulties associated with coordinating production decisions among different actors, especially when it involves guiding or restricting which crops specific producers should grow. Secondly, they emphasized that high climate variability, which could lead to shortages in certain crops even when prior planning is in place, introducing a level of uncertainty that is difficult to manage.

> "It's very difficult in a type of production or sector that is so tied to climate effects. Even though we use greenhouses and can minimize risks, it's still heavily influenced by the climate. So, planning production based on expected consumption is very difficult (…) From my perspective, I see it as impossible. I mean, without even getting into the details of telling a farmer to plant this or that crop, right? I wouldn't even go there (…) We might plan for 10,000 kilos of tomatoes, but if we get two straight months of frost or 15 straight days of rain, then what was supposed to be a precise plan ends up being a bad plan." (ID12, production)

3.3.5. Promotion of short supply chains

Another strategy highlighted to reduce fruit and vegetable losses and waste was shortening the distance products travel through the promotion of short supply chains, such as local markets or direct sales from producers to consumers. Within this framework, the potential of local public procurement from family farmers was recognized as an effective way to strengthen these circuits, improve access to fresh food, and minimize deterioration caused by prolonged transport.

3.3.6. Improvements in post-harvest handling and marketing conditions

Another strategy mentioned by interviewees to reduce fruit and vegetable losses and waste was improving handling conditions during post-harvest and storage. In this regard, the expansion of refrigeration systems during transport, storage, and retail was identified as a key factor. To achieve this goal, one interviewee highlighted the potential of small producers forming associations as a way to make the necessary investments feasible. This type of collaboration could also be complemented by government incentives or subsidies to facilitate access to appropriate technologies and reduce the economic barriers to their implementation.

3.3.7. Price reduction for imperfect products

Another strategy mentioned by interviewees to reduce losses and waste of imperfect fruits and vegetables was selling them at reduced prices. According to several people linked to the commercial sector, this practice is already being implemented in the country, especially for products with some degree of deterioration, though usually without a supporting communication strategy. In particular, those involved in neighborhood street markets noted that it is common to lower prices toward the end of the day in order to sell all available goods and avoid discarding them. However, one of the individuals involved in retail pointed out that price reduction alone has not worked for them, as consumers often avoid imperfect products: "Because customers, like I said, if I put out a bell pepper with some flaw, they immediately think it's rotten and won't buy it, even if it's cheaper." (ID14, sales).

3.3.8. Recovery of fruits and vegetables

The recovery of surplus and imperfect products was mentioned by several interviewees as a viable strategy to reduce fruit and vegetable losses and waste. In the country, such initiatives are already being developed through actions led by producers, retailers, the Montevideo government, and non-governmental organizations, with the goal of improving access to fruits and vegetables for vulnerable populations. As with existing experiences, participants referred to the recovery of products both at the production sites and at wholesale and retail points of sale. Several interviewees emphasized the importance of having an efficient logistics system that enables the collection and distribution of these products. In this context, the need for state funding was highlighted to cover costs associated with harvesting, transportation, and distribution. Additionally, wherever possible, it was suggested that producers should receive partial compensation for products recovered from their fields.

Table 3
Strategies to reduce fruit and vegetable loss and waste in Uruguay identified by the interviewees (n = 20).

Type	Strategy	Quotes
Reduce	Communication and education campaigns	"To me, communication is key, because people often choose not to buy these products thinking they taste different or believing they're not as nutritious. So I think communication would really help." (ID10, Government) "That's information, a lot of information … but it also has to come with a demonstration. Otherwise, it goes in one ear and out the other. 'Oh yeah, someone told me … ' People need to experience it to realize it's true." (ID5, commercialization) "As a way to raise awareness or help people feel they can contribute and add value more directly, I see it as something very doable … If I'm cooking broccoli and someone tells me, 'Hey, if you peel the stem, you can use that too,' people will do it." (ID10, Government) "I think a good strategy could come from schools or early childhood centers, working with children or teens to start showing that these parts are edible too—integrating them into what's taught about fruits and vegetables." (ID2, Research) "I think cooking, let's call it that, should be part of the school curriculum—and that should include learning to use all parts of food." (ID3, NGO)
	Genetic improvement	"It's about finding varieties that are a bit more uniform in the sizes that are most in demand. Fruit with the shape and colors that consumers …" (ID6, Production) "Improving the foundation of the raw material, which is the genetics of the cultivars (…) First, there's everything needed for the field to work well—adaptation, disease resistance, etc.—and that also includes the yields you can achieve (…) and then there's the issue of post-harvest life." (ID8, Research)
	Flexibility in quality standards	"[We should work with] those who have stalls in wholesale markets or large retailers, like supermarkets, to accept this type of product. I think that's a very important level to move the needle more quickly because there are fewer actors, and if they become aware—supermarkets, for instance—they could offer them at a lower price, or with different marketing, or quick-sale baskets with these imperfect products, and frame them as eco-friendly, reducing waste, etc. Or the intermediaries at UAM or other wholesale markets could start becoming aware that they're doing good—for the country, the environment, for employment—by incorporating this kind of product." (ID2, Research)
	Improvements in production planning	"Organizing internal production according to consumption patterns—I think there's a lot of work to be done on that front." (ID14, commercialization) "There should be a regional observatory that says, look, based on domestic market needs and the production conditions of the area, it would be important to have a certain number of hectares of one crop and another of a different one. In that sense, producers could distribute what they grow and generate food more rationally." (ID11, Government) "I would bet on coordination, yes, on coordination, being able to organize things differently so that all producers don't plant the same thing at the same time (…) Reality shows that if you're not organized, those people don't have support or guidance on how to sell their produce, because there's no planning. They're not organized—it's more about tradition or intuition—and sometimes it goes well, very well, and other years it's just average." (ID9, Production)
	Promotion of short supply chains	"Shorten the distance between production zones and consumers a bit. Because what often happens here is that produce travels to Montevideo and then goes back out again. So, the quality that reaches the final destination is very poor—especially with leafy vegetables. It happens with all of them, but it's more noticeable with leafy greens. There are some initiatives, in some places they are trying. It's even happening here in Canelones—they are trying to implement some local markets and get closer to the consumer to sell more directly." (ID13, government)
	Improvements in post-harvest handling and marketing conditions	"Here in the north, we experience it a lot … the issue of not having adequate infrastructure. For example, cold storage is very important for some products here in the north. So, being able to work with those involved in these processes to develop the proper infrastructure … When I say infrastructure, I mean cold storage facilities, appropriate sheds, the type of transport, and also the type of packaging." (ID11, government) "So, that's an important limitation [regarding cost] for accessing these things, which you sometimes achieve more easily through support—state support, or any kind of support associated with it." (ID2, research)
	Price reduction for imperfect products	"Obviously, I think that if those [imperfect] products were available in supermarkets at lower prices (…) I know a lot of people would prefer them, because they'd understand and appreciate the value." (ID3, NGO) "(…) for producers to make those fruits and vegetables available, but also for merchants—and I think the role of intermediaries in the supply chain is key here—to create offers or promotions so that consumers not only know that the product is safe to eat, but also know where to find it and that the conditions are favorable." (ID11, government) "Saturdays are the last market day of the week, and that's when, around 11 in the morning, I lower all my prices to sell everything and head home empty-handed." (ID18, sales)
Re-use	Recovery of fruits and vegetables	"One could imagine there's a way to take advantage of that produce I mentioned that doesn't leave the farms. But of course, that would require good resources—logistics, transportation, knowing what to do with the product and understanding that it will vary throughout the year and from year to year." (ID8, research) "I think the State should maybe start with some kind of pilot program targeting lower-income groups. That is, thinking about how the State can step in. If we have food being wasted on one hand, and on the other, people in need, how can we avoid putting more burden on any part of the supply chain to make this work, and how can the State support that (…) Maybe the State could bring some kind of tool—whether it's compensation or taking responsibility for the collection and logistics." (ID12, production)
	Industrialization of surplus and imperfect products	"The issue of figuring out—with a lot of imagination, given our conditions—an alternative use [in relation to industrialization] seems key to me, and would be very helpful." (ID4, research) "In Chile, for example, there was a group working with leaves, right? Of course, leaves or leaf scraps from wholesale markets are always available—if it's not one kind, it's another. So, they had developed a product for making soups (…) They had different recipes depending on the season." (ID10, government) "One planned action (…) has to do with adding value to food that would otherwise go to waste, right? Adding processing steps so the food can be used in different food service settings. We've proposed to work on this within the framework of community kitchens." (ID11, government) "I imagine something well-structured, well-coordinated, with the capacity to (…) [produce] semi-processed or fourth-range products, depending on the product type, to enter a market niche that is currently underserved—that of easier-to-use products. I would combine those two ideas. That is, the ability to use a product that might be free or very cheap, and at the same time already have in mind a way to market it outside of the channels that are currently blocked (…) I think there's a lack of more products that are ready-to-use in some way, whether fresh or frozen." (ID8, research)

3.3.9. Industrialization of surplus and imperfect products

Another strategy suggested by several interviewees to reduce fruit and vegetable waste was the use of imperfect or surplus production through small-scale processing ventures. Although significant challenges were acknowledged, mainly related to production costs and market scale, this strategy was considered potentially viable with strong cross-sector commitment. Purchasing products that are currently discarded could help reduce costs, at least covering harvest and logistics expenses. The importance of these ventures having the flexibility to adapt to a wide variety of products and fluctuating volumes, especially at certain times of the year, was also emphasized. In this context, the development of initiatives that use more consistently available raw materials, such as leafy vegetable residues, was proposed. Additionally, there was mention of encouraging small businesses with state support, such as community kitchens, which could serve a dual purpose: reducing food waste and generating social value.

One of the interviewees noted that recovering imperfect products through industrialization should focus on producing minimally processed products that make household meal preparation easier and faster. This strategy could help address one of the main barriers to fruit and vegetable consumption in the country: the time and effort required for preparation.

4. Discussion

The results of this study show that fruit and vegetable waste in Uruguay is perceived by key stakeholders across the supply chain as a complex and multi-causal phenomenon. Although interviewees highlighted the lack of precise national data to rigorously quantify the magnitude of the problem, they mostly agreed that the problem is relevant throughout the entire supply chain. These perceptions are consistent with evidence on the contribution of fruits and vegetables to national food waste (Giménez et al., 2023; Lema et al., 2017), as well as with the international evidence (FAO, 2019). The magnitude of the losses of fruits and vegetables in the production, postharvest storage and commercialization stages reported by the interviewees are in the mid range of the values reported by a recent systematic review of global studies (Ambuko et al., 2025).

The production stage emerged as one of the most critical points for fruit and vegetable loss and waste, consistent with national estimates (Lema et al., 2017). This finding contrasts with most global assessments, which indicate that the majority of losses and waste occur during postharvest handling, transportation, retail, and household consumption (Ambuko et al., 2025). Context-specific factors within the Uruguayan agricultural system may account for this divergence, as discussed in the following section.

4.1. Causes of fruit and vegetable loss and waste

Interviewees identified several interrelated drivers operating across the supply chain as causes of fruit and vegetable losses and waste. Four elements were particularly prominent in the Uruguayan case. First, commercial quality standards in generating losses, both at the production and commercialization stages. According to the interviewees, the demand for visually “perfect” products directly impacts selection, discarding, and marketing decisions throughout the entire chain, reinforcing a pattern that excludes products that do not meet these expectations, even if they are perfectly safe and nutritious. Consumer expectations and demands regarding the appearance of fruits and vegetables were identified as the main factor sustaining these standards.

Second, the interviews also revealed structural causes related to inadequate production planning and weak coordination among supply chain actors. Interview accounts indicated that decisions about crop selection and production volumes are largely individualized, with few mechanisms for collective planning or demand forecasting. According to stakeholders, this contributes to periodic market saturation and situations in which harvesting is not economically viable. In this sense, losses reflect governance and coordination constraints, not only technical inefficiencies or climatic factors.

Third, infrastructure and postharvest management limitations, particularly insufficient cold storage and transport conditions, were described as recurring causes of deterioration before products reach consumers. Although Uruguay is classified as a high-income country, stakeholders emphasized persistent logistical and technological gaps. Finally, the limited capacity of the national processing sector to absorb surplus or off-grade produce was highlighted as a structural constraint. Interviewees pointed to small scale, high production costs, technological limitations, and difficulties competing with imported products. These factors, combined with the relatively small domestic market, restrict the development of alternative channels for valorizing suboptimal products.

The causes of fruit and vegetable losses and waste identified in this study have been widely documented in high-, middle-, and low-income countries (Bartezzaghi et al., 2022; Beausang et al., 2017; de Hooge et al., 2018; Herzberg et al., 2023b; Johnson et al., 2019; Magalhães et al., 2021; O'Connor et al., 2023; Petrescu-Mag et al., 2024). This suggests that, despite its status as a high-income country, Uruguay continues to face challenges typically associated with middle- and lower-income contexts, particularly in areas such as transportation infrastructure, postharvest storage, and the adoption of appropriate postharvest management practices, as has been observed in countries like India and Brazil (Balaji and Arshinder, 2016; de Moraes et al., 2022).

Although the identified causes are not new, comparison with international evidence highlights relevant distinctions. First, while aesthetic standards are globally recognized as drivers of waste, Uruguayan producers reported limited use of alternative marketing channels for suboptimal products, in contrast to experiences documented in some European countries (de Hooge et al., 2018; Göbel et al., 2015). Products that do not meet cosmetic criteria are frequently left unharvested or diverted to low-value uses, particularly during surplus periods. Second, although consumer expectations were frequently identified as sustaining visual quality standards, interviewees rarely acknowledged the reinforcing role of retail practices. International literature suggests that retail display norms contribute to shaping consumer expectations (de Hooge et al., 2018). This discrepancy reveals how responsibility for losses may be perceived asymmetrically across actors. Thus, the contribution of this study does not lie in identifying novel causes, but in showing how well-documented drivers interact within a specific institutional, economic, and market configuration, shaping where and why losses and waste occur.

Upcycling has been identified as a key strategy to reduce food waste (Aschemann-Witzel et al., 2023). However, in the present study, interviewees emphasized the limited capacity of the national processing industry to absorb surplus products or those that do not meet fresh market standards. According to the interviewees, this weakness stems from various factors, including high production costs, low operational scale, the sector's limited competitiveness, and difficulties in accessing appropriate technologies. These barriers are compounded by Uruguay's relatively small domestic market and its dependence on imported equipment and inputs, which further constrains industrial innovation and flexibility. This situation appears to contrast with Uruguay's classification as a high-income country and highlights a broader structural characteristic of its agri-food industry, which has faced persistent competitiveness challenges since the market liberalization reforms of the 1980s (Timpers, 1996). These reforms exposed local industries, particularly small and medium-sized enterprises, to increased external competition without a corresponding increase in technological capacity or economies of scale (Bértola and Porcile, 2006). As a result, the processing sector has faced difficulties in evolving towards more integrated, circular models that could enable the valorization of off-grade products, as seen in some larger or more industrialized economies.

4.2. Strategies to reduce fruit and vegetables losses and waste

Interviewees proposed a wide range of responses encompassing cultural change, stronger coordination mechanisms, technological improvements, food recovery initiatives, and the development of small-scale processing alternatives. A central proposal was the promotion of a cultural shift to challenge prevailing aesthetic quality standards and revalue so-called suboptimal products. In this context, consumers were identified as key actors capable of influencing practices throughout the agri-food chain. Communication campaigns and educational strategies, particularly those implemented in schools, were considered essential to fostering a more critical and informed understanding of the value of food. Additionally, hands-on food experiences and the strengthening of culinary skills were viewed as important strategies for encouraging more sustainable consumption habits and reducing waste at the household level.

At the production level, improved planning and greater coordination among producers were seen as essential to prevent oversupply. Strengthening logistics and expanding access to refrigeration technologies were also emphasized, particularly as areas requiring public investment. In addition, stakeholders highlighted food recovery initiatives linked to social programs as promising mechanisms to reduce losses while addressing food insecurity, especially when supported by public policies that offset harvesting and logistical costs. Finally, the development of small-scale processing initiatives capable of handling heterogeneous volumes was also proposed. In the Uruguayan context, such initiatives were framed not only as environmental strategies but also as opportunities for local economic development and social inclusion.

The strategies identified align closely with the recommendations of international organizations and previous studies, which advocate for a systemic approach to reducing food loss and waste (Akbar et al., 2025; Bhattacharya and Fayezi, 2021; FAO, 2019; Herzberg et al., 2023a; HLPE, 2013; Lipinski et al., 2016; Matzembacher et al., 2021; Thyberg and Tonjes, 2016). Most of the strategies were located in the top of the food waste hierarchy as they intended to reduce fruit and vegetable losses and waste (Papargyropoulou et al., 2014), whereas strategies aimed at recycling were not mentioned by participants.

The contribution of this study lies instead in illustrating how stakeholders prioritize and interpret these strategies within a specific national setting. For example, while consumer education was emphasized, international evidence suggests that consumer preferences are shaped by broader supply chain practices (de Hooge et al., 2018). This indicates that interventions must distribute responsibility across actors rather than focus exclusively on end consumers. Similarly, although upcycling and processing are widely promoted internationally (Aschemann-Witzel et al., 2023), stakeholders in Uruguay emphasized structural barriers, such as scale and competitiveness, that may limit their feasibility without sustained policy support. Within this framework, the production of ready-to-eat foods, such as prepared salads or frozen products, was identified as a particularly promising strategy, not only for its potential to reduce waste but also for its capacity to increase fruit and vegetable consumption by addressing one of the main perceived barriers among the Uruguayan population: the time and effort required for preparation (Ares et al., 2018, 2025; Machín et al., 2018).

In addition, strategies aimed at recovering surpluses and suboptimal products were viewed positively, especially when linked to social inclusion goals, such as donations to civil society organizations or state-run food programs. In this regard, initiatives with government support that cover harvesting costs and facilitate the necessary logistics for the collection, conditioning, and distribution of recovered food were highlighted as effective ways to reduce loss and waste while also enhancing food security for vulnerable populations. The importance of supporting farmers through subsidies and tax exemptions has been emphasized in previous studies as a key strategy to enhance the feasibility and sustainability of food donation programs (Johnson et al., 2019; Lee et al., 2017).

Overall, the findings reinforce the international consensus that reducing fruit and vegetable loss and waste requires systemic approaches rather than isolated interventions. At the same time, they demonstrate that the effectiveness and prioritization of such strategies depend on national market structure, governance arrangements, industrial capacity, and stakeholder perceptions. The viability and sustainability of the identified strategies largely depend on a stronger inter-institutional coordination, which enables the alignment of actions among the various actors in the agri-food system, including the public sector, private sector, civil society, and community organizations (Bhattacharya and Fayezi, 2021). In this regard, the National Strategy for the Prevention and Reduction of Food Loss and Waste represents a key framework for coordination and collective action (Ministerio de Ambiente, 2023), aimed at promoting the structural transformations necessary to achieve a more efficient, equitable, and sustainable food management system. The effective implementation of the identified initiatives requires not only political will but also specific investments to strengthen technical, logistical, and organizational capacities throughout the entire chain, thus facilitating the fulfillment of the country's medium- and long-term commitments.

4.3. Limitations

The results of this study should be interpreted in light of several limitations inherent to its qualitative design and scope. As is characteristic of qualitative research, the objective was to explore how stakeholders conceptualize and make sense of fruit and vegetable loss and waste, rather than to quantify its magnitude or verify specific claims. Accordingly, the findings reflect subjective interpretations shaped by participants' roles, experiences, and institutional contexts.

The use of purposive and snowball sampling, while appropriate for identifying information-rich key informants, limits the transferability of the findings. Although efforts were made to incorporate perspectives from diverse stages of the fruit and vegetable supply chain, certain actors (such as small-scale producers in more remote areas) may be underrepresented. In addition, while several strategies were implemented to enhance analytic rigor, including iterative coding and team discussions, qualitative analysis necessarily involves interpretive judgment. No external auditor or independent reviewer outside the research team participated in the verification of coding or thematic development. Despite these limitations, the study offers an in-depth and contextually grounded account of how key stakeholders perceive fruit and vegetable loss and waste in a Latin American setting, where systematic empirical evidence on the underlying drivers of these losses remains limited.

5. Conclusions

This study shows that fruit and vegetable loss and waste in Uruguay is perceived by stakeholders as a significant and systemic issue affecting all stages of the supply chain, with a particular concentration in the production stage. The causes identified are diverse and often interconnected. At the production level, losses are closely linked to oversupply, price volatility, aesthetic quality standards, limited coordination among producers, and the frequent economic infeasibility of harvesting products that do not meet commercial criteria. At the distribution and retail stages, losses are associated with cosmetic standards, demand fluctuations, and logistical constraints—especially weaknesses in cold chain infrastructure—while retail practices contribute to reinforcing expectations regarding visual perfection. Across the chain, gaps in postharvest management and the limited capacity and competitiveness of the national processing sector constrain opportunities to valorize surplus or suboptimal produce. Overall, the findings indicate that food loss and waste in Uruguay is not merely a technical issue, but one also shaped by culturally embedded quality norms and by governance and coordination challenges rooted in market structure and institutional arrangements. Addressing the problem therefore requires integrated

measures, including improved production planning and coordination, investment in logistics and infrastructure, reconsideration of rigid aesthetic standards, communication and education strategies, strengthening of food recovery initiatives, and support for processing and upcycling alternatives. Advancing toward a more efficient, equitable, and sustainable fruit and vegetable system will depend on coordinated action among public institutions, private actors, academia, and civil society, supported by structural rather than isolated interventions.

CRediT authorship contribution statement

Ana Giménez: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Gastón Ares:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Ethical statement

The study was approved by the Ethics committee of the School of Chemistry of Universidad de la República (Protocol No 101900-000018-23).

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Data availability

Data will be made available on request.

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