



Culture of Sustainability *Culture della Sostenibilità*

International Journal of Political Ecology

ISSN 1972-5817 (print) 1972-2511 (online) web: culturesostenibilita.it

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To cite this article: Sganzetta L. M., Mura G., Borrelli N. (2021).
Urban food policies and public markets: opportunities for food waste
management. *Culture della Sostenibilità*, 28. DOI 10.7402/CDS.28.006



2021 · Istituto per l'Ambiente e l'Educazione Scholé Futuro Onlus



Published on line: Dicembre 2021



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Urban food policies and public markets: opportunities for food waste management

Lorenza Maria Sganzzetta, Giulia Mura, Nunzia Borrelli¹

Abstract

The following work stems from the observation that local public markets, with their potential to generate communities and spread good practices, can become “sustainable food places”, a spillover of virtuous behaviours. Public markets that are developing positive behaviours in terms of food waste, may prove to be the driving force behind bottom-up best practices, becoming active actors of Urban Food Policies (UFPs).

By observing 70 markets in the city of Milan, it is shown that participants to public markets differ in their practices of food waste management. The authors suggest the urgency for the public actor to modulate its actions in order to exploit the potential of the public markets as drivers for effective UFPs.

The first paragraph illustrates the birth of UFPs through a theoretical framework that defines their main characteristics. The second paragraph describes food waste and circular practices, identifying public markets as places favourable to their development, due to their characteristics of trust, mutuality and connection. The third focuses the attention on the case study of public markets in Milan, describing the survey carried out and the data analysis. Then, in the fourth part, the study identifies some peculiarities in Milan’s markets and structure an index assessing the propensity to virtuously manage waste and surpluses (Food Waste Avoidance Index).

The final paragraph discusses the research hypothesis, and the results of the case study. The features and the drivers identified lead the authors to suggest a variety of actions that the public actor could implement, in order to support effective UFPs.

Key words: public markets, food waste, food policies, circular economy, sustainable food places

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Riassunto

Il lavoro che segue nasce dall'osservazione del fatto che i mercati pubblici locali, con la loro potenzialità di generare comunità e diffondere buone pratiche, possono diventare “luoghi del cibo sostenibile”, dove si generano una serie di comportamenti virtuosi. I mercati pubblici che stanno sviluppando comportamenti virtuosi in termini di spreco alimentare, potrebbero rivelarsi la forza trainante dietro le migliori pratiche dal basso, diventando attori attivi delle UFP, ovvero delle politiche alimentari urbane.

Osservando 70 mercati nella città di Milano, è dimostrato che i partecipanti ai mercati pubblici differiscono nelle loro pratiche di gestione dei rifiuti alimentari. Gli autori suggeriscono l'urgenza per l'attore pubblico di modulare le proprie azioni al fine di sfruttare il potenziale dei mercati pubblici come driver per UFP efficaci.

Il primo paragrafo illustra la nascita delle politiche alimentari urbane attraverso un quadro teorico che ne definisce le principali caratteristiche. Il secondo paragrafo descrive lo spreco alimentare e le pratiche circolari, identificando i mercati pubblici come luoghi favorevoli al loro sviluppo, per le loro caratteristiche di fiducia, mutualità e connessione. Il terzo focalizza l'attenzione sul caso studio dei mercati pubblici milanesi, descrivendo l'indagine svolta e l'analisi dei dati. Infine, lo studio identifica alcune peculiarità dei mercati milanesi e illustra un indice, generato a seguito della valutazione della propensione a gestire in modo virtuoso sprechi e surplus (Food Waste Avoidance Index).

Il paragrafo conclusivo discute l'ipotesi di ricerca e i risultati del caso di studio. Le caratteristiche e i driver identificati portano gli autori a suggerire una serie di azioni che l'attore pubblico potrebbe implementare, al fine di supportare UFP efficaci.

Parole chiave: mercati pubblici, spreco di cibo, politiche alimentari, economia circolare, luoghi alimentari sostenibili.

Aknowledgments

We thank LANGUAGE ACADEMY SCARL for providing language help. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

■ Introduction

In recent years the issues relating to food waste and its prevention have increasingly gained attention in public and academic debates. Numerous initiatives have been promoted to find new solutions to the management of food related issues, at an international, national and local level.

The following work stems from the observation, developed through the reading of the scientific literature and the analysis of case studies, that local public markets, with their potential to generate communities and spread good practices, can become “sustainable food places”, a spill over of virtuous behaviours and attitudes.

We suggest that public markets that are developing virtuous behaviours in terms of food waste, may prove to be the driving force behind bottom-up best practices, becoming active actors of Urban Food Policies.

By observing 70 markets in the territory of the city of Milan, and by mapping them, collecting primary data and constructing the prototype of an index that measures the propensity to virtuous management of food waste, it is shown that participants to public markets differ in their practices of food waste management. The authors consequently suggest a need for the public actor to modulate its actions in order to exploit the potential of the local markets as drivers of good practices and spaces of intervention for effective Urban Food Policies.

In order to define the research question and support this hypothesis, the article is organized as follows. The first paragraph illustrates the birth and diffusion of Urban Food Policies in the world as well as in the city of Milan through a theoretical framework that defines their main characteristics and initiatives in the territory. The second paragraph introduces the issue of food waste and circular practices for the purpose of sustainable management of surpluses, identifying public markets as places favourable to the development and, above all, the spread of these practices, due to their characteristics of trust, mutuality and connection among stakeholders. The third paragraph focuses the attention on the case study of public markets in Milan, describing the survey carried out as well as the data analysis. The results make it possible to describe the sale and waste of food in Milan’s market stands, and the data have also been utilized to submit a proposal for an index assessing the propensity to virtuously manage waste and surplus food (Food Waste Avoidance Index).

The fourth and final paragraph discusses the research hypothesis in the light of the considerations proposed by the scientific literature, and the results of the case study. The variability of the situation highlighted in the markets as well as of the drivers that have an impact on the propensity to avoid food waste lead the authors to suggest a variety of actions that the public actor could implement, in order to exploit the potential of the local markets and structure effective Urban Food Policies.

■ The growing diffusion of Urban Food Policies

In this era, characterized by vast changes such as globalization, growing world population, rapid urbanization, volatile markets and climate change, the relationship between cities and food has become an increasingly crucial issue to be addressed for future sustainable development (Tricarico et al.,

2019). Scientific literature has recognized the importance of adopting public interventions such as urban food policies and bottom-up initiatives to manage territorial externalities and uneven developments, especially regarding the management of spatial functions for food production, distribution and consumption in urban areas (Morgan, 2015; Marsden, Murdoch, Morgan, 1999; Pothukuchi, Kaufman, 1999).

Moreover, the United Nations declared the need to ‘make cities and human settlements inclusive, safe, resilient and sustainable’, according to one of the Sustainable Development Goals (SDGs) adopted in 2015 (United Nations, 2015).

In the last decades, food policies have been conceived as part of the strategic plans of several governments in many parts of the world in an attempt to limit the unsustainable provisioning of food (Sganzzetta, Tricarico, 2018). They are oriented towards a new geography of the food system that generates new food production practices (Morgan & Sonnino, 2010). At the local level, a growing number of city governments are implementing “urban food policies”, with special focus on the urban scale of intervention (Baker & Zeeuw, 2015). To develop effective urban food policy a municipality needs to define and coordinate the effort of various actors; indeed, a significant involvement of civil society and other stakeholders is often at the origin of this typology of actions, which can be characterized by a systemic approaches or as single-issue policies (Calori, Magarini, 2015; Morgan, 2015). Systemic urban food policies represent policies that seek to address multiple challenges of the food systems, and therefore need the collaboration of various government departments. The process of developing integrated urban food policies often starts with an assessment of all the food-related issues and the policy tools to tackle them (Sonnino, 2016). Such actions, even when not systemic, but addressed at more specific concerns (e.g., obesity, food waste), can be beneficial in other policy areas (Sonnino et al., 2019).

Food waste, circular practices and promising role of public markets

The attention in terms of economic and human resources that the food policy of Milan and of other cities have dedicated to food waste has its roots in the connection of the theme with environmental, circular economy and public policy issues on which even supranational bodies are currently focusing².

Moreover, the promising trends towards the green sector of public policies of the city of Milan and other European cities, are oriented by the Circular Economy Action Plan, the document issued by the European Commission on Circular Economy, according to which the Commission will aim to analyse the impact of circularity on mitigation and adaptation to climate change; to improve tools for modelling the benefits of the circular economy on greenhou-

² See the EU Platform on Food Losses and Food Waste in order to better identify, measure, understand and find solutions to deal with food waste (https://ec.europa.eu/food/safety/food_waste/eu_actions/eu-platform_en) or the FAO initiative SAVE FOOD: Global Initiative on Food Loss and Waste Reduction (<http://www.fao.org/save-food/en/>)

se gases; and to promote the strengthening of the role of circularity in national energy strategies and climate plans.

Scientific studies report that one third of global food production is lost or wasted along the supply chain (Kummu et al. 2012) “1.3 billion tons of food meant for human consumption never reach tables, representing an economic value of about 1,000 billion dollars/year” (Segrè, Azzurro, 2016, p. 14).

Segrè and Falasconi (2011) explain that, in Italy, waste is a widespread phenomenon, in as much as on average, some 105,458 tons of fruit and vegetables are thrown away in the stores, which results in the consumption of more than 73 million m³ of water in a year, the use of environmental resources equal to almost 400 m² equivalent (and the emission of more than 8 million kg of CO₂ equivalent into the atmosphere). Even more worrying are the data relating to the waste of meat: in Italy, in the distribution and retail step of the food chain, 22,000 tons of meat are wasted, whose production requires 127 million cubic meters of water, 9.7 million tons of carbon dioxide and 8,360 hectares of land, necessary to absorb the emissions associated with the process³. Regarding the assessment of the economic impact of food waste throughout the supply chain, in Italy, a value of 10 billion euros per year has been estimated for the losses that occur in agriculture, 1.2 billion for industrial waste and 1.5 billion for those concentrated in the distribution phase, for a total of approximately 12.7 billion euro (Segrè, Falasconi, 2011).

Furthermore, the Waste Watcher Observatory report of 2019 on the assessment of the economic impact of food waste throughout the supply chain estimates a total waste at over 15 billion Euros, of which just over 3 billion linked to chain waste and nearly 12 billion to domestic waste.

The same report in 2013 reported that about 26% of Italians were “sensitive to the environment, concerned about poverty, and morally disturbed by wasting food, but it was still unable to check the expiry date on the packaging”, with obvious consequences in terms of food waste (Waste Watcher, 2013). Later, in 2015, the Waste Watcher Observatory promoted family diaries, pointing out that the real waste of domestic food was 50% higher than that perceived and declared in the polls, setting the annual cost for Italians at around 13 billion Euros.

As a matter of fact, the data of the family diaries presented in 2019 showed that roughly 4/5 of waste in Italy could be attributable to domestic consumption, and confirmed a limited perception of household waste issue within the Italian population, which often deems the waste deriving from commercial, industrial and public activities to be far more important

³ These data make the FAO data relating to farms which are responsible for 20% of harmful gas emissions all the more serious. If we add the weight of the tons of carbon dioxide generated by the waste to these emissions, we realize that the meat (produced and wasted) has a very negative impact on the environment and climate change (Segre, Falasconi, 2011).

(Waste Watcher, 2019).

The causes of food waste differ for each stage of the agri-food chain. As was pointed out by BCFN (2012), food losses in agriculture are attributable in the first analysis to climatic and environmental factors, to the spread of diseases and to the presence of parasites (Kummu et al. 2012; Williams et al., 2011).

In the first transformation phases of the agricultural and semi-finished products, the causes of food waste are mainly constituted by technical malfunctions and inefficiencies in the production processes. This phenomenon is called production waste. In the retail phase (both for large and small distribution), waste stems from multiple causes, including inappropriate orders and incorrect demand forecasts. Finally, domestic waste can arise from the consumer's difficulty in correctly interpreting food labelling; either because overly large portions are prepared (both in restaurants and at home); or owing to the mistakes made during the purchase planning phase (often induced by promotional offers); or finally when the food is not properly stored (Gustafsson et al., 2013).

In developing countries, the most significant losses are concentrated in the first part of the agri-food chain. In developed countries the largest share of waste occurs in the final stages of the agri-food chain (domestic consumption and catering in particular), but in these countries as well, there are significant losses in the production phase (BCFN, 2012, pag. 12-13; Parfitt et al., 2010).

One question already discussed in the scientific debate focuses on how and whether the recovery of food surpluses might tackle malnutrition and world hunger issues. Garrone et al (2012) examine the question in depth, stating that "at least in the short and medium term, there are no tools available with which the surpluses generated by rich countries can be used in massive way to respond to the drama of hunger and malnutrition in the poorest parts of the world" (Garrone et al, 2012, p. 45).

Another interesting debate regards the link between management of surplus food and the reduction of food insecurity in developed countries, such as Italy or other European countries.

The sociological debate on these issues focuses, on the one hand, on behavioural and attitudinal factors that drive a greater propensity to waste, or to greater attention to the recovery and redistribution of excess food (Koivupuro et al., 2012; Evans, 2012; Gaiani et al., 2018); and on the other hand, on how the practices of donating surplus food to fringes of the poor population can generate forms of social capital (Segre, Falasconi, 2011).

In this regard, interesting scenarios seem to be emerging, especially as concerns surpluses' recovery practices by public services or food banks⁴. In this sense, there is an interesting academic debate that illustrates the different impacts of food banks activities (Rizvi et al., 2021; Middleton et al., 2018),

⁴ Food Banks are public-private associations that recover unsold, but still edible food, and donate it to non-profit associations that take care of the poorest.

reducing food waste and reusing surpluses in a circular way for charity purposes (May et al., 2020).

In the latter case, translating food surpluses into donated food for the most disadvantaged categories might be a lever for the creation of territorial social capital. In other words, it may be an effective tool for the development of forms of trust, of place-based social relationships, rooted in the territories and generated by these roots⁵.

Public markets, in this sense, are characterized by these forms of trust and represent “sustainable food places”, favourable areas to the implementation of good practices, due to the close connection between vendors and producers and their frequent interaction with the public administration (Micheletti, 2010).

Although still not widely discussed, the connection between the role of public markets in reducing waste and the implementation of circularity practices shows a great deal of promise, owing to the characteristics of public markets as places of sociability and collectors of good practices. Several city councils around the world (see Milan Food Policy, London Recycles and NYC Food Policy Center) undertook to plan and support public-private initiatives aimed at recovering surpluses and waste in the main places of purchase and consumption of food, such as restaurants, bars, supermarkets, peddlers, and also public markets.

A concept of public space like public markets has been expressed by American and Northern European “farmers’ markets”, markets constituted solely by local farmers and vendors who must adhere to a series of sustainability and quality standards in order to access them, and often characterized by the presence of alternative food networks⁶ (Beckie et al., 2012).

Likewise, public markets generate and host virtuous and sustainable practices, as they support the local food culture and create a strong sense of community. These features are developed in public markets because of the values of locality and quality that help foster a relationship of mutual trust and motivations that encourage consumers to attend public markets (Oñederra-Aramendi et al. 2018).

By examining the linkages between producers and consumers at a public market, often embedded⁷ with a sense of local identity, there is the potential to

⁵ Alongside these positive readings of surpluses donations, others tend to see this approach as a mechanism that does not effectively help low-income families but feeds a welfare system that inhibits a real solution of the problem (Winne, 2005, p.204).

⁶ These networks are often defined as forms of food provision that are counteractive to conventional food systems because newly emerging networks of producers, consumers and other actors provide alternatives to the more standardized mode of production. They focus on the processes of localization of production and on the reconnection between producers and consumers.

⁷ Many authors deconstructed Polanyi’s concept of embeddedness related to the market, society and politics, connecting it to the semantic field of the local food systems and of public markets.

better understand how social interactions can support the spread of sustainable good practices (Hunt, 2007).

Social embeddedness⁸ conveys principles of social connectivity, reciprocity and trust, in public places like public markets, characteristics which are essential to all economic life in general, but which fundamentally underpin grassroots and “alternative” initiatives and community development strategies (Sage, 2003).

Public markets, hosting public and private best practices, have proven to be vehicles of innovation and fertile places for the promotion of environmental sustainability and virtuous circular economy behaviours. They can therefore stimulate political and strategic innovations of cities (Tangires 2020; Morales 2009).

They are very complex places where commercial and social functions co-exist (Lipari, 2019)⁹.

Public markets, from mere places of commercial exchange, reveal a multifunctional character and a determining potential on the neighbourhood and on social behaviour, influencing attitudes towards good practices (Morales, 2009). Furthermore, Tangires (2020) demonstrates how market design influences community use, and Gerend (2007) suggests that markets can provide uses for underutilized and vacant sites. In this way, urban public markets affect the spatial evolution of cities and strengthen the sense of local community, while maintaining structural differences with the markets of rural areas and playing an important role of innovator and reconstructor of the territorial network (Marsden et al. 2000).

■ Milan’s food policy and the actions in public markets

The assessment of Milan’s food system started in 2014, with a specific focus on the urban cycle of food, the socio-economic context and the main actors dealing with the food chain. In 2015, the study was shared with around 700 stakeholders through open roundtables and public conferences, which led to the publication of a comprehensive urban food policy. One of the main priorities identified by this strategy was food waste, among another five areas of intervention. Then, in 2016, a specific set of guidelines was laid down with the aim of tackling food losses and waste at the local level, supporting bottom-up and top-down actions.

Over the following years, the Municipality of Milan implemented some

⁸ The concept of embeddedness indicates the roots of economic activities in society. The production, distribution and consumption of goods depend on social factors such as culture, habits, a sense of responsibility and reciprocity towards others (Granovetter, 1985).

⁹ For a definition of public markets, see Lipari, L. *I mercati rionali: luoghi iconici dell’urbano tra tradizione ed elementi innovativi* in Nuvoletti, G. (Ed.). (2019). *Enciclopedia Sociologica dei Luoghi* (Vol. 1). Ledizioni.

interventions aimed at reducing food waste across the city. One of the most relevant is a discount on the waste tax, approved by the Municipal Council in February 2018. This measure reduced the tax on waste for food businesses (supermarkets, restaurants, canteens, producers etc.) that donate their food losses to charities, by 20 percent. Three main departments of the municipality (Fiscal, Environmental, Food Policy) cooperated in a working team to plan the action.

In 2016, the National law governing food and pharmaceutical products donation and distribution for social help and to limit waste (Legge 19 Agosto 2016, n. 166 ‘Disposizioni concernenti la donazione e la distribuzione di prodotti alimentari e farmaceutici a fini di solidarietà sociale e per la limitazione degli sprechi’) was issued by the Italian Parliament. Through this regulation, operators from the food sector are encouraged to donate leftover food to associations and charities that are in charge of the collection of these goods.

Specific attention was paid, in this context, to the role played by local markets and the development of initiatives and actions at this level.

One example of an anti-waste initiative activated in public markets concerns the company set up with the public investment of the Municipality of Milan, AMSA¹⁰ which, in 2016, started separate waste collection in 15 city markets and obtained effective results: “About 89 tons of organic fraction were collected thanks to bio-compostable bags, compared to just 11 tons that finished in the bins in some markets in the same 2015 period”. At the end of 2017, the separate collection was carried out by 46 markets (AMSA data provided by the Municipality of Milan, February 2018). AMSA estimates that 2,500 tonnes of wet food could be collected in a differentiated way once the service has been extended to all outdoor markets. In this case, the emission of 420 tons of greenhouse gas (CO₂ equivalent) and the consumption of 148 tons of oil equivalent per year would be avoided (AMSA data provided by the Municipality of Milan, February 2018).

Another action of particular interest for this research is that promoted by the RECUP association¹¹. This is an active citizenship project that came into being towards the end of 2014 from the free initiative of two students who then got other volunteer citizens, meeting in the WhyZ association involved in collaboration with the web newsletter of urban environmental policies Eco delle Città and Fondazione Cariplo.

Whilst the project’s goals include food waste recovery, it also includes strengthening the sense of community, through an action to change working habits in the local markets of Milan. Starting from the Viale Papiniano market, the project has spread to other areas and is today present in ten markets in the

¹⁰ AMSA (acronym for Azienda Milanese Servizi Ambientali) is a company of the A2A group that manages the collection and disposal of municipal waste in the city of Milan and fourteen municipalities in the Milanese metropolitan area.

¹¹ For further information on RECUP Association, see <http://associazionerecup.org>

Milan area (Cambini, Martini, Pasteur, Curiel, Valvassori Peroni, Bonola, Vespri Siciliani, Val Maira and Piazza IV Novembre a Melegnano), also thanks to the award, in 2017, of the renowned “Giacimenti Urbani e Eco Nelle Città”. The formula promoted provides that at the end of the market, volunteers shall retrieve the food, which is then brought to a collection point, selected and then distributed among the volunteers themselves. According to the association “in this way a concept of collaboration and community between different people is created, an intercultural and intergenerational contact that was previously missing”. In the last year alone, the initiative has made it possible to recover 25 tons of food products (Data provided by RECUP, February 2018). The association also promotes workshops in schools, focused on acquiring greater awareness of nutrition and the waste attached to it.

■ The case study: Milan’s public markets and non-waste propensity

In order to observe the dynamics of waste management and food surpluses in public markets, Milan was selected as a case study and a collection of primary data was undertaken, through GPS tools, interviews and questionnaires.

Thanks to the data collected and the considerations on the literature on waste and markets, the prototype of an index was designed to measure the propensity of public market vendors to waste food products.

The survey benefited from the support of a group of students from Bicocca University of Milan who, supervised by the authors, carried out the field work, administering a questionnaire to vendors of different markets, exploring the propensity for virtuous behaviours in terms of reuse of surplus food. A total of 846 questionnaires were collected, consisting of questions relating to the personal characteristics of the respondents, the products sold and the perception of surplus food, to understand if there was a greater propensity to waste or to circular practices.

In the construction of the index that measures the propensity of the markets to donate and recycle the unsold, thus avoiding food waste, variables were employed relating to the most frequent behaviours and those that could be activated in the presence of certain conditions.

The following paragraphs introduce the questionnaire first, then describe the sample, the markets and how they manage the unsold, then finally discuss the main results that emerged.

The questionnaire, the data collection and the sample

The questionnaire adopted for data collection was created ad hoc for this research and collect information on:

- Characteristics of the stand (products offered, supply methods and lo-

gistics management ...)

- Perception and representation of surplus, waste, recycling, and donation of unsold products
- Personal data of the respondent.

In the comprehensive panorama of Milan's commercial activities, the reference universe of this research is represented by the 86 local markets hosted by the city on daily or weekly basis. Of these, 70 were included in the research, allowing an almost complete coverage of the areas of the city. A total of 846 questionnaires were collected and used for the analyses. Data were collected in May 2017, through a pen-and-paper questionnaire completed by the respondents with the assistance of the researchers. The respondents were contacted in person during their work in the markets. Once informed of the purposes of the research they expressed informed consent for the anonymous treatment of the collected data.

The sample is mostly composed of middle-aged men of medium to low educational qualifications (in greater detail, 70% of respondent is male and 30% female, the age span goes from 18 to 80 with average age of 46 and 49% who stopped their education at 14 years of age, while only 3% has a higher education degree). Consistently, these are mostly workers with many years of experience, who have generally sold in the market where the interview has been held for several years. Almost all of them also sell in other markets (96% of respondents) and work several days a week (34% have a market every day, 59% several times a week).

The products sold in the markets includes vegetables (46%), fruits, (46%), milk and derivatives (16%), cured meats, (14%), eggs (12%), meat (12%), bread and baked products (10%), pasta (7%), oil (6%), preserves and marmalades (6%), rice (5%), jams (5%), honey and beehive products (5%), wine (4%), flour (4%), legumes (4%).

By analysing the correlations between the products most sold by the same stand, it is possible to identify 5 groups of products that are generally sold together:

1. Fresh (Fruits and vegetables): 48%
2. Products of animal origin (Eggs, milk, meat, and cured meats) 30%
3. Starchy food (Rice, pasta, flours, bread): 15%
4. Preserved products (Honey, jams, marmalades, preserves): 11%
5. Bottled products (Oil and wine): 8%

Although the offering of the stands is varied and there are no fixed categories of products that are sold jointly, it is possible to identify groups of products that tend to be sold in combinations. The stands generally offer either fresh products, or various combinations of the other types of products.

In most of the cases, products are purchased from suppliers (91%) and only rarely self-produced (9%). If self-produced, in 70% of cases they come from the province of Milan. In rare cases, the production company is part of one or more networks (5%).

As concerns attention paid to specific customer requests, 24% sell organic

products, 16% gluten-free products, 12% lactose-free products, 10% km0 products, 8% vegan products, 5% no-GMO products, 1% fair trade products. In 65%, products with a quality mark are sold (DOP, etc.).

In their election of suppliers, respondents mainly turn to wholesalers (75%). In 28% of cases the products are purchased through direct contact with the manufacturer, and in 24% with a representative of the manufacturer. The products are purchased from national suppliers in 48% of cases, otherwise they come from regional (16%), local (14%), European (14%), non-European (8%) suppliers.

The main weekly load is carried out in 71% of the cases several times a week (two or three times by 36% of the respondents and more than three times a week by 35% of the respondents); 22% of the respondents do it once a week and the rest does it less frequently.

Management of daily waste among sellers

The first topic emerging from the data collected is related to the daily food leftovers. There is a very high variability in the kg of advanced products: it ranges from 0 to 400 kg, with an average amount of 51 kg, a median of 23 kg, and a mode of 10 kg. Basically, those stands selling fruit and vegetables report the highest levels of daily surplus (average surplus = 72 kg), significantly detaching themselves from the stands selling other products (average surplus = 27 kg).

Unsold products are mainly stored in refrigerators (46%), privately owned storehouses (35%) and refrigerated vans (27%). 7% use a shared storehouse and only 4% say they do not store any products.

The respondents indicate that goods that remain unsold, in their opinion, because

- They expected to sell more (54%);
- There is high variability of taste and needs between customers of different markets (34%)
- It is convenient to buy larger amount of stock (15%);
- The goods were damaged or scarcely attractive (8%);
- Other reasons (6%);
- Does not know (5%);
- The products that are not sold are then:
 - Sold on other markets (55%);
 - Donated (16%);
 - Thrown away (8%);
 - Other (9%);
 - Sold at a lower price (7%);
 - Sold to restaurants (5%).

The proportions of the types of food that get wasted are consistent with those of the foods that are sold: mainly fruit and vegetables, followed,

with a wide detachment, by products of animal origin such as meat, cured meats, milk and derivatives, eggs and baked goods.

In fact, the amount of discarded food is highly connected with the sale of fresh food (Kendall's tau b = .216; $p > .001$).

When asked to give an assessment of the amount of food they waste in their work, respondents generally agree over a vision of very low waste: in fact, 88% of them affirm to waste very little or nothing.

Accordingly, they don't seem to be generally preoccupied with the produce waste, (not at all/mildly concerned 69%; quite concerned 12%; very much concerned 18%)

The food waste avoidance index: a prototype

This index has been created to summarize information concerning the propensity to waste of each respondent, and to ultimately try to organize them on a geographical basis, mapping the propensity to waste in the different markets of Milan.

The first step of analysis led to the selection of the variables to be included in the index.

Several Categorical Principal Component Analysis were then run to identify the best way to resume the different variables, identifying underlying patterns. The final model includes 7 variables (amount of food left over after each market; how leftovers are disposed of; propensity to donate; propensity to donate if incentives were to be provided; amount of food thrown away weekly; estimation of the cost and concern about the wasted food) and explain the 72.87% of the total variance, with three components. The first component account for the 32.5% of the variance, the second for the 21.13 % and the third one for the 19,47%.

Dimension	Cronbach's Alpha	Total (Eigenvalue)	Variance Accounted For
1	.650	2.258	0.32
2	.378	1.479	0.22
3	.311	1.363	0.19
Total	.938	5.101	0.73

Looking at the component loadings it possible to see what each component represents: component 1 is connected with the aversion to throw away food; component 2 sums up the propensity to donate food and component 3 relates mainly to data of leftover goods.

	Components	
	Waste aversion	Propensity to donate
Daily leftovers	.263	.111
Leftovers disposal strategy	-.275	-.309
Propensity to donate leftovers	-.423	.783
Propensity to donate leftovers in exchange for incentives such as budes	-.430	.761
Evaluation of the amount of edible products wasted daily	-.796	-.212
Evaluation of the cost of edible products waste	.709	.170
Level of worry about edible product waste	.783	.325

Therefore, to compose our index only components 1 and 2 were included and the following formula was applied*:

$$\text{Waste Avoidance Index} = (\text{Explained var C1}) / (\text{Total explained var}) * c1(a-n) + (\text{Explained var C2}) / (\text{Total explained var}) * c2(a-n)$$

Waste Avoidance Index:

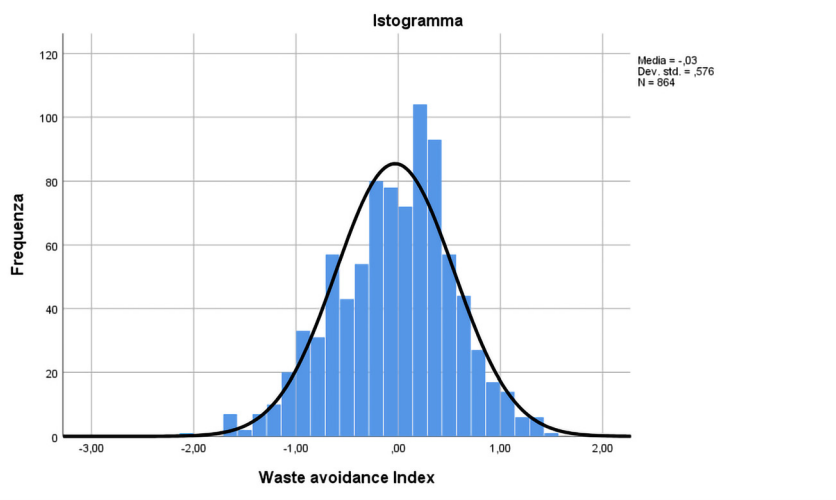


Fig. 1 - Waste avoidance index

Of the 70 markets investigated, in 2017 only 6 of them (Esterle/Cambini, Martini, Termopili/Monza, Curiel, Papiniano and Valvassori Peroni) were involved in RECUP's action, the organization devoted to the reduction of food waste and its distribution among market's users that was presented in paragraph 3.

The analysis of significant differences in the value of the waste avoidance index does not give positive results. However, when checking for mean differences in the values of the three components identified via CPC is possible to see that the mean values for the third component (related to the amount of food remaining and its disposal as waste of possible donation) have a slight but significant difference ($p < 0.000$), with the markets where RECUP is developing its action scoring mean = 0.29 and those where RECUP is not present scoring mean = -0.08.

This data seems to suggest that RECUP's main impact is related to the actual donation of leftovers, while it does not reach a more extensive impact, on the general attitude and representations of the respondents

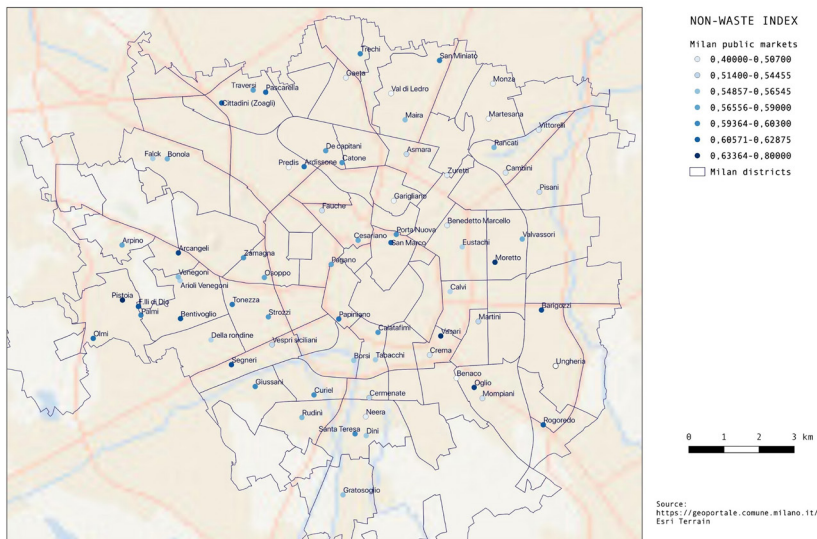


Fig.2 - The food waste avoidance index applied to 2017 data collection in Milan's public markets

■ Discussions and conclusions

The case study of Milan's public markets was analysed to apply the methodological prototype of the food waste avoidance index. The analysis provided for a geographical mapping of 70 Milanese markets spread throughout the city's districts, by means of GPS detection of the geographical coordinates, a primary data collection through questionnaires to vendors of the markets and the final processing of the index, through which it was possible to observe different levels of propensity for non-waste in the Milan public markets.

The study revealed different levels of propensity that have been grouped into seven ranges, as shown in Figure 1. Although the index and the visual representation of the results highlight the geographical distribution of the propensity to avoid waste, it was not possible to identify drivers or elements of spatial and economic connection of the results, such as the concentration of the markets with a certain index in the poorest or richest areas of the city.

However, it is possible to make considerations on the observed index and on potential action designs for the various cases detected.

The characteristics of public markets, described in the previous paragraphs as "sustainable food places", concentrations of social embeddedness and collectors of good practices, make them a potential tool for the implementation of city's anti-waste policies. In this sense, public markets represent an actor who can contribute to public policies and sustainable urban planning.

In those markets that achieved a low value in the index, and which therefore reveal a low propensity to avoid waste, it is necessary to intervene with public awareness raising policies and information campaigns on the topic, to spread a different culture that promotes a circular system of resources. There is, in these markets, the potential to spread good anti-waste practices in the community of vendors and users, through targeted communication and narratives of the public actor on environmental, health and economic issues related to food.

Public markets that achieved a high value in the index represent, instead, virtuous models that can act as a spill over for good practices also in other markets.

These markets, in some cases, already host public-private anti-waste initiatives, as for example groups of volunteers and associations at the end of the sales activities collect the leftover fruit and vegetables still edible, demonstrating the potential of markets as "sustainable food places"

These and many others could represent good practices to be activated in high index markets, already inclined towards virtuous behaviours of reuse of surplus and reduction of waste

The work here present is a first suggestion of an instrument that should be however further validated. To assess the propensity to avoid waste and to apply the proposed index more effectively, it would be necessary to undertake a new and extended data collection that establishes geographical and territorial connections between the index and the type of market. Once the instrument is

further validated, it could become a useful tool of screening for the assessment of the real situation of different realities when planning extensive intervention, allowing to modulate the offer based on the specific needs detected in the area.

The authors also suggest the Municipality of Milan, already sensitive to the issue of sustainable food systems, support research and allocate funds for anti-waste initiatives within public markets, as places full of potential and favourable characteristics to the dissemination and spill over of best practices.

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