# Evolution of a collection scheme in 15 years: quality and efficiency in the North Italian experience

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**Abstract**

When considering organic waste collection, quality is always a critical aspect. This work summarizes the experience of the Northern Italian waste management public consortium TV3 (Treviso Tre), which has been running residential source separation schemes of organic waste since the mid 1990s. Today the mature separate collection scheme shows contamination rates of less than 2% in the collected feedstock.

The aim of the work is to show the evolution of the scheme in a timeframe of 15 years, looking at major changes and improvements that helped to achieve the present performance.

Waste characterization analyses have been an essential tool in the planning and monitoring of such schemes, and this work is based on a large data set of more than 300 analyses performed between 1998 and 2009.

Evidence is shown about how the type of collection ("fetch" schemes vs. "bring" schemes) and the choice of tools used in the household (containers and bags) is essential in determining the quality of the collected food waste.

**Keywords**

Organic Waste, Food Waste, Residential Source Separation, Waste Analysis, Compostable Bags

# 1 Introduction

## 1.1 Background

At present, Italy is treating approximately 3.5 M tonnes per year of biowaste. More than one third of that is residential food waste collected separately.

According to CIC (Consorzio Italiano Compostatori), the Italian Composting Consortium, in 2008 1800 municipalities in Italy were performing residential food waste collections, serving 17.5 M people or 30 percent of the total Italian population. In 2010, the population served by residential food waste collections is estimated to be around 20 million people (CENTEMERO ET AL., 2008).

In terms of quality of the collected feedstock, in 2009 CIC performed 530 waste characterization analyses in 29 different Italian provinces. A contamination rate lower than 5%

was found in 57% of the samples; another 25% of the samples showed a contamination between 5 and 10%. The rest are above 10%.

Looking at how the food waste collection systems work in Italy, there are two predominant models: “fetch” schemes with door-to-door collection vs. “bring” schemes with large centralized containers placed on the roads (Figure 1). According to the organic waste characterization analyses of CIC, in 2009 the road container schemes showed an average contamination of 6.11%, whereas in the door-to-door schemes it was 2.52% (CENTEMERO, 2010). Although the door-to-door schemes may seem more expensive in the collection stage, recent comprehensive data demonstrate that this kind of collection is achieved without raising overall costs, keeping them at the same level or lower than the collection of bring schemes. (REGIONE LOMBARDIA, 2010; GIAVINI ET AL., 2010).

*Figure 1 Road containers vs. curbside bins (food waste) and bags (residual waste)*

## 1.2 The “I.S.S.O.” collection model

The door-to-door system in most cases includes curbside collection of residential food waste and will be here defined as “intensive source separation of organics” (I.S.S.O.). This method is characterized by specific features and tools that allow for high captures, low contamination rates and strong participation by citizens.

In the I.S.S.O. model, all of the waste fractions (food waste, dry recyclables and residual waste) are collected at the curbside. Unsorted waste generation is reduced because it can no longer be dropped off anonymously in centralized roadside containers.

Unlike central European systems, curbside collection of garden waste is discouraged to address waste minimization, limiting it to seasonal collection services linked to “pay as you throw” systems, and via promotion of home composting or direct delivery to recycling facilities or waste transfer stations (FAVOINO ET AL., 2006). Recent research from the UK confirms that schemes with combined food and garden waste collection achieve a much lower yield per household, compared to weekly food waste only collections,

and hence a lower level of diversion of food waste from the residual waste (WRAP, 2010). In the I.S.S.O. model, all of the collections are intimately connected, focusing on the management of food waste. The system calls for high frequency collections of food waste in order to keep the organic fraction low in the residual waste stream (less than 10%). Food waste collection typically ranges from one to three times a week, depending on season and local climate conditions (mediterranean/continental). Because of the reduced content of putrescible materials, residual waste can therefore be collected on a weekly or biweekly (fortnightly) basis.

*Figure 2 Mechanical and manual tipping of food waste in compostable bags*

The food waste is collected in smaller (3- to 5-$m^3$ capacity), quicker, cheaper and more environmentally friendly (e.g. methane powered) collection vehicles, without compaction (Figure 2). There is also manual tipping of 35-liter bins for single houses, which allows for reduced pick-up time compared to mechanical tipping of larger bins (condominiums are still provided with 120- to 240-liter bins, serving 10 to 20 households each). A final feature of the system is the use of indoor household tools for maximizing ease of use and increasing participation. Vented kitchen bins (8-liter) and yearly supplies of compostable bags are given to each household (Figure 3). Bags are certified according to European compostability standard EN 13432.

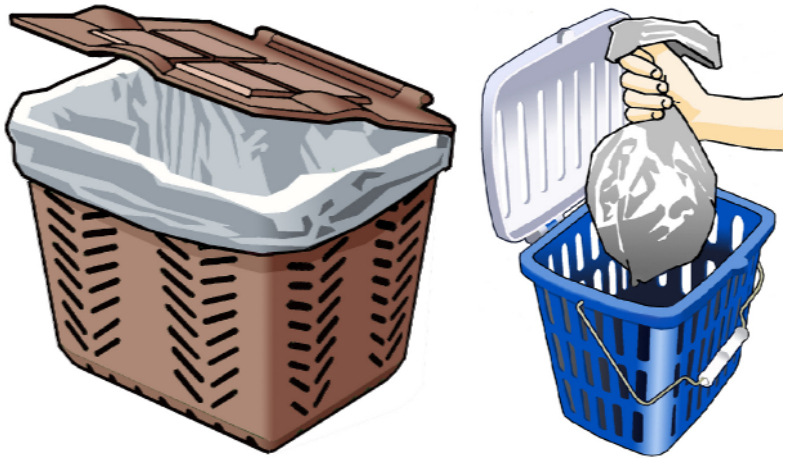

*Figure 3 Vented kitchen bins and compostable bags*

# 2 The experience of the waste consortium TV3

In the present study the results of a series of waste characterization analyses are shown and discussed. The analyses refer to the residential food waste fraction collected in the area managed by the waste management public consortium Treviso 3 (TV3).

The territory of TV3 has a population of approximately 220.000 inhabitants and lies on the western part of the Province of Treviso within the Veneto Region, in the north-eastern part of Italy (about 30 Km from Venice). It includes 25 Municipalities scattered on an area of approximately 620 $Km^2$. The two main Municipalities are Castelfranco Veneto (33.591 inhabitants in 2008) and Montebelluna (30.887 inhabitants in 2008). In the residential areas detached or semi-detached housing is predominant together with low-rise buildings.

*Table 1 Waste data of the TV3 Municipalities in the period 2004-2008*

| Municipality | Population | Waste per capita (kg/inh*y) | Total waste (Tons) | Separate collection (Tons) | S.c. % 2004 | S.c. % 2005 | S.c. % 2006 | S.c. % 2007 | S.c. % 2008 |
|---|---|---|---|---|---|---|---|---|---|
| Altivole | 6.679 | 346 | 2.310 | 1.571 | 63,75 | 63,97 | 64,34 | 64,12 | 68,02 |
| Asolo | 9.222 | 330 | 3.048 | 2.083 | 64,28 | 62,96 | 68,89 | 64,17 | 68,35 |
| Borso del Grappa | 5.756 | 367 | 2.112 | 1.266 | 60,5 | 60,85 | 60,51 | 62,02 | 59,95 |
| Caerano di San Marco | 7.941 | 386 | 3.069 | 2.076 | 67,56 | 67,92 | 67,13 | 67,53 | 67,63 |
| Castelcucco | 2.173 | 376 | 816 | 571 | 68,47 | 66,94 | 66,6 | 68,48 | 70,00 |
| Castelfranco Veneto | 33.591 | 498 | 16.725 | 10.811 | 64,57 | 64,26 | 64,52 | 61,71 | 64,64 |
| Castello di Godego | 7.018 | 334 | 2.346 | 1.611 | 63,61 | 64,83 | 64,95 | 65,45 | 68,68 |
| Cavaso del Tomba | 2.965 | 381 | 1.130 | 715 | 61,02 | 59,74 | 60,58 | 60,41 | 63,28 |
| Cornuda | 6.183 | 394 | 2.436 | 1.639 | 66,81 | 65,34 | 66,42 | 64,97 | 67,28 |
| Crespano del Grappa | 4.767 | 400 | 1.908 | 1.204 | 61,13 | 59,91 | 61,05 | 61,83 | 63,11 |
| Crocetta del Montello | 5.989 | 384 | 2.301 | 1.457 | 61,14 | 62,57 | 63,69 | 60,99 | 63,32 |
| Fonte | 6.119 | 350 | 2.143 | 1.423 | 67,32 | 64,57 | 66,45 | 65,5 | 66,41 |
| Istrana | 9.055 | 360 | 3.260 | 2.046 | 57,01 | 58,99 | 60,73 | 63,86 | 62,77 |
| Loria | 8.913 | 289 | 2.579 | 1.623 | 57,94 | 57,97 | 58 | 59,48 | 62,91 |
| Maser | 4.913 | 371 | 1.824 | 1.285 | 67,74 | 67,78 | 71,08 | 69,67 | 70,43 |
| Monfumo | 1.463 | 284 | 416 | 287 | 68,59 | 65,12 | 66,36 | 68,19 | 69,12 |
| Montebelluna | 30.887 | 465 | 14.354 | 10.461 | 73,81 | 72,88 | 73,69 | 71,47 | 72,88 |
| Paderno del Grappa | 2.161 | 391 | 844 | 549 | 62,2 | 59,95 | 62,97 | 62,65 | 65,00 |
| Pederobba | 7.466 | 413 | 3.084 | 2.106 | 66,17 | 64,98 | 65,52 | 64,83 | 68,31 |
| Possagno | 2.260 | 421 | 952 | 642 | 65,46 | 61,16 | 65,18 | 67,48 | 67,41 |
| Resana | 9.125 | 352 | 3.210 | 2.040 | 62,4 | 64,47 | 64,72 | 64,68 | 63,54 |
| Riese Pio X | 10.821 | 344 | 3.718 | 2.359 | 65,34 | 63,77 | 63,59 | 63,63 | 63,46 |
| San Zenone degli Ezzelini | 7.383 | 306 | 2.258 | 1.513 | 68,59 | 67,83 | 66,86 | 66,64 | 67,03 |
| Trevignano | 10.424 | 314 | 3.275 | 2.226 | 69,61 | 68,04 | 68,04 | 68,48 | 67,97 |
| Vedelago | 16.455 | 325 | 5.352 | 3.325 | 55,54 | 56,75 | 60,17 | 62,04 | 62,13 |
| **Total / Average** | **219.729** | **367** | 85.467 | 56.890 | **64,42** | **63,74** | **64,88** | **64,81** | **66,15** |

The TV3 collects organic waste, dry recyclables and residual waste separately. It has now reached an overall diversion rate of almost 70% (Table 1). The organic fraction has been collected since 1994. In a timeframe of fifteen years, the scheme has gone through three very distinct stages.

1. Until July 2000 the organic waste collection was based on a “bring” scheme, with large centralized containers placed on the roads serving all the households of one or more streets.

2. After July 2000 the system moved to a “fetch” scheme with curbside collection (door-to-door). In this second phase, the households were using non-compostable plastic bags to collect the food waste. Bags were opened and plastic contamination was screened out at the composting facility.

3. Finally, in June 2008 after the introduction of mandatory use of certified compostable bags for food waste collection, according to the national environmental law D.Lgs.152/2006, the consortium started distributing to the households yearly supplies of certified compostable bags. The considerable improvement in the quality of the collected material led to the optimization of the pretreatment process at the composting facility by removing the front-end debagging and screening stages.

## 2.1 Waste characterization analyses

During the evolution of the system, waste characterization analyses have been the primary tool for understanding the weak points and the margins for improvement. In the first years the analyses were performed by the consortium TV3 itself; between 1998 and 2003, the regional agency of the environment of Veneto (ARPAV) conducted the analyses in order to develop a standard methodology which can be found in the annex B of the “regional technical directive on composting” approved by the regional bill DGRV 766/2000 (Giunta Regionale Veneto, 2000) and confirmed by the DGRV 568/05 (Giunta Regionale Veneto, 2005). The analyses after 2003 were performed by the waste consulting company Idecom Srl, according to the above mentioned methodology.

## 2.2 Quality classes

In 1998, the Authority of the Regione Veneto finished a framework agreement with the composting facilities based on its territory (Giunta Regionale Veneto, 1998). This agreement was confirmed by the bill DGRV 568/05 (Giunta Regionale Veneto, 2005) and sets criteria for the acceptance of the collected feedstocks. It defines three quality classes depending on the contamination rate as shown in Table 2.

*Table 2 Quality classes of the collected organic waste according to DGRV 568/05*

| | **Class A** | **Class B** | **Class C** |
|---|---|---|---|
| % in weight of non compostables | X < 2,5 | 2,5 < X < 5 | X > 5 |

## 2.3 Evolution of the collection system

### 2.3.1 Phase 1: "bring" scheme with large centralized containers on the roads

From 1994 to July 2000 the separate collection was based on a "bring" scheme with large centralized containers placed on the roads, each serving the households of one or more streets. Besides dry recyclables and residual waste, organics were also collected this way. A waste characterization campaign performed between July and October 1998 in 20 municipalities of the consortium showed an average contamination rate of the collected organic fraction of 12,7% (LAZZARI, 1998).

### 2.3.2 Phase 2: "fetch" scheme with curbside collection in polyethylene bags

Given the overall high contamination and the low yields, in July 2000 the consortium switched to a "fetch" scheme with curbside collection of all the waste fractions (food waste, paper and cardboard, glass and cans, plastics, residual waste). For collecting the food waste, detached and semi-detached houses were supplied with 25-liter bins and transparent polyethylene bags. Multifamily buildings with more than 5 households were provided with 120- or 240-liter wheeled bins. Collection frequency was two times a week.

After more than one year from start up, between November 2001 and January 2002 the first waste characterization campaign was made to assess the performance of the Phase 2 collection system. The main result was a 75% reduction of the contamination, but the polyethylene bags alone were accounting for 1,5% of contamination causing also a drag effect towards additional contamination (BENAZZATO, S. ET AL., 2002). To this respect, an assessment by the Environmental Protection Agency of the Veneto Region (ARPAV) on Municipalities of the Region had already shown that collecting food waste in compostable bags would allow for total contamination rates lower than 1% (BOZZO, G.P. ET AL., 2001). Between 2003 and 2005, yearly characterizations where made (except for 2004) on all the 25 municipalities of the consortium. The average results are shown in Table 3.

*Table 3 Average contamination of the collected food waste in TV3*

| **Year** | 2003 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| **% in weight** | 4,49% | 6,03% | 3,56% | 4,63% |

### 2.3.3 Phase 3: "fetch" scheme with curbside collection in compostable bags

In order to reach the highest purity of the collected material, in 2008 the TV3 decided to distribute to each household a yearly supply of compostable bags and a vented bin to be stored in the kitchen. The choice of distributing directly these tools to the citizens had 3 goals:

1. Avoid the risk of the householders not using compostable bags;
2. Limit the contamination of plastics in the food waste;
3. Perform education activities during the delivery of the tool kits.

The waste characterization analyses performed in 2008 (after the delivery of the compostable bags) and in 2009 showed a significant increase in the quality of the collected feedstock. Almost all municipalities were falling under quality class A. Table 4 summarizes the average contamination rates of the 25 municipalities during the two different phases before (2003-2007) and after (2008-2009) the introduction of the compostable bags. The different colours refer to the different quality classes of the collected material according to DGRV 568/05 (Table 2).

*Table 4 Contamination rates of the food waste collected in TV3 from 2003 to 2009*

| Municipality | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2003 | 2005 | 2006 | 2007 | 2008 | 2009 |
| ALTIVOLE | 4,56% | 5,60% | 3,38% | 4,93% | 1,70% | 1,42% |
| ASOLO | 4,57% | 6,41% | 4,25% | 3,95% | 3,96% | 1,43% |
| BORSO DEL GRAPPA | 3,15% | 4,42% | 2,26% | 4,46% | 1,79% | 1,83% |
| CAERANO SAN MARCO | 3,88% | 6,67% | 3,36% | 4,84% | 1,56% | 1,34% |
| CASTELCUCCO | 4,45% | 6,16% | 3,60% | 3,51% | 1,33% | 1,21% |
| CASTELFRANCO VENETO | 6,67% | 6,59% | 6,80% | 8,14% | 0,86% | 2,57% |
| CASTELLO DI GODEGO | 3,66% | 6,42% | 4,37% | 2,73% | 1,75% | 2,29% |
| CAVASO DEL TOMBA | 4,34% | 3,62% | 4,44% | 3,70% | 2,07% | 0,88% |
| CORNUDA | 3,35% | 6,84% | 4,00% | 4,29% | 1,54% | 1,34% |
| CRESPANO DEL GRAPPA | 3,83% | 6,68% | 2,72% | 3,96% | 3,37% | 1,58% |
| CROCETTA DEL MONTELLO | 4,24% | 5,56% | 2,07% | 3,49% | 1,04% | 1,88% |
| FONTE | 4,71% | 5,64% | 3,95% | 3,74% | 2,99% | 1,83% |
| ISTRANA | 3,22% | 5,72% | 4,02% | 3,36% | 2,31% | 1,12% |
| LORIA | 5,70% | 5,77% | 2,43% | 4,61% | 2,15% | 4,48% |
| MASER | 3,18% | 5,59% | 2,21% | 4,47% | 1,34% | 0,70% |
| MONFUMO | 4,73% | 6,17% | 3,43% | 4,39% | 1,62% | 1,28% |
| MONTEBELLUNA | 9,33% | 7,00% | 6,68% | 6,89% | 2,51% | 1,07% |
| PADERNO DEL GRAPPA | 4,69% | 7,73% | 2,33% | 4,23% | 3,87% | 2,95% |
| PEDEROBBA | 4,95% | 6,28% | 2,23% | 4,19% | 1,54% | 1,28% |
| POSSAGNO | 4,63% | 5,76% | 3,35% | 3,04% | 3,30% | 1,30% |

| | | | | | | |
|---|---|---|---|---|---|---|
| RESANA | 4,44% | 5,75% | 3,32% | 12,79% | 2,67% | 1,50% |
| RIESE PIO X | 3,87% | 7,43% | 4,31% | 2,98% | 1,69% | 1,74% |
| SAN ZENONE DEGLI EZZELINI | 4,49% | 6,22% | 2,28% | 4,98% | 3,28% | 1,37% |
| TREVIGNANO | 3,15% | 4,76% | 3,01% | 3,39% | 1,25% | 0,63% |
| VEDELAGO | 4,37% | 5,84% | 4,31% | 4,65% | 1,63% | 1,33% |
| **AVERAGE** | **4,49%** | **6,03%** | **3,56%** | **4,63%** | **2,12%** | **1,61%** |

| |
|---|
| Class A <2,5% |
| Class B 2,5% < X < 5% |
| Class C > 5% |

## 2.4 The composting facility

### 2.4.1 General features

The TV3 waste management public consortium owns an in-vessel composting facility of 35.000 tonnes per year capacity based in Trevignano. The facility is certified ISO14000 and produces quality compost in accordance with the regional bill DGRV 568/05 (Giunta Regionale Veneto, 2005). There is an enclosed area of 7.200 $m^2$ under negative pressure which includes the waste delivery and storage zone, the pretreatment and the active composting areas. The facility is treating all the biowaste collected by TV3 (food waste and garden waste). The technology uses automated windrow turning equipment, air insufflation, moisture control and leachate recirculation. Maturation occurs outdoors where the compost piles are turned repeatedly with a wheel loader. Final product refining is performed with a 40-mm sieve.

### 2.4.2 Impact of polyethylene contamination

Until 2008 (before the introduction of compostable bags), a bag opener and a 100-mm drum screen were used in the pre-processing stage. After screening of the input material, the overs were sent to disposal and the fines were mixed with green waste and composted. Since 2002, approximately every 3 months characterization analyses were made on the overs and fines in order to monitor the screening efficiency and the drag effect of the screened bags that were pulling with them significant portions of organic material. Table 5 shows the percentage of overs generated during the pretreatment. Because of the high amount of material excluded by the primary screening process (average 42,22%), during 2003 it was decided to put the overs through a second screening step in order to maximise the inputs. This secondary screening step allowed a reduction

to 20,44% in average of the residues generated, but was more time and energy consuming as it required a second transit through the drum screen.

*Table 5 Efficiency of the primary and secondary screening at the composting facility*

| Date | % of overs (weight) | Screening step |
|---|---|---|
| 12-dec-02 | 37,96% | Primary |
| 16-dec-02 | 40,76% | Primary |
| 19-dec-02 | 42,29% | Primary |
| 21-may-03 | 26,58% | Secondary |
| 18-jul-03 | 47,89% | Primary |
| 18-jul-03 | 27,98% | Secondary |
| 17-oct-03 | 19,12% | Secondary |
| 30-apr-04 | 20,05% | Secondary |
| 29-mar-05 | 19,12% | Secondary |
| 8-jul-05 | 25,65% | Secondary |
| 7-ott-05 | 26,92% | Secondary |
| 22-dec-05 | 19,09% | Secondary |
| 17-mar-06 | 18,39% | Secondary |
| 14-jun-06 | 17,00% | Secondary |
| 4-jul-06 | 21,75% | Secondary |
| 30-aug-06 | 18,31% | Secondary |
| 24-nov-06 | 15,25% | Secondary |
| 20-mar-07 | 16,23% | Secondary |
| 29-jun-07 | 15,77% | Secondary |
| 8-jul-07 | 25,65% | Secondary |
| 7-oct-07 | 18,37% | Secondary |
| 13-dec-07 | 18,76% | Secondary |
| 25-jun-08 | 18,37% | Secondary |
| **AVERAGE** | **42,22%** | **PRIMARY** |
| **AVERAGE** | **20,44%** | **SECONDARY** |

### 2.4.3 Removal of the pre-treatment step

After the introduction of the compostable bags and the significant reduction of contamination, in July 2008 the bag opening and screening steps at the front end of the process were removed. Besides the savings of time and energy consumption, the most significant impact of this change was the avoided overs sent to disposal. Considering that the total volume of food waste per year treated by the facility has not changed significantly, a comparison between the total quantities of residues generated by the screening proc-

esses in the years 2007 (still with high plastic contamination) and 2009 (only compostable bags) shows a net balance of 2.000 tonnes of avoided disposal (Table 6).

*Table 6 Total residues generated by the screening processes (tonnes)*

| | Year 2007 | Year 2009 |
|---|---|---|
| Overs from the front end pre-treatment | 2.500 | - |
| Overs from the final refining screening | 1.100 | 1.600 |
| Total residues generated | 3.600 | 1.600 |

# 3 Conclusion

In terms of quality of the separately collected organic waste, a first threshold of acceptability can be identified when a purity of about 90-93% is reached. This level makes it possible to recover the organic waste for quality compost production, however relatively complex screening and refining systems at the composting facility are needed. A threshold of excellence could be defined with a purity of 96-97%. This limit meets the needs of very simple and less expensive ways of refining and separating the non-compostable contaminants. In other words, by keeping contamination rates lower than 3-4%, it is possible to simplify the pre-treatment systems and keep a simple sieving step at the end of the process for refining the final product, with significant savings on capital investments and operational costs of additional machines.

The experience of the waste management consortium TV3 shows that the collection phase has an important impact on the subsequent treatment phase:

- Fetch schemes at the curbside are much more efficient compared to bring schemes in centralized containers in terms of quality and yelds of the collection;
- Mechanical screening processes do not guarantee the most efficient levels of recovery. The best way to achieve this is by ensuring a good quality of the source separated material;
- The direct distribution of compostable bags in combination with collection tools like vented kitchen bins has ensured the highest purity levels of the collected food waste;
- The use of compostable bags has allowed for significant savings at the composting facility, such as:
    a. Removal of the front end screening system;

b. Significant reduction of the residues and related transport and disposal costs.

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