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*Case report*

# Home composting in remote and cross-border areas of the In.Te.Se. project

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**Abstract:** The In.Te.Se. project - Innovation Territory and Services, for waste management in scattered areas is an Interreg V-A France Italy (ALCOTRA) project, financed within the framework of European cross-border cooperation programmes, in the Alpine region between France and Italy. On the subject of the local exploitation of organic waste, it permits the experimentation of home composting in scattered and cross-border areas in the Italian territories of the Province of Cuneo (Consorzio Servizi Ecologia e Ambiente, CSEA) and in the French areas of the PACA Region (Syndicat Mixte de Traitement des Ordures Ménagères des cantons du Guillestrois et de l'Argentièrois, SMITOMGA), through the use of individual and collective, manual and electromechanical composters. During the project it is estimated that a quantity of organic waste equal to about 2% of the not sorted waste produced in 2019 has been valorised, in 3 municipalities of CSEA and 23 municipalities followed by SMITOMGA where a separate collection circuit does not exist and it is conferred with the general unsorted waste. Overall, 31.72 tons of compost are obtained. The environmental balance deriving from the cooperation of the territories also makes it possible to estimate a negative balance of $CO_2$ produced, with 3,212.78 $kgCO_2$ avoided. The economic assessment of not sending the organic component for disposal produced a saving for the two communities as a whole of €10,397.56, involving only 15% of the total population in the municipalities investigated. At the same time, a comparison with a separated collection system for the organic matter, determines the saving of €27,295.73 considering the all tested area. The implementation of this good practice has the potential to achieve interesting results from an environmental, social and economic point of view and to be extended to further portions of the territory

and has demonstrated the successful choice of cross-border cooperation and the diversification of applied techniques.

**Keywords: cooperation, organic waste, composting, exploitation, compost, home composting, collective composting**

## 1. Introduction

The In.Te.Se. project, France-Italy, is financed by the INTERREG V-A Alcotra Programme 2014-2020, European Regional Development Fund, under priority axis 1 APPLIED INNOVATION (innovation and development of innovative cross-border services) and involves 6 partners: Consorzio Servizi Ecologia Ambiente (CSEA) project leader, Consorzio Albese Braidese Rifiuti (CoABSeR), E.R.I.C.A. soc. coop., Communauté de Communes du Pays des Ecrins (CCPE), Syndicat Mixte Intercommunal du Traitement des Ordures Ménagères du Guillestrois et de l'Argentièrois (SMITOMGA), Communauté de Communes du Guillestrois et du Queyras (CCGQ).

The project defines an innovative model for the management of household waste, focused on Reduction, Reuse and Recycling implemented in the Alpine area and in scattered areas and which permits improving the quality of the service provided in the area and increasing its effectiveness and efficiency in economic and environmental terms.

The main experimental activities carried out by the project concern the themes of prevention, reuse, and innovation in pre-sorted waste collection and in particular self-composting.

Self-composting, carried out in scattered areas and for large producers, makes it possible to exploit organic matter, transformed into compost, eliminating the wet waste collection service or diverting it from the unsorted waste stream, enabling users to manage waste directly and independently and reducing the impacts generated by it. The project involved 1,070 users and 26 municipalities.

## 2. Materials and method

The self-composting experiment was carried out in two different ways:

- Individual composting, carried out individually by a single user through his/her own manual composter;
- Community composting, carried out by several users in conjunction with one another, through two types of composters: manual and electromechanical.

The activity was carried out in mountain and remote areas and led to the involvement of residential and non-residential users in 26 municipalities, 3 Italian and 23 French, belonging to the project areas.

None of the municipalities where the experiment was carried out had a waste collection service dedicated only to the organic component, which is discarded by users with unsorted waste.

Table 1 shows the indication of the consortia and local authorities involved and the resident population, in Table 2 the number of users actually involved, the type of composting carried out and the type of composter used for household waste treatment is indicated for each municipality.

**Table 1.** List of the competent consortia and territorial authorities involved in the project action and demographic data

| Competent consortium/ organisation | Resident population involved in the experiment (number of inhabitants actually involved) | Total resident population in the municipalities where the experiment is realised |
|---|---|---|
| CSEA (3 municipalities) | 345 | 1,306 |
| SMITOMGA (23 municipalities) | 2,024 | 14,736 |
| **TOTAL** | **2,369** | **16,042** |

**Table 2.** List of the involved areas, relative users (families, actually involved in the experiment) and general type of self-composting and composter

| Municipality | Consortium | Number of users involved | Type of self-composting done | Type of composter used |
|---|---|---|---|---|
| Melle | CSEA | 115 | Community self-composting | Electromechanical |
| Murello | CSEA | 25 | Community self-composting | Electromechanical |
| Ostana | CSEA | 10 | Community self-composting | Electromechanical |
| Ceillac | SMITOMGA | 62 | Individual and community self-composting | Manual |
| Champcella | SMITOMGA | 26 | Individual and community self-composting | Manual |
| Château-Ville-Vieille | SMITOMGA | 6 | Individual and community self-composting | Manual |

| Municipality | Consortium | Number of users involved | Type of self-composting done | Type of composter used |
|---|---|---|---|---|
| Mont-Dauphin | SMITOMGA | 20 | Individual and community self-composting | Manual |
| Puy-Saint-Vincent | SMITOMGA | 8 | Individual and community self-composting | Manual |
| Saint-Clément | SMITOMGA | 11 | Individual and community self-composting | Manual |
| Abriés-Ristolas | SMITOMGA | 29 | Individual and community self-composting | Manual |
| Aiguilles | SMITOMGA | 14 | Individual and community self-composting | Manual |
| Arvieux | SMITOMGA | 14 | Individual and community self-composting | Manual |
| Molines en Queyras | SMITOMGA | 18 | Individual and community self-composting | Manual |
| Réotier | SMITOMGA | 17 | Individual and community self-composting | Manual |
| Vars | SMITOMGA | 12 | Individual and community self-composting | Manual |
| Risoul | SMITOMGA | 39 | Individual and community self-composting | Manual |
| Saint-Crépin | SMITOMGA | 100 | Individual and community self-composting | Manual |

| Municipality | Consortium | Number of users involved | Type of self-composting done | Type of composter used |
|---|---|---|---|---|
| Saint-Martin-de-Queyrières | SMITOMGA | 15 | Individual and community self-composting | Manual |
| St. Véran | SMITOMGA | 15 | Individual and community self-composting | Manual |
| Eygliers | SMITOMGA | 116 | Individual and community self-composting | Manual |
| Freissinières | SMITOMGA | 6 | Individual and community self-composting | Manual |
| Vigneaux | SMITOMGA | 19 | Individual and community self-composting | Manual |
| La Roche de Rame | SMITOMGA | 28 | Individual and community self-composting | Manual |
| Guillestre | SMITOMGA | 151 | Individual and community self-composting | Manual |
| Vallouise-Pelvoux | SMITOMGA | 70 | Individual and community self-composting | Manual |
| Argentière-la-Bessée | SMITOMGA | 124 | Individual and community self-composting | Manual |
| **TOTAL** | | **1,070** | **-** | **-** |

The composters used for the activity and the relative technical details are described in Table 3.

**Table 3.** Types of composters used and characteristics

| Type of composter | Treatment capacity | Model | Number of installations |
|---|---|---|---|
| Electromechanical community composter installed in wooden housing | 25 t/year | laCompostiera.it – Sartori Ambiente | 1 |
| Electromechanical community composter installed in wooden housing | 10 t/year | Compost 10 - Ecopans | 1 |
| Electromechanical community composter installed in wooden housing | 5 t/ year | Compost 5 - Ecopans | 1 |
| Manual community composter made of wood | 600 l – 800 l | Gardigame classique NF024 - Gardigame | 31 |
| Manual individual composter made of wood | 300 l | Gardigame classique NF024 - Gardigame | 610 |
| **TOTAL** | **-** | **-** | **644** |

Electromechanical composters are semi-automatic machines, fed by connection to the power mains and consist of two chambers, the first one for treatment and the second one for maturation, in which the organic material passes through automatically to ensure its complete transformation into compost. The equipment does not need to be connected to the sewer network because the liquids produced are recirculated inside the chambers. The machines are equipped with automatic mixers which ensure correct and continuous turning of the material inserted inside them, fans which provide the necessary supply of oxygen to the process and automatic dosing units for the pellets (structuring effect).

All models are also equipped with safety devices and automatic stoppage in case of danger or anomaly, to ensure the safety of users during all the operating phases of the machinery. They have ventilation systems and dedicated openings to allow air intake.

For the composter model laCompostiera.it there is an initial chamber of smaller dimensions (10 litres) intended for the placement of waste by the user, equipped with a mechanical shredder to shred the waste and connected to the pellet storage department (structuring effect), inside which it is added as required. The composter is equipped with a control panel through which it is possible to start the transit of the material from the first to the second chamber and to proceed with the withdrawal of the compost, as well as to set and control the parameters to trigger the correct aerobic biodegradation process. Using this panel, it is also possible to remotely access the machine data.

The Ecopans composter models do not have a shredding chamber, so the organic waste is inserted by the user directly into the first treatment chamber. The machines are equipped with control panel and temperature sensors.

The manual community composters, made of wood, Gardigame classique NF024 model, consist of two separate treatment sections closed by an upper wooden door, so that the biodegradable material contained inside is moved manually by the operator from one compartment to the next, based on the degree of maturation of the waste inside. From the second maturation chamber the compost is then extracted once it has been obtained. Individual wooden composters of the same model consist of a single module.

For the electromechanical composters installed in the wooden housings, a card or access key has been provided only to the users interested in using it.

For wooden composters located outdoors, there is no type of access control or limit to the same.

All community composters are supervised by appointed and trained staff, who take care of management.

The compost produced is currently made available to the community for private use, with possible future uses in local farms. The use of compost as a soil improver causes a reduction in the use of fertilizers.

The period of waste treatment in the composters varies according to the models, as specified below:

**Table 4.** Period of treatment of organic waste for each composter

| Composter model | Length of stay in first chamber | Length of stay in second chamber | Total period of treatment to obtain compost |
|---|---|---|---|
| laCompostiera.it – Sartori Ambiente | 20 days | 20 days | 40 days (minimum period indicated for the model, increased up to 60 days in operation) |
| Compost 10 - Ecopans | 30 days | 30 days | 60 days |

| Composter model | Length of stay in first chamber | Length of stay in second chamber | Total period of treatment to obtain compost |
|---|---|---|---|
| Compost 5 - Ecopans | 30 days | 30 days | 60 days |
| Gardigame classique NF024 – Gardigame – modulo doppio | at least 30 days | at least 30 days | at least 60 days |
| Gardigame classique NF024 – Gardigame – modulo unico | single chamber | single chamber | at least 60 days |

The period of experimentation is different depending on the sites, since the installation and start-up of the composting activity does not take place simultaneously. Table 5 shows the period of observation and monitoring of the experimentation, referred to each site.

**Table 5.** Period of experimentation monitoring

| Composter model | Experimentation period | Total duration of experimentation |
|---|---|---|
| laCompostiera.it – Sartori Ambiente | December 2019 – September 2020 | 10 months |
| Compost 10 - Ecopans | March 2020 – September 2020 | 7 months |
| Compost 5 - Ecopans | December 2019 – September 2020 | 10 months |
| Gardigame classique NF024 – Gardigame – double module | September 2019 – September 2020 | 12 months |
| Gardigame classique NF024 – Gardigame – single module | September 2019 – September 2020 | 12 months |

The use of electromechanical composters results in electricity consumption, that allow them to function properly. The average annual consumption values for the models used are shown below.

**Table 6.** Electricity consumption attributed to electromechanical composters

| Composter model | Electrical annual consumption [kWh/year] |
| --- | --- |
| laCompostiera.it – Sartori Ambiente | 900 |
| Compost 10 - Ecopans | 900 |
| Compost 5 - Ecopans | 900 |

The following assumptions are also considered for the monitoring of the trial:

- The average per capita production of organic waste, suitable for home composting, is 50 kg/inhabitant per year;
- Waste is discarded on average once a week by users;
- The average composition of users in Italy is 2.3 persons/user, while in France it is 2.2 persons/user;
- The yield of compost production starting from organic waste in a range between 20% and 40% of the initial mass, so an average value of 30% is considered;
- The average specific mass of compost falls within the range 0.3 – 0.4 kg/l, so an average value of 0.35 kg/l has been used for the conversion from volume to mass of compost;
- The carbon sink effect in the soil is considered with a $CO_2$ storage index equal to -17.6 kg $CO_2$/t organic waste sent for composting, considering the methodology applied to calculate the $CO_2$ balance determined by the use of compost in agriculture;
- The emission mitigation factor following the non-use of fertilizers for the land is set equal to -18.7 kg $CO_2$/t organic waste sent for composting, for which the emissions avoided for the production of fertilizer and for the production of ammonia and nitric acid are considered, seeing the methodology applied to calculate the $CO_2$ balance determined by the use of compost in agriculture;
- The average cost of $CO_2$ is set at 24.18 € / t $CO_2$, calculated on the average for the period September 2019 – September 2020.

For the 3 sites of Melle, Murello and Ostana, the volumetric or mass measurement of the compost produced was directed, by the municipalities, with subsequent sending of the data to the reference consortium (CSEA). From the produced compost data, the data relating to the organic waste conferred by users were obtained.

For the 920 sites of all the French communities, the definition of the compost produced was carried out by estimate, based on the assumptions made, and the definition was also made of the flow of organic waste to the composters.

The average costs per tonne for the disposal of unsorted waste, containing the organic waste in absence of the trial, at the CSEA and SMITOMGA sites for subsequent economic analysis are shown below:

- Average cost for the disposal of unsorted waste containing organic waste at CSEA: 109.60 €/ton of waste;
- Average cost for the disposal of unsorted waste containing organic waste at SMITOMGA: 97.90€/ton of waste.

On the other hand, if we assume the average cost of creating a dedicated organic waste collection service as an alternative to the combined collection with unsorted waste, the parameters to be considered would be the following:

- Average cost for the collection of organic waste at CSEA: 132.00 €/ton of waste;
- Average cost for the treatment of organic waste at CSEA: 88.00€/ton of waste;
- Average cost for the disposal of unsorted waste containing organic waste at SMITOMGA: 174.00€/ton of waste;
- Average cost for the treatment of organic waste at SMITOMGA: 86.00€/ton of waste.

## 3. Results

The results obtained through community composting and individual composting in the Italian and French communities are presented below, with regard to each site involved in the experiment, in terms of the quantity of organic waste conferred and the compost consequently obtained.

**Table 7.** Quantity of organic waste conferred to composters and compost produced in Italy

| Composter model | Conferred organic waste [kg] | Compost produced [kg] |
|---|---|---|
| laCompostiera.it – Sartori Ambiente | 3,465 | 1,050 |
| Compost 10 - Ecopans | 578 | 175 |
| Compost 5 - Ecopans | 429 | 130 |
| **TOTAL [kg]** | **4,472** | **1,355** |

**Table 8.** Quantity of organic waste conferred to composters and compost produced in France

| Composter model | Conferred organic waste [kg] | Compost produced [kg] |
|---|---|---|
| Gardigame classique NF024 – Gardigame – modulo doppio | 67,100 | 23,485 |
| Gardigame classique NF024 – Gardigame – modulo unico | 34,100 | 11,935 |
| **TOTAL [kg]** | **101,200** | **30,360** |

Overall, at 30$^{th}$ September 2020, it is estimated that 105.67 tonnes of organic waste were not conferred to the public service and were home composted with the production of 31.72 tonnes of compost. This compost can be used directly by users in the municipalities involved as a soil improver for gardens and vegetable gardens.

As far as the economic analysis is concerned, Table 9 shows the savings obtained from the non-disposal of organic waste, which was not brought to the unsorted waste collection circuit.

**Table 9.** Savings deriving from the non-disposal of organic waste in Italy and France

| Competent consortium/organisation | Savings estimated during the course of the project [€] |
|---|---|
| CSEA | 490.08 |
| SMITOMGA | 9,907.48 |
| **TOTAL [€]** | **10,397.56** |

On the basis of the relative unsorted waste disposal costs, the flow of which also includes biodegradable waste of household origin, as at the 30th September 2020, it is estimated that the experiment could produce a total saving of €10,397 if the Italian and French quotas are added together.

If, on the other hand, we compare the composting activity with the creation of a collection circuit dedicated only to the fraction of organic waste, the resulting expenses for the collection, transport and treatment service for each consortium would be as follows:

**Table 10.** Costs deriving from a possible dedicated collection system for organic matter in Italy and France

| Competent consortium/organisation | Costs estimated during the course of the project [€] |
|---|---|
| CSEA | 983.73 |
| SMITOMGA | 26,312.00 |
| **TOTAL [€]** | **27,295.73** |

The establishment of a specific collection system for the organic matter and its proper treatment as an alternative to the composting would cost €27,295.73 for the two communities.

By carrying out the balance of $CO_2$ emitted following the operation of the electromechanical composters and $CO_2$ avoided thanks to the carbon sink effect of the organic carbon sequestered in the compost and the $CO_2$ avoided following the non-use of fertilizers, the following results are obtained:

**Table 10.** Balance of $CO_2$ equivalent resulting from the use of compost

| Action | Quantity of $CO_2$ generated/avoided [kg$CO_2$] | Reference territory |
|---|---|---|
| Electricity energy consumption | +623.09 | CSEA |
| Carbon sink capacity | -78.70 | CSEA |
| | -1,781.12 | SMITOMGA |
| Mitigation for the non-use of fertilizers | -83.62 | CSEA |
| | -1,892.44 | SMITOMGA |
| **TOTAL BALANCE [kg$CO_2$]** | **-3,212.79** | **-** |

Overall, it is estimated that the individual and collective home composting activity carried out until 30th September 2020 avoided the emission of -3,212.79 kg of $CO_2$, which economically correspond to an environmental benefit of -77.69 €.

If we consider the budget divided by territory, in the case of CSEA, with the results obtained so far, we would not obtain a saving of carbon dioxide emitted and, on the contrary, a production equal to 460,78 kg would result, with an environmental cost of € 11.14.

## 4. Discussion

The implementation of home composting has made it possible to exclude from the unsorted waste collection circuit a quantity equal to 4.47 tonnes of waste for the municipalities of the CSEA areas and 101.2 tonnes for the areas under SMITOMGA management.

Comparing these locally reused waste flows with the flow of unsorted waste collected during 2019 in the municipalities involved, it can be seen that:

- the quantity of waste sent for home composting in the CSEA area represents 1.6% compared to the dry residual waste conferred during 2019;

- the quantity of waste sent for self-composting in the SMITOMGA area represents 1.9% compared to the dry residual waste collected in 2019.

Comparing the estimated data relating to compost locally produced by users and referring it only to the population actually involved in the experimentation (2,369 people), on the basis of the average number of components per user depending on the area involved, we see that the per capita amount of compost produced per inhabitant in Italy is equal to 3.93 kg/inhabitant and for France equal to 15.00 kg/inhabitant during the project.

The environmental benefit deriving from the practice of self-composting translates into the subtraction of 3,212.79 kg of $CO_2$, corresponding to -3.00 kg /$CO_2$ for users specifically involved in the experiment (1,070 experimental users) and -0.20 kg $CO_2$/ inhabitant considering the entire population present in the test areas (16,042 inhabitants). If the balance was broken down by territory, in the case of CSEA an environmentally positive benefit would not be achieved, or in the period considered, there would be a production of $CO_2$ resulting from the implementation of composting using electromechanical composters, equal to 460.68 kg. Cooperation is therefore a fundamental success factor, together with the choice to diversify the technologies used in experimentation.

From the economic analysis, it is obtained instead that the savings obtained from the non-disposal of organic waste together with the dry residue, referring to the entire population of the municipalities involved in the project action (1,306 inhabitants for CSEA and 14,736 for SMITOMGA), is equal to 0.38 €/inhabitant for the Italian territories and on 0.67 € /inhabitant for the French municipalities. The savings obtained are divided on the overall population of the municipalities where the experiment is realised for each Consortium and not only on the only involved one, because the costs of the service is generally referred to all the territory.

On the other hand, the comparison with other alternative solutions, such as the separate collection of organic waste with a dedicated system, would again lead to additional costs, saved to the communities through self-composting and amounting to €27,295.73 for the overall test area. It is possible to estimate a saving of 0.75€/inhabitant for CSEA territories and of 1.79€/inhabitant for SMITOMGA territory.

To these values it is possible to add the savings deriving from the overall $CO_2$ balance, meaning it as a joint parameter of the project areas, which converts into a saving of € 77.69 globally, or equal to € 0.005/inhabitant (out of the total of 16,042 inhabitants).

At the same time, by separating the carbon dioxide balances between the territories, a cost of € 10.97 would be obtained for the CSEA area of competence (equal to € 0.008/inhabitant of the test area) and a saving of € 87.43 for municipalities followed by SMITOMGA (corresponding to -0.006 €/inhabitant of the test area territory).

The amount of $CO_2$ generated with the two collection systems (with unsorted waste and with dedicated collection of the organic matter) was not calculated due to the multiple variables existing and the complexity of the context considered.

## 5. Conclusion

The areas investigated with the experimentation of the In.Te.Se. project are scattered and remote communities, where the collection service dedicated only to organic waste is not envisaged. Such waste is consequently conferred together with the residual dry waste, conveyed for disposal without recycling.

The implementation of home composting in these areas, with particular reference to the 3 municipalities in the CSEA territory and the 23 municipalities covered by SMITOMGA, made it possible to avoid sending for disposal a percentage equal to about 2% of the unsorted waste totally produced by the same areas, a figure comparable to that of 2019 and involving only 15% of the population living in the same areas.

The environmental benefit deriving from the implementation of the experimentation is determined by the cooperation between the territories, which offset the carbon dioxide emissions produced by the electromechanical composters, allowing for an overall balance of -3,212.79 $kgCO_2$, corresponding to -3 $kgCO_2$ per user involved.

From the experimentation, it is estimated that a total of €10,597.56 will therefore be saved, due to the non-disposal of biodegradable waste with the residual dry waste, which spread over the entire population of the municipalities involved in Italy and France, amounts to a saving of €0.67 per inhabitant. Comparing to a separate collection system with organic waste collection, the saved amount would raise to €27,295.73, corresponding to €1.70 per inhabitant for the global test area considering together CSEA and SMITOMGA territories.

To these values would be added € 77.69, corresponding to the savings deriving from the negative balance of $CO_2$ emissions (€ 0.005 saved / inhabitant).

The application of this good practice has shown to have valid potential for the local treatment and enhancement of organic matter carried out directly by users, also in a collective and collaborative form, as well as to reduce the environmental impacts of this fraction of waste on the overall cycle, dedicating them an alternative channel to collection with residual dry waste or to the need for an ad hoc collection and transport service with treatment. Also from an economic point of view, already from the first months of experimentation it was possible to quantify the achievable savings.

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