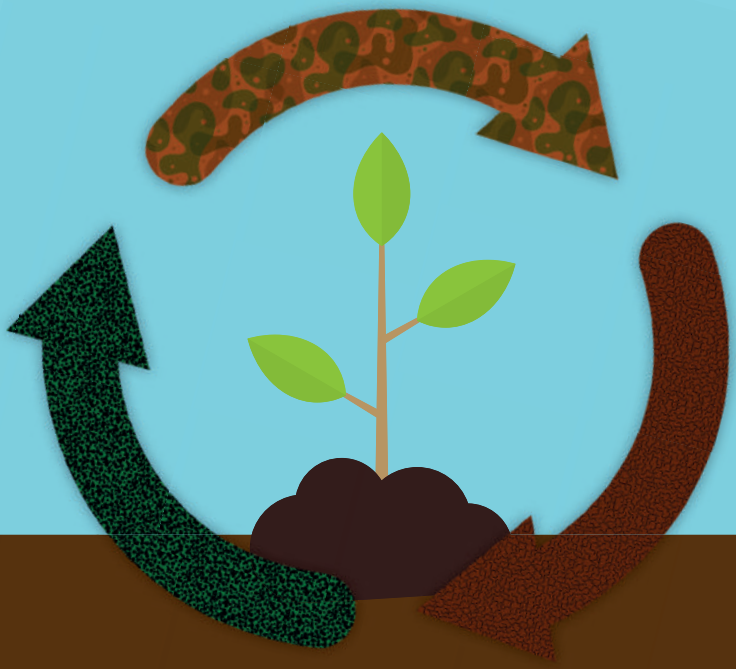
A HANDBOOK FOR SCHOOLS ON ORGANIC WASTE MANAGEMENT



CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

ISWA
International Solid Waste Association

ACKNOWLEDGEMENTS

This Handbook was possible thanks to CCAC Municipal Solid Waste Initiative who provided the funding and the faith that allowed the idea to become a work plan which aims to turn organic waste recycling into a reality in the schools of Sao Paulo, and potentially worldwide.

Acknowledgements also go to the commitment of the Municipal Secretariat of Public Services (SES) and its Waste Management Authority (AMLURB), the Municipal Secretariats of the Green and Environment (SVMA) and of Education (SME) of the City of Sao Paulo, in playing an important role in spreading the Handbook among 1.500 municipal public schools of the City.

Special thanks should be given to the Regional Directorate of Education of Butanta (DRE Butanta), who believed in the project since the beginning and led the contact with most of the participating schools: EMEI Profª Clycie Mendes Carneiro; EMEF Profª Maria Antonieta D'Alkimin Basto; EMEF Brasil Japão; EMEF Vila Munck; EMEF Tarsila do Amaral; EMEF Profº Olavo Pezzotti; EMEI Prof. Camillo Ashcár; EMEI Desembargador Dalmo do Valle Nogueira; EMEI Antonio Bento; EMEF Dep. Cesar Arruda Castanho; EMEI Anísio Teixeira; EMEI Emir Macedo Nogueira; EMEF Firmino Tibúrcio da Costa; EMEF Joel Fernandes de Souza; EMEF Coronel Romão Gomes; EMEF Profº Antonio Duarte de Almeida; EMEF Vinicius de Moraes; EMEI Dona Leopoldina.

Finally, appreciation goes to Morada da Floresta who administrated the online school platform Escolas Mais Orgânicas which is also part of the ISWA-led CCAC City Assistance Project to Sao Paulo. Morada da Floresta facilitated the acquisition of data from the participating schools of the online platform which allowed us to make the estimations and calculations in this Handbook.

TECHNICAL PROFILE

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Marco has over 20 years of experience in planning municipal solid waste management, designing and upgrading collection and transport schemes, assessing recycling facilities (focused on composting), planning communication and participation initiatives and chairing multi-linguistic, multi-tasking working groups and projects.

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This Handbook makes references to different literature about home-composting, among which three documents are of particular value to be mentioned: Alla Scoperta del Compostaggio Domestico, Scuola Agraria del Parco di Monza, 1998; the Composting troubleshooter, Jane Gilbert, 2015; Manual de Compostagem Domestica com minhocas, Morada de Floresta, 2016.

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1 INTRODUCTION

The Handbook has been realized as part of the 2nd phase of the City Assistance Project offered to the Municipality of Sao Paulo under the framework of the Climate and Clean Air Coalition Municipal Solid Waste Initiative (CCAC MSWI), implemented by ISWA, the International Solid Waste Association, with local coordination of ABRELPE, the Brazilian Association of Public Cleaning and Special Waste Companies, ISWA's National Member in Brazil. The 1st phase of the Project was a city assessment and the establishment of an Action Plan for Sao Paulo in line with Sao Paulo's PGIRS (the Solid Waste Integrated Management Plan 2014 - 2024). The 2nd phase aims to provide technical and strategic guidance on how to pursue the Action Plan and to build capacity in public communication and bio-waste treatment plant operation.

This document is an outcome of one of the activities of the 2nd phase of the Project – to develop a handbook for schools on waste management focused on the organic fraction which aims to:

- √ Emphasize the important role that schools play as a waste generator as well as an educational agent sensitizing the future generations on solid waste management; demonstrate the potential for reduction of waste and GHG emissions from schools through source separation, reuse and recycling of organic waste.
- √ Empower teachers and school directors by providing technical knowledge on waste and particularly on organic waste management: characteristics, treatment techniques, challenges and benefits;
- √ Present cases of schools in Sao Paulo that have been successful in managing the organic fraction of their waste;
- √ Encourage schools that do not yet take actions to start activities regarding managing waste particularly the organic fraction;
- √ Spread waste management education wide across schools in Sao Paulo and eventually in others countries by providing a handbook in a comprehensive approach.

The target audience of the Handbook is teachers who intend to introduce the topic of recycling organics by means of composting in schools, but also to improve the separation of quality dry recyclables.

It provides a general overview about the opportunities and possibilities to teach about composting, practical information about how to sort organic waste in schools and how to manage the composting process with children between 3 and 14 years old.

The Handbook is divided into nine chapters. Examples and case studies referring to public schools in Sao Paulo are shown in Chapter 7.2; examples and instruments to guide teachers in setting up activities are shown in a "toolbox" in Chapter 8.

1.1 WHAT DOES IT MEAN BY "ORGANIC WASTE"?

This Handbook defines solid organic waste as all kinds of waste that can be composted, hence at schools organic waste includes:

- √ residues from food preparation
- √ food leftovers
- √ residues from the maintenance of the school's green areas, gardens and vegetable gardens

Go to Chapter 4.1 for a more detailed list of organic waste produced in a school.

2 EDUCATION ON WASTE MANAGEMENT IN SCHOOLS

Nature is a "circular economy" with "zero-waste": the organic matter no longer "useful" for human consumption (dry leaves, faeces, dead animals, etc.) is decomposed by soil's microorganisms that turn it into "useful" compost back into the natural cycle. Working on and talking about waste management in schools is an excellent way to teach young citizens about the possibilities to prevent waste generation and to recycle waste. In addition, in the case of composting, it is also an opportunity to teach them about nature and natural processes.

2.1 SEPARATE COLLECTION OF MSW AND COMPOSTING

Since separate collection of municipal solid waste (MSW) is organized locally according to existing infrastructure and national or regional legislation, it is not always easy to suggest which waste flows should be separated at schools.

In the case of the City of Sao Paulo in Brazil, according to the strategies outlined in the waste management plan 2014-2014 (PGIRS), at least the following waste streams should be separately collected in a school:

- Paper and cardboard
- Glass
- Plastic and cans

  To be collected by different separate collection schemes provided by local waste management services, or used at schools for bricolage and creative recycling initiatives

- Organic waste

  Used for organizing composting trials and education at school; the part or type of organic waste that cannot be managed at school is to be collected with the scheme for residual waste provided by local waste management services

A responsible participation in separate collection is the starting point for quality sorting of waste into homogeneous and clean fractions, a prerequisite for them to be recycled. At industrial level it is technically difficult to recycle contaminated or "dirty" recyclables and it is economically inefficient.

2.2 LINKING WITH OTHER EDUCATIONAL ACTIVITIES

There are numerous opportunities to link a composting project to many standard educational topics of ground and middle schools such as:

THE LINK BETWEEN COMPOSTING AND OTHER TOPICS ABOUT THE ENVIRONMENT

Composting	Managing a vegetable garden at school	Food and education about nutrition
Recycling	Consuption and sustainability	Management of garden waste
The natural cycle of organic matter	Express creativity	Management of water

Science:

- show the capacity of nature to totally recycle organics;
- investigate the role of microorganism in natural cycle;
- test the degradation and compostability of different materials.

Environment and Sustainability

- learn about waste and local environmental issues;
- encourage correct separate collection of all recyclable waste, including packaging waste, electronic waste and others that are produced at school and at home;
- discuss with students about the problems of local environment and propose solutions;
- show the role of compost as a fertilizer for growing vegetables locally.

Mathematics

- practice volume and weight measurements of waste and compost;
- plot data in graphs and tables;
- record data by performing a waste audit.

Literature

- express opinion and experience about composting and recycling;
- listen to others' experiences and opinions about waste.

The pedagogical advantages of initiatives focusing on recycling and composting are multitude: students can learn by practicing, interacting and expressing their creativity, being aware that the topic of waste is also relevant to their life and the environment outside their schools. What students learn at school has an enormous potential to be immediately applied at home with their families as well.

2.3 Reaching Beyond Students

A composting project at school has the possibility to involve multiple target groups; students and teachers will be involved directly, as well as other working staff at schools such as cooks, gardeners and administrative personnel.

Parents and local governmental administration will be involved indirectly, especially if visits or events are organized at the school to show the achievements

and output of the project to interested parties from outside the school. At such events sharing the ultimate products of the activities would be ideal, for example, a meal cooked with the vegetables grown inside the school garden where compost is applied.

A list of target groups and topics that can be involved directly into composting initiatives at schools or that are affected indirectly due to the activities developed is shown in Figure 1.

FIGURE 1: TARGET GROUPS AND TOPICS INVOLVED DUE TO A COMPOSTING PROJECT IN A SCHOOL

INVOLVED DIRECTLY	STUDENTS	TEACHERS	KITCHEN STAFF	LOCAL MSW COMPANIES	GARDEN WASTE MAINTENANCE COMPANY (OF THE SCHOOL)
ACTIVITY	LEARN ABOUT WASTE	FIND NEW TOPICS TO INCLUDE IN EDUCATIONAL PROGRAMMES	INVOLVED IN SORTING RECYCLABLES AT SCHOOL	COOPERATION WITH THE SCHOOL INITIATIVE (SITE VISITS)	INVOLVED IN RECYCLING GARDEN WASTE AT SCHOOL

INVOLVED IN-DIRECTLY	PARENTS AND RELATIVES	CATHERING COMPANY	LOCAL AUTHORITIES
ACTIVITY	PRACTICE SEPARATE COLLECTION AT HOME	OPTIMISE DELIVERIES AND REDUCE WASTE PRODUCTION	STIMULATED TO REVISE AND ENHANCE WASTE RECYCLING STRATEGIES

3 THE SCHOOLS OF SAO PAULO AND THE POTENTIAL FOR ORGANIC WASTE DIVERSION AND SLCPs MITIGATION

3.1 HOW MUCH ORGANIC WASTE IS GENERATED IN SCHOOLS?

According to existing investigations[1;2] about 40-50% of a school's waste bin is food and garden waste (the two waste fractions are commonly defined together as organic waste); this is also confirmed in the case of the schools in Sao Paulo (see figure 2) where the average waste generated daily by a student or teacher is estimated at about 216g, according to a questionnaire conducted with a sample of public schools that voluntarily participated on the online platform Escolas Mais Orgânicas.[3]

To learn how to practically perform a waste audit in your school please see **Toolbox n°7.**

According to the data obtained from the questionnaire, each student/teacher generates 40g/day of dry recyclables (paper, cardboard, glass, plastics and cans) and an estimated[4] amount of 42g of residual waste; food waste represents the largest amount- about 134g/day. The amount of garden waste has not been investigated.

Hence a large portion of the waste in a school's waste bin could be recycled by composting the organic waste it contains, thus:

- reducing the waste sent to disposal (i.e. incineration or landfill) and the cost for disposal
- emitting less greenhouse gases produced by the degradation of organic waste in landfills
- recycling valuable natural resources to be used in school gardens and grounds

FIGURE 2: AVERAGE COMPOSITION OF RECYCLABLE WASTE INSIDE SAMPLED SCHOOLS IN SAO PAULO ACCORDING TO THE QUESTIONNAIRE OF THE ONLINE PLATFORM

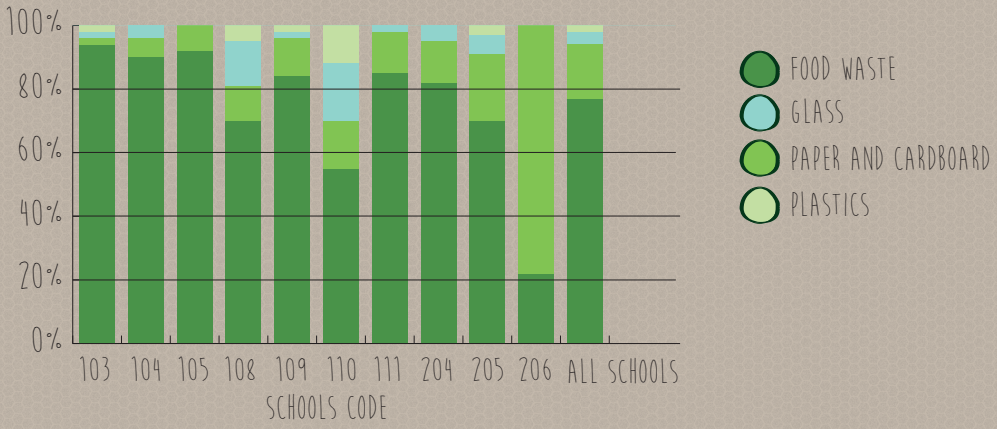
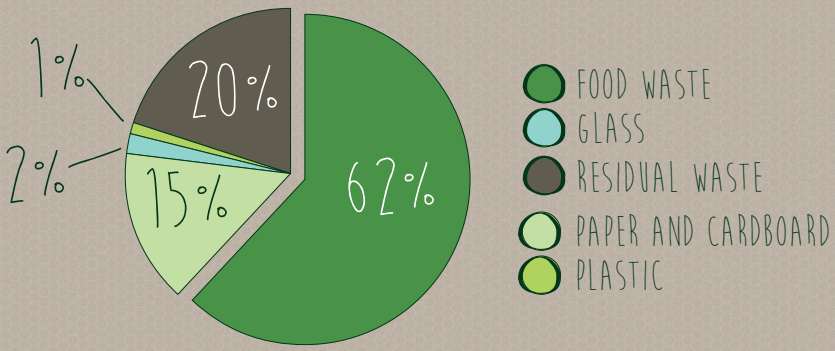


FIGURE 3: ESTIMATION OF MSW COMPOSITION OF A TYPICAL SCHOOL



Composting is an easy-to-perform, natural process that transforms organic waste into compost, a valuable and nutrient-rich natural fertilizer to be applied on a school's ground and gardens, thus diverting the organic waste from disposal. Composting typically can handle food waste, garden waste, paper and cardboard.

1 Digging Deep Through School Trash, Minnesota Pollution Control Agency, 2010

2 http://www.calrecycle.ca.gov/

3 The survey involved 18 schools for a total population of about 10650 students and 700 teachers; according to the data from the survey, the avarage production of recyclables (i.e. organic waste, paper, glass and plastics is about 118 g/person/day.) The amount of residual waste was estimated in about 30 g/person/day (i.e. 20% of the total production of waste).

4 Estimation by the Lead Technical Expert according to existing analysis on MSW.

3.2 How many schools can be potentially involved in diversion initiatives in Sao Paulo?

The potential of reducing organic waste at schools has been clearly addressed by Sao Paulo's waste management plan for 2014-2034 (PGIRS[5]) with the "Programa Municipal para Manejo Diferenciado de Resíduos Sólidos nas Unidades Educacionais da Rede Municipal de Ensino" addressing about 1.500 municipal schools and foreseeing targets for MSW management. The programme aims to:

- establish separate collection of recyclables with schools including packaging waste, organic waste and others and specifically organic waste collection or local recycling;
- promote in-situ composting and develop local vegetable garden activities with children;
- raise environmental awareness amongst the young generation attending the schools.

Photo: EMEI Desembargador Dalmo do Valle Nogueira

A tentative assessment of the amount of students and therefore families that could be potentially involved in initiatives of organic waste recycling and composting in schools, as shown in this Handbook, is based on the current[6] statistics of students in Sao Paulo aged up to 14 years - estimated at 675.000 persons. In addition, there are about 64.000 teachers and administrative staff involved. This evaluation is underestimated since it does not include the private schools in Sao Paulo which are also not directly involved by the prescriptions of the PGIRS.

In other words if all schools would be involved, approximately 340.000 families[7] would be indirectly aware of the possibilities to sort and recycle organic waste, potentially affecting 10% of the families in Sao Paulo.

3.3 WHAT IS THE POTENTIAL IMPACT OF ORGANIC WASTE DIVERSION AND SLCPs MITIGATION?

The number of meals provided each year in basic, fundamental and middle public schools in Sao Paulo is quantified[8] at about 245,7 million.

Considering an average production of 134g of food waste per meal consumed at school, the potential reduction of food waste due to composting initiatives at school is equal to at least 30.000 ton/year. These amounts do not include the quantity of green waste that can be recycled directly inside the school gardens and which can be estimated at least at 45% of the amount of food waste. Hence, in-situ composting in public schools is potentially able to divert 45.000 tons/year of organic waste from disposal.

Calculation of greenhouse gas (GHG) production assesses the balance between the emission of a process and the benefits from the process or its out-

5 PGIRS, page 13.

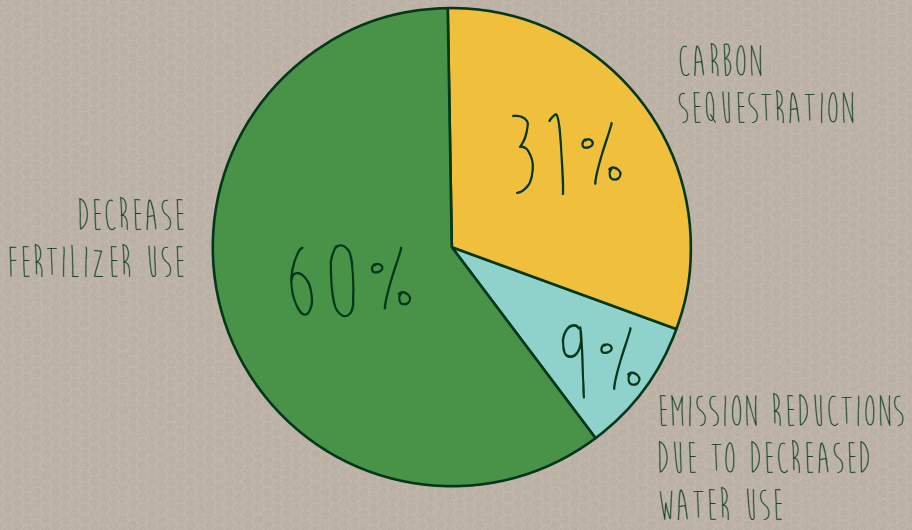
6 Relatório Gerencial da Secretaria Municipal de Educação - Dados de Escolas, Turmas, Matrículas, Recursos Humanos. October 2015. Provided by email in 22 Feb 2016.

7 We assume an average of 2 children per family.

8 Information provided by email in 01 March 2016 by the Divisão Técnica do Departamento de Alimentação Escolar da Secretaria Municipal de Educação de São Paulo.

puts. Emissions calculation from home composting have been addressed in literature[9] , showing an average carbon emission of 49% CO_2, 0,21% CH_4 and 0,83 N_2O (g/kg C). This leads to an average emission of 80,64 kg CO_2 eq /t of input waste. The benefits from compost use include replacement of mineral fertilizers and other benefits from compost application to the soil such as weed suppression, improved workability, water retention, protection against erosion, etc. Not all benefits are easily quantifiable, such as protection against soil erosion. A conservative evaluation quantifies a benefit of -130,5 kg CO_2 eq/t of input waste. Hence the net impact of home composting leads to an average of -49,86 kg CO_2 eq/t of input waste.

FIGURE 4: BENEFITS FROM COMPOST USE AND REDUCTION OF GHG EMISSIONS: TOTAL REDUCTION -130,5 KG CO_2EQ /T WET INPUT WASTE



In addition, we need to also consider the avoided emissions for not disposing waste into a sanitary landfill like those in Sao Paulo with landfill gas collection: a net GHG emission of 819,12 kg CO_2eq/t of input waste.

9 To compost or not to compost: Carbon and energy footprints of biodegradable materials' waste treatment B.G. Hermann a, L. Debeer b , B. De Wilde b , K. Blok a , M.K. Patel. Polymer Degradation and Stability 96 (2011) 1159e1171

So in the ideal case of recycling all 45.000 tons/year of organic waste at Sao Paulo's schools by in-situ composting, it would lead to a reduction of -39.104 tons/year CO_2eq, about -58 kg CO_2eq per student per year. Therefore by effectively composting organic waste in schools in Sao Paulo, SLCP mitigation could be achieved due to avoided disposal into landfills and the use of compost on school's soils and playgrounds .

CALCULATION OF AVOIDED GHG EMISSIONS DUE TO COMPOSTING IN THE SCHOOLS OF SAO PAULO

$$GHG_{AV} = (G1 + G2) * M_{ORG} / S$$

G1	GHG EMISSIONS AVOIDED FROM COMPOSTING AND COMPOST USE	-49,86	KG CO_2EQ /T.
G2	GHG EMISSIONS AVOIDED FROM PREVENTING LAND LLING	-819,12	KG CO_2EQ /T.
M_{ORG}	ORGANIC WASTE FROM SCHOOLS IN SAO PAULO	45.000	TON/YEAR
S	STUDENTS POTENTIALLY INVOLVED	678.115	PERSONS
GHG_{AV}	GHG EMISSIONS AVOIDED AT SCHOOLS PER YEAR PER STUDENT	- 57,7	KG CO_2EQ /STUDENT

10 Further details about GHG calculation can be found in the document "Strategy for organic waste diversion including collection, treatment and recycling and their challenges and opportunities" prepared by ISWA, under the CCAC MSWI City Assistance to the City of Sao Paulo.

4 HOW TO SORT ORGANIC WASTE AT SCHOOL

4.1 WHAT TYPES OF ORGANIC WASTE ARE PRODUCED IN A SCHOOL?

Schools usually generate different types of organic waste, at specific areas of the school and involving different waste generators. It is obvious that green waste is produced mainly on school grounds or in vegetable gardens during maintenance activities, while food waste arises mainly in schools with a kitchen or a catering service.

	GREEN WASTE	FOOD WASTE (VEGETABLE, GARDEN FRUIT)	FOOD SCRAPS
ORGANIC WASTE AT SCHOOL			
DESCRIPTION	GRASS MOWING, HEDGE CLIPPINGS, LEAVES, PLANT RESIDUES	FRUIT PEELINGS AND PULP, LEFTOVERS (VEGETABLE)FROM MEAL PREPARATION AND COOKING: UNCOOKED FOODS WASTE	COOKED FOOD WASTE, LEFTOVERS FROM LUNCH AND MEALS
LOCATION OF WASTE PRODUCTION	SCHOOL GARDEN, VEGETABLE GARDEN	SCHOOL KITCHEN	SCHOOL LUNCH HALL AND KITCHEN
ACTORS INVOLVED IN SCHOOLS	GARDENERS AND SCHOOL STAFF	COOKS AND KITCHEN STAFF	STUDENTS, TEACHERS

4.2 WHICH TYPES OF ORGANIC WASTE CAN BE SORTED FOR COMPOSTING AT SCHOOL?

Not all types of organic waste can be composted the same way into compost; it depends on the type of technique applied and the effective capacity of managing the process. Techniques include composting (i.e. aerobic decomposition) or vermicomposting (i.e. using earthworms to decompose organic matters into nutrient-rich fertilizer). Remember: generally aerobic composting can easily recycle large amounts of green waste and food waste, while vermicomposting can handle only limited amounts of food waste added continuously to feed the earthworms.

Generally we can define four groups of organic waste arising from a school shown in the chart below. If your school prepares fresh food and if the portions are planned correctly the amount of leftovers will be minimum and most of the food waste is made of vegetable and fruit residues from preparing the meals.

GREEN WASTE	UNCOOKED FOOD WASTE (VEGETABLE, FRUIT)	COOKED FOOD WASTE (VEGETABLE AND OTHER FOOD)	COOKED FOOD WASTE (INCLUDING MEAT, FISH)
√	√	!	✗
GREEN LEAVES GRASS HEDGE TRIMMINGS	COFFEE GROUNDS, USED TEA BAGS, BREAD CRUSTS, COOKIES, CAKE LEFTOVERS, VEGETABLE PEELINGS, FRUIT PEELINGS AND LEFTOVERS, CEREALS, SALAD LEFTOVERS	VEGETABLE LEFTOVERS, EGG SHELLS CRUSHED UP, CHEESE, PASTA OR RICE LEFTOVERS, SALAD LEFTOVERS, SOUP	MEAT AND FISH, LIQUID FATTY WASTE, SUCH AS OIL AND SOUP

Note: a green tick means ok to compost at school; an orange exclamation mark means caution needs to be taken when composting; a red cross means not recommended to compost at school.

4.3 How to sort garden and food waste at school

Organic waste should always be collected in rigid plastic bins that can be emptied and rinsed easily to guarantee hygienic conditions and avoid the attraction of pests and animals.

Garden waste is the organic waste fraction which can be more easily collected separately at school. It is usually bulky, produced during maintenance activity of school grounds and gardens. Leaves and garden waste from pruning are especially important ingredients for balancing the composting process. Garden waste can be stored easily in storage areas, plastic bags or fenced areas, ideally maintained in well aerated condition and covered to prevent excessive moisture during raining seasons.

Food waste produced **inside a school kitchen** can be easily collected separately in buckets up to 30 liters or wheel bins of 120 liters. If the school's composting process is not going to handle the cooked food waste including meat and fish, the cooked food waste needs to be collected separately from uncooked food waste. Excessive moisture can be collected by wrapping the buckets with liners made of paper or compostable bioplastics.

Food leftovers from meals can be sorted by children directly by providing them with a system of two bins of up to 30 liters each: one for cooked leftovers and one for uncooked vegetable and fruit residues. Children will immediately learn how to sort and distinguish the two waste fractions. In addition smaller caddies (6-10liters) can be distributed around the school: at the playground, in the staff room and in the cafeteria in order to collect as much as possible leftovers from fruit and snacks.

Do **not add traditional PE-plastic bags** to your composting process, since they do not biodegrade! Instead, try to add compostable bioplastic bags (better if the compostability is certified) or paper bags, to see how they biodegrade together with organic waste.

SEPARATE COLLECTION OF ORGANIC WASTE AND OTHER COMPOSTABLES: (LEFT) AT EMEF VILA MUNCK: EGG SHELLS AND VEGETABLES ARE SEPARATE IN CARDBOARD BOXES TO BE BROUGHT TO THE COMPOSTING PLACE: (RIGHT) EMEI DALMO DO VALE (BRAZIL): FOOD WASTE COLLECTED FOR COMPOSTING

Toolbox 1 shows some standard buckets and bins that can be bought to collect different types of organic waste at different locations inside a school; but you can make your own bins by recycling used plastic-bins for oil, butter, etc. or simply re-define the use of your existing school-bins by clearly labeling them in order to make separate collection easy.

TOOLBOX 1: TOOLS AND INSTRUMENTS FOR SEPARATE COLLECTION OF ORGANIC WASTE IN SCHOOLS

Collection of garden waste		Grass mowing, hedge clippings, leaves, plant residues		Grass mowing, hedge clippings, leaves, plant residues
Collection of food waste inside kitchen		Buckets (20-30 liters) with handles and lids are useful to collect food waste		Wheel bins (up to 120 liters) allow for larger storage and easy transfer but are more difficult to empty and to clean
Collection of food scraps at the lunch hall				
Collection of food waste inside classrooms staffroom, cafeteria		Buckets (6-10 liters) with handles and lids are useful to collect food waste		

5 UNDERSTAND THE PROCESS OF ORGANIC WASTE RECYCLING

5.1 WHAT TYPES OF ORGANIC WASTE ARE PRODUCED IN A SCHOOL?

The process to create compost is "copied" from nature. There are two main techniques that can be used for composting of garden and food waste at schools:

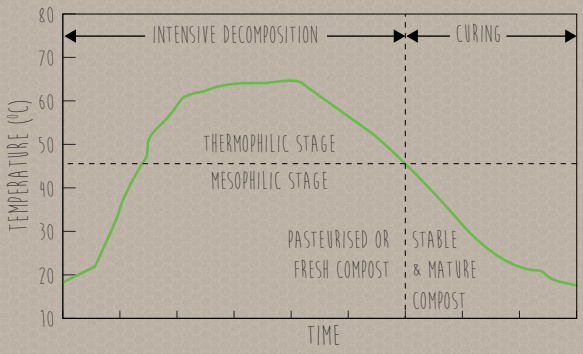
- **Aerobic composting:** is an intentional biodegradation of organic matter. The decomposition is performed in aerobic conditions (i.e. in the presence of air) by micro-organisms, mostly bacteria, but also fungi. The mature compost is dark brown to black in colour and has a soil-like texture.
- **Vermicomposting:** is the breakdown of organic matter using earthworms, usually red wigglers, white worms and others. It produces a heterogeneous mixture of decomposing food waste, bedding materials and worm humus (or worm manure) that is rich in nutrient as a fertilizer.

Both techniques involve the bio-oxidation of organic matter, resulting in a rich, humus-like material. As 'bio-oxidation' implies, they both require oxygen for optimal performance. A lack of oxygen activates other micro-organisms which give rise to fermentation and putrefaction, with strong odour emissions.

The main difference between the two techniques rests on the types of organic waste that can be recycled, the amounts and specific aspects of their process. In addition, while aerobic-composting has a solid output only, vermicomposting can have a liquid output in addition.

	AEROBIC COMPOSTING	VERMICOMPOSTING
PROS +	ENABLES PROCESSING OF LARGE QUANTITIES OF ORGANIC WASTE CAN PROCEED RELATIVELY QUICKLY UNDER IDEAL CONDITIONS CAN KILL WEED SEEDS AND PATHOGENS	LESS LABOR-INTENSIVE – NO TURNING/AERATING NECESSARY PROCESS IS FAST SUITED FOR BEING MANAGED BOTH INDOOR AND OUTDOOR
CONS –	CAN BE LABOR-INTENSIVE (TURNING, MIXING, ETC) MAY REQUIRE SOME STOCK-PILING OF STRUCTURING MATERIAL (DRY LEAVES, WOOD CHIPS, ETC.) MOISTURE NEEDS TO BE MANAGED CAREFULLY ONLY OUTDOOR	WON'T KILL SEEDS AND LESS EFFICIENT IN KILLING PATHOGENS CAN TREAT ONLY LIMITED AMOUNTS NOT SUITABLE FOR LARGE AMOUNTS OF GARDEN WASTE

5.2 HOW DOES AEROBIC COMPOSTING WORKS?



Composting occurs in two successive phases.

During the first phase complex organic molecules are degraded by microorganisms such as bacteria and fungi into simpler and more stable chemical compounds such as mineral salts, water and carbon dioxide. The intense bacterial activity causes significant heating with temperature rising up to 55-60°C, thus eliminating pathogens, guaranteeing sanitation and killing weed seeds .

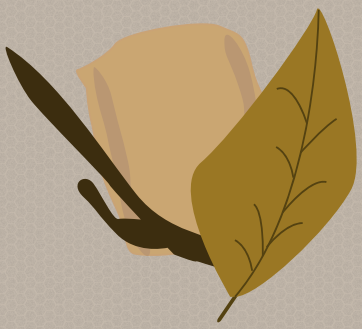
In the second phase, microorganisms synthesize humus and the final product is called compost, a stable material in which most of the chemical changes have

taken place; the remains do not involve excessive oxygen consumption or production of phytotoxic substances (harmful for plants).

Aerobic composting needs a balanced mixture of organic materials, divided into two groups: the browns and the greens. The browns are rich in Carbon (C), low in Nitrogen (N) and so biodegrade slowly; the greens are the "high-energy" stuff for the composting process- they have a high moisture content, are rich in Nitrogen (N), low in Carbon (C) and biodegrade fast.

An effective aerobic composting process needs the right mixture of bulky materials (the browns) and greens- the optimal C:N ratio is between 25:1 and 40:1. Translated into common practice the rule of thumbs is to mix the greens and the browns in a ratio of 2:1.

The Greens	
Characteristics	Waste/Sources
• Soft • Moist • Rich in Nitrogen N • Degrade quickly • Compacts easily	• Grass clippings • Flower heads and stems • Bedding plants • Discarded vegetables and fruits



The Browns	
Characteristics	Waste/Sources
• Woody • Dry • Rich in Carbon C • Low in Nitrogen • Bulky • Slow to degrade	• Tree trunck and branches • Fallen leaves • Straw • Shredded paper and card

A small-scale composting site in a school will take at least 4 to 6 months to produce compost which will have a brown, uniform color and will smell like wet earth. It is rich in organic matter and potentially lives like worms, small buds and other insects.

5.3 How does vermicomposting work?

Vermicomposting or "worm-composting" is applied mainly to compost food waste in plastic containers and is particularly useful for households without direct access to a garden. Unlike aerobic composting in windrows, piles or solid composters, vermicomposting relies almost exclusively on greens.

Microbes still play a fundamental role in the degradations of organic waste, as they are responsible for decomposing the greens; the microbes then become the source of food for the worms. The worm cast is nutrient-rich and biologically active which makes an excellent bio-fertilizer.

The organic waste mixture must act as a hospitable living environment, usually called "bedding", for the worms. Some materials make good beddings all by themselves, while others lack one or more of the characteristics mentioned in the box above and need to be used in various combinations. Shredded cardboard or sawdust are suitable materials as the bedding for your worms.

Characteristics of an optimal bedding for vermicomposting

- High absorbency
- Good bulking potential
- Low protein and/or nitrogen content

High nitrogen levels can result in rapid degradation and is associated with heating, an inhospitable, often fatal condition for worms. Therefore meat and high-fat food waste (such as cheese and oils) can create odours, attract pests and fatal anaerobic conditions for worms and should not be included.

The key of the process management is to ensure the correct moisture level (between 70% and 90% water content by weight) and the optimal tempera-

ture range of 15-30°C. If the moisture level is too low the worms will dry out; if it is too high the air channels will fill with water and the organic waste starts to smell, being in an anaerobic condition. Therefore many commercial plastic vermicomposting bins have a tap on the box at the bottom in order to easily remove excess liquid that can be used as a fertilizer.

5.4 WHAT IS COMPOST AND HOW CAN WE USE IT?

The main benefit of compost is that it is rich in organic matter and in humus, a brown substance which is an important part of soil. Humus acts like a sponge helping to soak up water and stop plant nutrients from being washed away hence reducing soil erosion. Organic matter reduces compaction of the soil, creating small channels for roots to grow into and worms and other soil creatures to tunnel through. In addition, organic matter acts as food source for soil microbes and invertebrates, helping to maintain a living, biologically diverse soil.

There are two main ways to use compost: either as a soil improver or as a growing medium.

- Soil improvers: are materials that are added to soil for improving the physical properties and the structure of the soil and the effects depend on the organic matters in the compost
- Growing media: are materials other than soil in which plants are grown;

Depending on the use and types of plants that are available in a school, different amounts of compost can be used directly for maintaining school grounds.

VEGETABLE GARDEN

Purpose: for a cross-fertilization that favours the growth of plants

Dose: 2-3 kg/m^2

Application: spread the compost on the soil and dig it into a depth of 10-15 cm

POTTED PLANTS

Purpose: as a growing media for vegetables and ornamental plants

Dose: depends on the size of each pot

Application: make a mixture between compost and turf by adding 30-50% compost

FLOWER BEDS

Purpose: fertilization of flower beds in preparation for the planting of ornamental plants

Dose: 10-15 kg/m^2

Application: spread the compost on the soil and dig it into a depth of 10-15 cm

GREEN LAWN

Purpose: for the fertilization of the ground during planting operations

Dose: make a thin layer of 1 cm

Application: mix compost with sand and earth (30-40% compost) and distribute a homogeneous layer of the mixture on the existing green lawn, then sow the new green lawn

TREES AND SHRUBS

Purpose: as a fertilizer for trees and shrubs

Dose: 10-20 litre/planting hole

Application: mix compost and earth with the same proportion; before planting the tree put the mixture at the bottom of the planting hole

Source: CIC, Italian Composting and Biogas Association.

6 How to practice composting at schools

This chapter aims to give practical guidance about how to set up composting inside a school. It assumes that your school has a garden or green area with trees, shrubs or at least a green lawn.

6.1 How to set up composting at schools

Setting up composting for showing and teaching students about the possibilities to recycle organic waste by composting can be done in the following steps:

Decide what type of composting to perform

- Demonstrative composting initiative
- Regular composting of garden and food waste

Decide which type of organic waste to compost

- Garden waste
- Food waste (partially or all)
- (Don't forget to separate dry recyclables!)

Prepare specific activities and task inside the school

- Decide which classes to involve
- Define tasks for students, teachers, school staff
- Inform and involve local MSW service provider

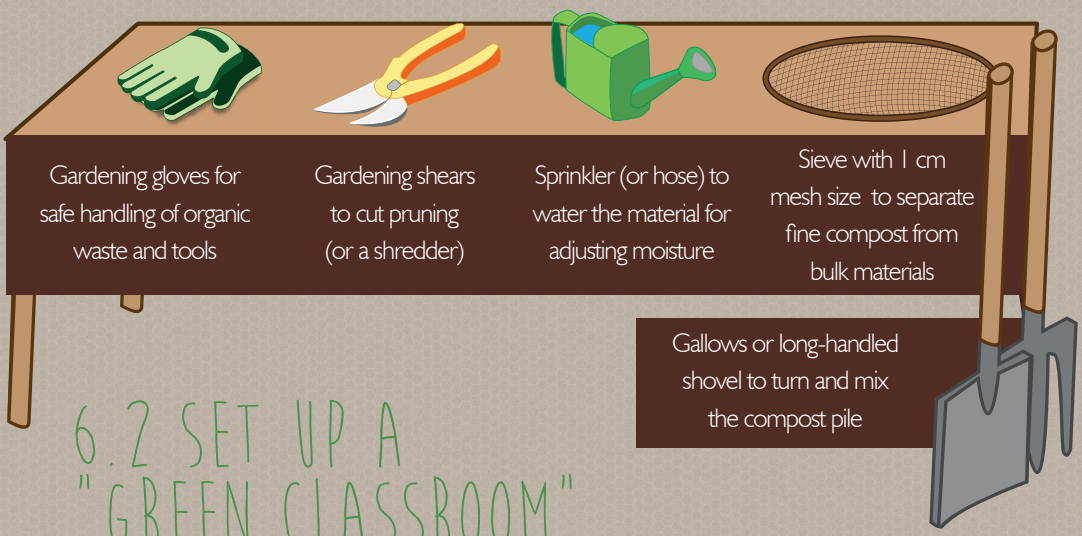
Prepare equipment and teaching material

- Collect and consult suitable information for developing the topic at school
- Obtain the equipment for separate collection
- Obtain equipment for performing composting

Start the initiative

- Teach the concepts
- Collect organic waste separately
- Perform composting
- Use the mature compost

TOOLBOX 2: BASIC INSTRUMENTS NEEDED FOR MANAGING THE COMPOSTING PROCESS AT SCHOOL



Gardening gloves for safe handling of organic waste and tools

Gardening shears to cut pruning (or a shredder)

Sprinkler (or hose) to water the material for adjusting moisture

Sieve with 1 cm mesh size to separate fine compost from bulk materials

Gallows or long-handled shovel to turn and mix the compost pile

6.2 SET UP A "GREEN CLASSROOM"

Composting at school entails two activities: teaching and practicing. Therefore locate a spot in the school garden to set up a small composter there. It will become your permanent "green classroom" to show students how composting works. If there is a vegetable garden in your school, locate the composting site next to it, so that you can easily combine composting and the application of compost together.

Examples of a green classroom (Escola EMEI Dona Leopoldina, Sao Paulo, Brazil)

6.3 AEROBIC COMPOSTING: A STEP-BY-STEP GUIDE

Composting requires little effort, but it requires some care to make the microorganism work effectively for us. Choose the type of composting style you would like to realize: a plastic composter, a self-made composter or composting in a windrow? Look at **Toolbox n° 3** for suggestions.
There are some simple rules to follow in order to manage the process correctly.

1 FIND THE RIGHT SITE

Ideally your composting area should be in a reasonably sunny site on bare soil. If you have to put your composting bin on concrete or patio slabs, ensure there is a layer of twigs or a pallet at the bottom of the composting material above the ground. Choose a place where you can easily add ingredients and get the compost out.

2 ADD THE RIGHT INGREDIENTS

Empty your kitchen caddy along with your garden waste into your composting windrow or bin. A 50/50 mix of greens (waste high in nitrogen like food waste and grass clippings) and browns (waste high in carbon like wood and paper) is the ideal recipe for good composting practice.

3 GIVE IT THE RIGHT SHAPE

A composting windrow needs natural aeration; compost heaps should not exceed 1.2m in height so that the organic waste mixture does not compact. Therefore, when processing large amounts of organic waste, extend the heap horizontally.

4 CHECK THE MOISTURE

The moisture tends to change due to weather conditions, rainfall and sunlight. To check the moisture level, an easy and immediate test is the so-called "fist test" (see Toolbox n° 6).

5 LET IT BREATHE

The composting process takes place in the presence of oxygen, thus guaranteeing a good transformation and the absence of bad smells. Turn the material periodically (once every month or so) to restore the porosity of the composting pile.

6 TAKE YOUR TIME

Composting is a natural process. Once the composting bin is full or the composting pile reaches its limit size, it is time to stop adding fresh organic waste. It takes between six to nine months for your compost to become ready for use, so now all you need to do is to wait and let nature do the work. Keep on adding greens and browns regularly to top up your compost when volume reduces.

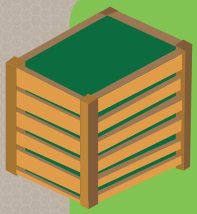
7 SEPARATE THE FINISHED COMPOST

The mature compost is usually located at the bottom of a composting pile, with a dark brown colour and the smell of wet earth. Compost is to be separated from coarse and woody parts by a sieve of about 1 cm mash size.

Do not forget to shred or reduce the size of bulky garden waste in order for the composting material to have a larger surface exposed to microorganism. Do not use sawdust as it is not an effective bulking material, but it is useful in correcting the moisture content of the mixture.

If you decide to also include cooked food (rich in fats) such as meat or fish, the process of which needs to be managed well which comes with experience, start with small amounts (up to 10%) and verify that they do not create odor emission or attract mice; in case of odour or mice, cover the food waste immediately with leaves or other vegetables.

TOOLBOX 3: DIFFERENT TYPES OF AEROBIC COMPOSTING SOLUTIONS FOR SCHOOL

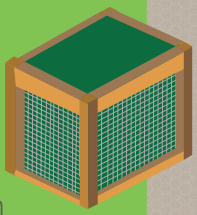


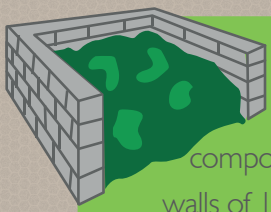
WOOD BOX

Place it on a wooden pallet to allow aeration from the bottom. Make a cube of about 100 cm length. Leave about 2 cm between wooden planks for air circulation. One side should be made easy to open for collecting mature compost.

WOOD AND WIRE MESH

Organic waste is poured within the four walls of wire mesh framed by wood, one of which acts as a door for collecting mature compost.



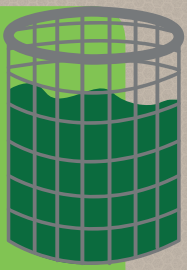


CONCRETE WALLS

It is a highly durable composter made of three brick walls of 1x1 meter. Leave a space of 2cm between blocks to facilitate circulation of air.

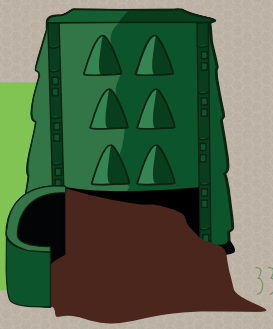
METAL MESH

Use a mesh sheet to form the wall of a cylinder and fix it to the ground by small wooden poles.



PLASTIC

There are different models sold in the market.
Prefer solutions with good ventilation, without sealing the bottom and with a window at the bottom for collecting mature compost.



Examples of composting sites at school (left: concrete wall composter in school Escola EMEI Leopoldina; right top: wood composter in school Tarsila do Amaral; right bottom: composting windrow of CEPAGRO)

6.4 VERMICOMPOSTING: A STEP-BY-STEP GUIDE

Vermicomposting can be performed using commercial or self-made bin (see **Toolbox n° 4**) that consists of a set of vertical boxes with a box at the bottom for collecting excess liquid. There are some simple rules to follow to manage the process correctly.

1

FIND THE RIGHT SITE

Your vermicomposting bin should be placed in a shady area when placed outdoor to avoid excessive heating and drying of the worms. The ideal temperature for the worms is room temperature (between 15°C and 22°C). The bin can also be located indoor.

2

CHOOSE THE RIGHT BEDDING

Use coarse sawdust from unpainted wood or produce it from the plants inside your garden. Do not use plywood sawdust that has glue in its composition. You can also use stripes of unbleached cardboard and shredded newspaper. Moisten the bedding material so that the overall moisture is like a wrung-out sponge.

3

FIND THE RIGHT WORMS

For vermicomposting the earthworms most commonly used are red worms *(Eisenia foetida* or *Eisenia andrei)* also known as red wigglers or manure worms, and European Night Crawlers *(Eisenia hortensis)*.

4

ADD THE RIGHT INGREDIENTS

Add only fresh uncooked food waste that can feed the worms; focus on vegetables and fruits and cut them into pieces. Avoid overfeeding the worms. Do not add meat and cooked food or food rich in fats. Mix fresh organic waste with bedding (carbon-rich) material and cover them completely. This will ensure an effective decomposition process and prevent flies, maggots and odour.

TOOLBOX 4. DIFFERENT TYPES OF VERMICOMPOSTERS.

Commercial plastic composter	Self-made composter
	
Commercial composters made of plastics can be bought in different sizes. They usually consist of three boxes.	You can build it yourself with plastic buckets used for colour or food storage. Drill holes on the bottom of the two boxes at the top.

5

INSTALL THE VERMICOMPOSTER

Fill the first box at the top with bedding material, add the worms and start adding organic waste. Swap it with the middle box when full (i.e. place it in the middle and place the empty box at the top now); fill the empty box with bedding material and start adding organic waste. There is no need to put worms in this box as they will climb through the holes at the bottom of the box in search of new food.

6

MANAGE MOISTURE EXCESS

The box at the bottom is for collecting excess liquid; empty this box regularly, do it at least once when you swap the boxes on top.

7

TAKE YOUR TIME

Composting using worms is a natural process; the worms need about 30 days to digest the organic waste and transform it into an organic fertilizer.

8

RECOVER THE COMPOST (AND THE WORMS)

To collect ready compost you need to separate the worms from the compost. Place the box into sunlight and the worms will retreat to the bottom of the box where it is dark. Take the compost but leave the first 5cm layer at the bottom with a high concentration of worms for reuse.

6.5 TROUBLESHOOTING

Problem-solving requires the identification of the causes of the problem, reviewing the options for action and making the necessary changes to the composting process and observing the effects of such changes. The main problems in in-situ composting are linked to the wrong mixture between greens (waste high in nitrogen like food waste and grass clippings) and browns (waste high in carbon like wood and paper).

PROBLEM	CAUSE	SOLUTION
COMPOST PILE CONTAINS EARWIGS, LUGS AND/OR OTHER INSECTS	PILE IS COMPOSTING CORRECTLY	INSECTS ARE A GOOD SIGN OF A PRODUCTIVE COMPOST PILE!
COMPOST PILE IS ATTRACTING RATS, DOGS, FLIES OR OTHER PESTS	AMOUNT OR TYPE OF GREENS INCORRECT	AVOID MEATS, BONES, OILS
	EXPOSED FOOD SCRAPS	PLACE FOOD SCRAPS IN CENTER OF PILE AND COVER COMPLETELY WITH BROWNS
	COMPOST BIN NEEDS REPAIR	KEEP THE BIN WELL MAINTAINED
COMPOST PILE IS NOT HEATING UP	IF IT SEEMS DAMP AND SWEET-SMELLING, IT MAY BE A LACK OF NITROGEN	MIX IN FOOD SCRAPS OR OTHER MATERIALS HIGH IN NITROGEN
	NOT ENOUGH MOISTURE	ADD WATER
	NOT ENOUGH OXYGEN	TURN OR FLUFF THE PILE
	PILE MAY BE TOO SMALL	BUILD THE PILE UP TO 1M X 1M X 1M

PROBLEM	CAUSE	SOLUTION
MATTED, UNDER COMPOSED LAYERS OF LEAVES OR FOOD SCRAPS	COMPACTION, POOR AERATION	BREAK UP LAYERS WITH GARDEN FORK, OR SHRED THEM, THEN RE-LAYER OR TURN THE PILE. AVOID ADDING THICK LAYERS OF BULKING MATERIALS
COMPOST PILE HAS A BAD ODOUR LIKE A MIXTURE OF RANCID BUTTER, VINEGAR AND ROTTEN EGGS	NOT ENOUGH OXYGEN, COMPACTION	TURN THE PILE AND SHAKE MATERIALS TO LOOSEN AND AERATE
	NOT ENOUGH OXYGEN, TOO WET	TURN THE PILE AND ADD COARSE DRY MATERIALS SUCH AS LEAVES, WOOD SHAVINGS, SAWDUST, STRAW OR SHREDDED NEWSPAPER TO SOAK UP EXCESS MOISTURE
COMPOST HAS A BAD ODOUR LIKE AMMONIA	PILE MAY HAVE TOO MUCH NITROGEN	ADD MATERIALS HIGH IN CARBON SUCH AS LEAVES, WOOD SHAVINGS, SAWDUST, STRAW OR SHREDDED NEWSPAPER. MIX IN TO AERATE
COMPOST PRODUCES TOO MANY FRUIT FLIES	FRUIT FLIES ARE NATURAL "INHABITANTS" OF A COMPOSTING PROCESS; THEY LAY THEIR EGGS IN THE BEDDING OR IN THE MIXTURE	TO PREVENT FRUIT FLIES BURY FOOD WASTE A FEW CENTIMETERS BELOW THE BEDDING MATERIAL (VERMICOMPOSTING) OR BELOW THE "BROWNS". REDUCE THE AMOUNT OF FOOD WASTE IN THE MIXTURE OF "GREENS" AND "BROWNS"

7 SHARING EXPERIENCES

7.1 THE ONLINE PLATFORM FOR THE SCHOOLS IN SAO PAULO

The online platform "Escolas Mais Orgânicas" is an activity under the same CCAC MSWI City Assistance Project to the city of Sao Paulo, implemented by ISWA . The idea of this activity came about in March 2015 after the project team visited CEI Vila Leopoldina, a public school at the Leopoldina district in Sao Paulo. The school has a set of activities to recycle most of its solid waste, from plastics, paper and metal to organic waste. There are, both vermicomposting and aerobic composting activities at the school, the products of which are used for plantation of seasonal fruits and vegetables. The idea of creating an online social networking platform is for schools with different initiatives on waste management especially organic waste management, to inspire each other by exchanging their experience, questions and accomplishments in their initiatives. In the long term, the online social network platform should also attract schools that would like to start recycling to learn from experienced schools.

The aims of the networking platform are:

- Collect information from schools about existing initiatives;
- Promote exchange of ideas and information among schools;
- Provide an online platform that can be easily used by schools and stimulate interaction;
- Foster long-term cooperation among schools beyond the project.

The Escolas Mais Orgânicas platform was set as a Facebook group launched officially in February 2016. After two months of existence, 50 members representing 17 schools are sharing their experiences with composting through photos and comments as shown in the Figure 8.

Figure 8: Examples of post and interaction between participating schools on the online platform "Escolas Mais Orgânicas"

7.2 ORGANIC WASTE TREATMENT - SCHOOLS AT A GLANCE

Some best practises of public schools in Sao Paulo are briefly highlighted in this section with the description of the main activities developed in each of the highlighted schools. These include the recycling of organic waste by composting and the use of compost or liquid fertilizer for gardening activities at the schools and for growing vegetables for consumption inside the schools.

7.2.1 EMEI ANÍSIO TEIXEIRA

The school has about 500 students and 50 teachers and administrative staff. The amount of organic waste produced per month is approximately 1,5 tons from food waste and garden maintenance, which is recycled by vermicomposting.

Each classroom is equipped with its own vermicomposting plastic box.

The compost is applied in the school's gardening activities.

Training teachers talking about vermicomposting

Teaching vermicomposting with children at the School

7.2.2 EMEI CAMILO ASHCÁR

This school has about 350 students and 50 teachers and administrative staff. It generates monthly 230 kg of food waste and garden waste.

All garden waste and most of the food waste are composted with the aerobic composting technique and children are engaged to manage the compost and apply it in gardening activities in the school. The functioning of the organic carbon cycle is practically taught and applied at this school.

Part of the vegetables grown in the school is used for preparing meals.

Students involved in sieving the mature compost; the “fine” fraction is used in gardening activities in the school

The vegetable garden of the schools involving students in using compost as an organic fertilizer

7.2.3 EMEI PROFª CLYCIE MENDES CARNEIRO

With 250 students and about 35 teachers and administrative staff, this school generates per month about 220 kg of food waste and garden waste.

Both techniques of vermicomposting and aerobic composting are used to treat organic waste and students are engaged in its process management.

Starting aerobic composting at school and adding food waste (left) and green waste (right);

Mixing food and green waste for aerobic composting

7.2.4 EMEI DONA LEOPOLDINA

The school has about 230 students and 40 teachers and administrative staff. Its monthly waste generation is about 300 kg of food waste and garden waste.

All organic waste is treated by techniques of vermicomposting and aerobic composting, which are managed by a maintenance worker with participation of students and teachers.

The school is trying to add at least one type of vegetable per week from its own vegetable garden into the menu prepared for students and teachers.

About the positive impact of these activities on the school community, the Director Marcia Covelo says: *"The major impact of the composting practices at the school is the promotion of zero food waste- once it is transformed into compost it is applied to the school garden. Beyond that, it is part of an environmental education project where there is no "trash" and hygiene acquires new meanings for children and their parents"*.

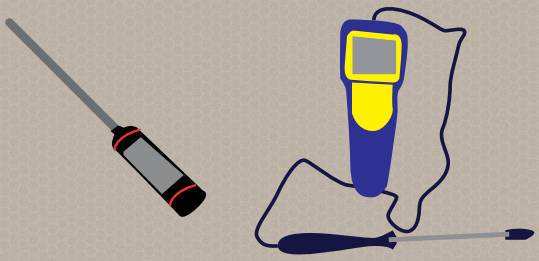
Adding fresh food waste into a aerobic composting site in the school

Harvesting at the vegetable garden and delivery to the school's kitchen for cooking

8 TOOLBOXES

TOOLBOX 5: HOW TO PERFORM A TEMPERATURE TEST FOR AN AEROBIC COMPOSTING PROCESS

The temperature of an aerobic composting process can be measured with a basic thermometer with a probe of 10-20 cm depth. Test the temperature at different points of the composting process, the range usually is between 30 and 45 °C, but can reach higher (up to 65°C) in larger composting windrows.



Temperature measurements should be performed before opening or turning the composting pile. Measurements need to be more frequent (once/day) at the beginning and after the first month can be reduced to one measurement each week.

Plot the data on a graph, putting the time (days) on the x-axis and the temperature on the y-axis.

Example of a table for registering temperatures of a composting process

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T external (°C)															
T compost (°C)															
Day	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
T external (°C)															
T compost (°C)															
Day	35	42	49	56	63	70	77	84	91	98					
T external (°C)															
T compost (°C)															

TOOLBOX 6: HOW TO PERFORM A MOISTURE TEST FOR AN AEROBIC COMPOSTING PILE

The composting windrow should have an ideal moisture content of 50-60%. But how can we measure moisture without an expensive lab-equipment?

A simple test can be performed using your fist!

How to make the moisture test:

1. Take a handful of material (use a glove) from the center of the composting windrow or your composter. Choose material that is a mixture of food waste and green waste, not the fresh organic waste only.
2. Squeeze the material in your hand and observe what happens:

- If you can squeeze water out of it > the compost is too wet
- If it does not release water or just a few drops > it is just right
- If it does not release water but crumbles apart when released > it is too dry

3. Then act according to the outcome of your moisture test:

- If the compost is too wet > add dry materials (the browns) or turn the windrow during a warm, sunny day (moisture will evaporate)
- If the compost is too dry > add water, then mix or turn the windrow

Lesson learned:

The right moisture content can be adjusted by mixing correctly greens and the browns (see chapter 5). Moisture content can be regulated also by:

- Covering the windrow during rainy season
- Rinsing with water in dry season (if necessary)

TOOLBOX 7: HOW TO PERFORM A WASTE COMPOSITION ANALYSIS

Waste composition is usually assessed by separating the waste into homogeneous fraction and by weighting each separate fraction separately.

If your school has its own bins or bags for the MSW service, collect the bags and bins before the emptying service and weigh them. This allows you to assess the specific production of waste for each student or for each person of the school including teachers and administrative staff.

Equipment needed:

Plastic sheet (2x2 m), plastic gloves, a balance with a sensitivity (minimum detail) of 100 gram, plastic baskets or plastic bags, a camera

How to make a waste composition analysis:

1. Collect waste produced in one week from the waste bin of at least 5 classrooms
2. Empty the waste onto a plastic sheet
3. Start sorting waste into different types of fractions as suggested in the tables below
4. Weigh each fraction by putting it into a basket or plastic bag and measuring it on a balance (subtract the tare)
5. Calculate the percentage of each fraction over the total waste analysed
6. Rank the fractions according to their percentage in total waste- which fraction is most present, which is the second one, which is the third, etc.
7. For each fraction, define whether it can be recycled or not according to your local waste collection service; define whether it is biodegradable or not (food waste, green waste, paper and cardboard are biodegradables, while other waste produced in a school are usually not)

Below is an example of tables for registering the production of waste at school and the waste composition.

PRODUCTION OF WASTE IN A SCHOOL

NUMBER OF CLASSROOMS	
NUMBER OF STUDENTS	
NUMBER OF TEACHERS	
NUMBER OF EMPLOYEES	
TOTAL POPULATION OF THE SCHOOL	

MIXED MSW PRODUCED	KG
DRY RECYCLABLES PRODUCED	KG
FOOD WASTE PRODUCED	KG
GARDEN WASTE PRODUCED	KG
OTHER WASTE PRODUCED	KG
TOTAL MSW PRODUCED AT SCHOOL	KG

AVERAGE MSW PRODUCTION PER PERSON/WEEK AT SCHOOL	KG/PERSON

ANALYSIS OF WASTE COMPOSITION IN A SCHOOL

PAPER AND CARDBOARD	KG	%
PLASTIC BOTTLES	KG	%
OTHER PLASTICS	KG	%
CANS AND TINS	KG	%
OTHER METALS	KG	%
GLASS BOTTLES	KG	%
OTHER GLASS	KG	%
WOOD	KG	%
FOOD WASTE	KG	%
E-WASTE	KG	%
NAPPIES	KG	%
MIXED WASTE (NON RECYCLABLE)	KG	%
TOTAL WASTE ANALYZED	KG	100%

TOOLBOX 8: HOW LONG DO MATERIALS TAKE TO BIODEGRADE?

The concept of biodegradation (degradation under the activity of microorganism) is quite important when teaching about waste and composting.

This simple test allows students to learn intuitively which types of material are biodegradable. The test should be done immediately after or before explaining the concept of biodegradation to students. The test is intended for students up to 10 years old.

How to present the test to students:

The following can be a simple exercise to acquaint students with material types and their degradation process.

Each of the objects below is made of a different material. If they are left in the sun, wind and rain, they will eventually break down (biodegrade or decompose).

Under each picture asks students to write the name of the materials each object is made of.

Ask them to draw a line between each material and the length of time they think it will take to break down.

Reveal and correct answers and explain the concept.

1 month

6 months

5 years

80 years

200 years

400 years

9 CONCLUSIONS

Organic waste-food waste from food preparation and leftover meals and green waste from gardens, represents the vast majority of solid waste produced at a school. The question of its correct disposal represents a challenge and opportunity for schools, its teachers and students, to engage proactively in order to prevent waste, reduce its amounts and learn how to sort and recycle it.

This Handbook has been prepared to be circulated among schools of Sao Paulo, a mega-city of 12 million inhabitants, to promote initiatives of recycling organic waste by composting it directly inside schools. The aim is to prevent organic matters from becoming waste, recycle them with low-tech, low-cost techniques and apply the compost and liquid fertilizer onto school gardens. Initiatives and didactic projects are already running in some schools in Sao Paulo and students are learning how the natural cycle of organic matters works.

There are many local initiatives and environmental NGOs that promote and support in-situ composting, so interested schools and teachers can easily find networking opportunities to learn, share and cooperate. The initiative of the online platform for schools on organic waste management, "Escolas Mais Orgânicas", is an example of creating a network among schools using social media instruments.

Reducing disposal of organic waste into landfills is a key element for mitigating SLCPs (methane and black carbon emissions). Recycling all organic waste produced at schools of Sao Paulo with in-situ composting would avoid GHG emissions that arise from transportation and disposal of such waste into a sanitary landfill. GHG emissions are also reduced by replacing mineral fertilizers with compost and by improving soil health and condition. We have estimated that in-situ composting would lead to a reduction of about -58 kg CO_2 eq per student per year in Sao Paulo.

Hence with the right knowledge and tools, organic waste recycling in schools is achievable, contributes to the reduction of SLCPs, constitutes an important environmental education and is fun.