



PAST, PRESENT AND FUTURE OF COMPOST

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Overview

We cannot talk about compost, its reality, history and future without considering the soil that receives it or without speaking about the evolution of society, the economy and what has been happening with the resources and waste over the years. Important features of the soil (fertility, structure, risk of erosion) are closely related with its contents in organic matter (OM). From an agronomic viewpoint, each type of soil should have a determinate level of OM depending on the climatic conditions, to maintain a determinate productivity and fertility. OM contents between 2.5 and 3% have been proposed for agricultural soil and a 74% of the soil in Southern Europe is estimated to have contents of less than 3.4% in the plow layer (0-30 cm) [1] [2].

For an effective maintenance of the OM content in soil suitable farming practises must be applied (crop rotation, use of harvest waste and organic waste from different sources, application of green manure...) The *European Conservation Agriculture Federation* (ECAAF) [3] suggests that in twenty years of intensive cultivation of the soil up to a 50% of its contents in OM can be lost if quality organic amendment contributions are not added. In the zones where there is a shortage of organic amendments, applying compost from activities other than agriculture may be highly beneficial. Composting, that imitates the transformation of OM in nature, may provide the soil a good source of OM transformable into humus [4].

What importance has been given to organic matter and to organic waste throughout history? How has its use developed parallel to progress in society, to economic changes, to development of agronomic science or the discovery of fertilizers? Maximum importance has been paid over the years to its contents in phytonutrients being essential for agricultural production; eras when efforts were made to collect, maintain and use the components present in animal waste and harvests when these were scarce. Also, in time, waste from towns (table 1) was gradually introduced in the recovery of nutrients. Interest in using (recycling) waste gave priority to its contents in nutrients rather than a direct interest in maintaining the levels of OM.

Over the years and with the appearance of new knowledge about the core features of crop production¹ and mineral fertilisers, interest in these materials varied. Town waste mainly became considered as a source of phytonutrients leading to sanitary problems and consequently requiring a controlled collection and landfill². Parallel to intensifying

¹ In 1840, in his book "The natural laws of Agriculture" von Liebig recalls the importance of reusing nutrients extracted by plants and comments that "the fertility of Sicily was lost in Rome's sewers"

² In the Middle Ages, the growth in the population and appearance of towns would break the natural cycle and detritus accumulate in them; despite problems of salubrity however, many of them were used by the local farmers to fertilise their crops in view of the lack of manure. At the beginning of the 17th century, Olivier de Serres, one of the first agronomists, in his work "Les mesnage des champs", passionately defends the garbage picked up in the streets as being a valuable fertilizer [5]. It is considered that in the year 1830 farmers recycled half the waste produced in the city of Paris. At the end of the 19th century, as consequence of the discoveries by Pasteur², a radical change took place in the history of waste, implementing collection and landfill systems to avoid sanitary problems.

agricultural production and the use of mineral fertilisers, a decline in the OM content of soil commenced with the appearance of problems of contamination that accompany the development of intensive crop techniques.

Table 1.- Some references about the use of organic waste [6]

<p>Lucio Junio Moderato Columela in "Los doce libros de agricultura" (year 42 of our era): <i>"I frequently hear complaints about the land having been invaded by sterility, as could occur from some ailment, it is not befitting of a sensible person to think that the land has aged like man.... For land does not age or tire if it is fertilised... our laziness is to blame for the fields with less freedom. Thus more plentiful fruits can be reaped, if the earth is returned to its original state, fertilising it frequently, suitably and in moderation"</i></p> <p>Ibn al Awam (11th century) in his book about agriculture: "Kitab al Falahah" speaks about manure, compost and the utility of blood, even human blood, as fertilizer.</p> <p>Moses Maimonides (1135-1204) <i>"All that is made of matter ends up changing and disintegrating. Live substances are decomposed in other organisms. All things come and go, incessantly, every day, every hour, changing from one to another, Combining and producing other substances; of human beings, of animals, of plants, of stones and of minerals, slowly, gradually, throughout long periods of time"</i></p> <p>Miquel Agustí in the book "Secrets de l'Agricultura" (17th century) wrote sentences like: <i>"...totes les terres que estan destinades a produyr gra, fe ha de acomodar en lo Hiuern al Aduent, en femarlas ab fems de eftable, o de beftiar menut, i aço en les terres magras, de tres en tres anys per tenirla bona...tambe ha de hauer confideracio a la qualitat del fems, per que lo bon femar fe ha de fer de fems que hajen repofat un any, y fi fon mes vells manco valen, y los millors fems fon los de colom, apres lo del home, majorment effent mefclats ab les inmundicies dela cafa..."</i></p> <p>Olivier de Serres (1600), one of the first agronomists, in "Le theatre d'agriculture et mesnage des champs" quotes: <i>"les immondices et les boues des roues, lorsqu'on les laisse reposer assez pour les décharger de tout ce qu'elles ont d'humidité, engraisent les terres; ...autour de Paris où les terres assez maigres par elles-mêmes deviennent très fécondes par le recours a ces amendements"</i></p> <p>Shakespeare (1606) mentions in Hamlet <i>"Do not spread the compost on the weeds, to make them ranker"</i>. And in another of his books (Timon of Athens) quotes <i>"The earth's a thief, that feeds and breeds by a composture stolen from general excrement"</i></p> <p>Francis Bacon (1620) in his "Natural history" comments that <i>"...plants degenerate by removing into worse earth, or forbearing to compost the earth"</i></p> <p>Ramon Garrabou in his book "La fertilización en los sistemas agrarios: una perspectiva histórica" (1996) quotes several examples of the value of manure and the use of waste: <i>"lo masover deurà cuydar ab lo major esmero de la conservació y bon ús de la palla, invertinla en fems y abono de las terras" "els fems quan es treien de l'estable es posaven en una fosa on patein un escalfament espontani, desprenen carbonat amonic... la fermentació calia moderar-la porque no es perdes nitrogen..."</i></p> <p>Émile Zola (1873) in "Le ventre de Paris" evokes the interest of one of his characters in market waste <i>"Claude abatí une amitié pour le fumier, les épluchures de légumes, les boues des halles; les ordures tombées de cette table gigantesque restaient vivantes, pour tenir chaud à d'autres générations de choux, des navets, de carottes... Paris pourrissait tout, rendait tout a la terre qui sans jamais se lasser, reparait la mort."</i></p> <p>In his book Les Misérables (1862), Victor Hugo wrote: <i>"It is meaningful to apply lode to crops, forests and mineral earth. Thanks to human fertilisation, the earth in China is still as young as in the days of Abraham... All human and animal manure that the world loses, restored to the land instead of tipping them into the water, would suffice to nourish the world"</i></p> <p>Mahatma Gandhi (1869-1948). <i>"To forget how to dig the earth and to end the soli is to forget ourselves"</i></p>
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Today, the scenario of organic waste has changed completely, and is at the same time considered a serious problem for society and a profitable business proposal.

There is a large variety of organic waste that is produced and very high amounts that need a suitable destination, competing for a plot of land where they can be applied. In this competition greater priority is given to getting rid of the waste rather than in improving the soil and its productive capacity. Although some waste can be applied directly, the problems arising from how it is stored, transported, applied and controlled in most cases advise that these receive a prior biological treatment (anaerobic digestion and/or composting) to stabilise their OM and/or to make the maximum use of their potential.

Table 2.- Various definitions of composting [6]

<p>We can find numerous definitions about composting in the bibliography: Technique for treating and stabilising the Organic Waste (OW).</p> <ul style="list-style-type: none"> ➤ Action of fermenting organic matter in the presence of air. ➤ Fermenting OW in the presence of air oxygen to obtain a fertiliser rich in humus ➤ Recycling the OW and closing the natural cycles that have been interrupted for having abandoned suitable farming practices. ➤ Biological process that ensures the transformation of organic components of subproducts and waste in an organic product rich in humus compounds: compost. ➤ Ecotechnology that permits OW to be returned to the soil and its reinsertion in the vital ecological cycles of our planet ➤ Biological treatment method of agronomic valuation of the biomass. ➤ Technique for sanitary treatment of Organic Waste, which differentiates between the mere discharge of waste (generally anaerobic evolution of heterogeneous waste) or even more from the direct application (non thermal process). Performed under controlled conditions that distinguish it from a putrefaction or uncontrolled decomposition that occurs at open landfills, piles of manure or in the soil. ➤ Controlled biological process of transformation and valuation of organic substrates in a stabilised, hygienised product, similar to leaf mould and rich in humus substances. ➤ Biological decomposition and stabilisation of organic substrates in conditions that permit the development of thermophil temperatures, product of a calorific energy generation of biological origin, from which a sufficient stable end product is obtained to store and use it in soil without negative impacts on the environment ➤ Stabilisation technique and treatment of biodegradable Organic Waste, aimed with priority at solids and semi-solids; it destroys, by temperature, germs and parasites, vectors of diseases and seeds of weeds. It produces a product that is factor of stability and fertility of the soil ➤ It is the result of a complex microbiological activity arising from specific conditions, that may be considered a biotechnology according to the definition of the <i>Délégation Générale à la Recherche Scientifique et Technique (D.G.R.S.T.)</i>: "Industrial exploitation of the potential of micro-organisms, of plant cells or animals, and of the waste they produce" ➤ Biooxidative process on an organic substrate (solid and heterogeneous) that evolves through a thermophil phase and temporal liberation of phytotoxins that produce CO₂, water, minerals and stabilised organic matter ➤ Stabilisation system of waste requiring controlled conditions, particularly aeration and humidity, to reach temperatures favouring the thermophil microorganisms. ➤ Ecological, dynamic and extremely complicated process where the temperature, pH and assimilability of nutrients are in continuous change as consequence of the number and species of responsible micro-organisms. ➤ In this process, a solid organic phase permits an eminently aerobic biological activity to: <ul style="list-style-type: none"> ➤ Act as physical support and matrix of exchange of gas ➤ Facilitate organic and inorganic nutrients and water ➤ Provide endogenous micro-organisms ➤ Collect the metabolic waste generated and act as thermal insulant

Composting and compost

Composting is an anaerobic biological treatment historically considered an art or science that converted waste into a beneficial resource for preserving the fertility of soil: compost. Table 2 contains definitions that have been given to compost in different eras. What is the importance of composting today and for whom? Are the interests the same for users as for the producers or society? Can we take it that all sectors would accept the following definition?

Composting (biological transformation of results under controlled conditions) means managing organic waste in a respectful environmental manner, involving and holding the society that produces it responsible and giving compost the suitable destination

Past of compost and of organic fertilisation

In the past, owing to the amounts of waste generated and the need to make the maximum use of nutrients it contained, the collection systems were simple and when waste was not applied directly to the soil it was kept in piles that were usually known as "dung-yards". It was well known how to store, treat and use them to preserve nutrients, which added to the scarce amounts produced, avoided the appearance of contamination problems. Table 2 shows how composting may be considered one of the oldest techniques related with agriculture; it has been a treatment of organic waste (OW) with a pendulum course throughout the different eras, repeatedly changing from being a highly appreciated technology to a reviled and forgotten system.

At the end of the 19th century it was mainly used in the United States as a means for treating human waste in those towns that did not have a sewage system and it was at the end of the first half of the 20th century when Albert Howard systematised composting (Indore system) and valued it as a hygienic technique for treating waste without forgetting compost production [7] [8].

Present situation of composting and compost

It has been mentioned that composting has had a pendulum course over the years; in recent times it has again become an interesting option due to: Increase in the generation and problem of different types of organic waste, as well as the laws that demand a reduction in OW that reaches the landfills, protection of the soil and control of emissions relating to climatic change. If there were times when interest for composting was due to the need to have stabilised organic matter and the nutrients that it could provide, today obtaining quality compost in order to maintain the fertility of the soil and avoid problems of erosion and desertification has been delegated to a second plane. In our country in recent years many biological processing plants have been built whose real purpose is mainly not to obtain compost but is a business linked with its construction and the entry of waste. This is the reason why the compost that is obtained in most cases does not comply with a quality scale and/or its manufacture in some cases involves such high economic and environmental costs that question the environmental benefits of this processing system.

What quality scales should compost fulfil? Only those that appear in current law? Those that interest possible users, technical experts or scientists? Who should control the quality? How should this quality be rated at the actual plant facilities? How should the composition of compost be disseminated? How should it be interpreted?

There are various types of compost that can be found, highlighting those from sewage sludge of water treatment plants, municipal waste (MW), organic fraction of municipal

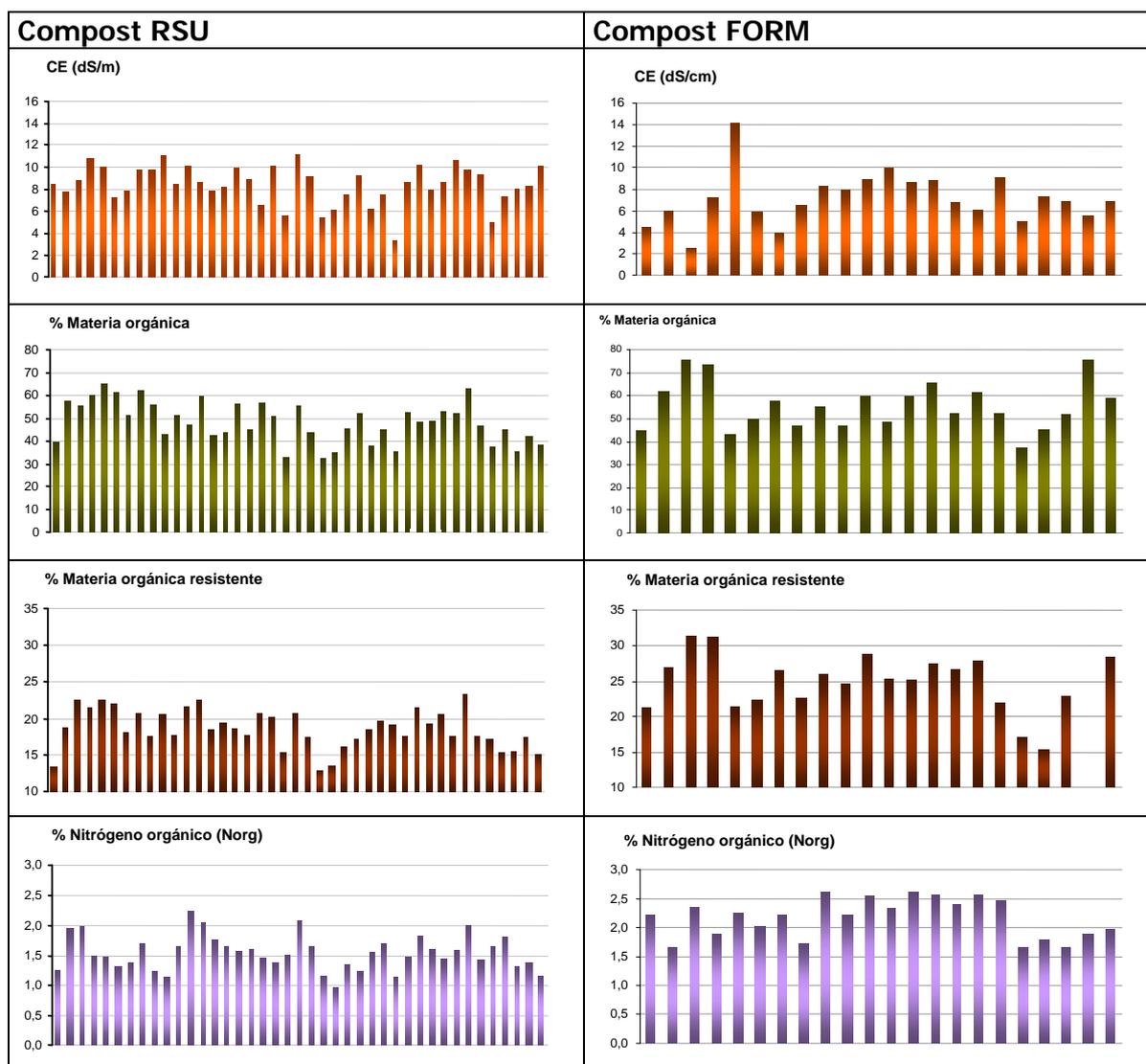


Figure 1.- General characteristics of samples of RSU and FORM compost

Contents in heavy metal of compost from different sources

The content in metal of compost samples depends on the raw material, the possible contamination throughout the process and the relative concentration due to the reduction in OM. Usually compost from cattle waste presents low contents of metal and compost from lode, due to an insufficient control of the water entering the treatment plants, has higher levels [11] [12] [13] [14]. Figure 2 shows the different contents in metal of compost samples of municipal waste (RM)^{4, 5} distinguishing whether it comes from facilities that treat RSU or FORM. The higher levels in samples of RSU compost that may be attributed to the raw material and contamination throughout the process due to contact with the impurities are highlighted [10] [14] [15] [16] [17] [18].

⁴ All these samples correspond to projects carried out at the ESAB financed by the Instituto Geológico y Minero de España, Ministerio de Medio Ambiente and Servei de Medi Ambient of the Diputació de Barcelona.

⁵ When preparing the sample for analysing heavy metals, after being dried and before being crushed up, the impurities they contain are eliminated.

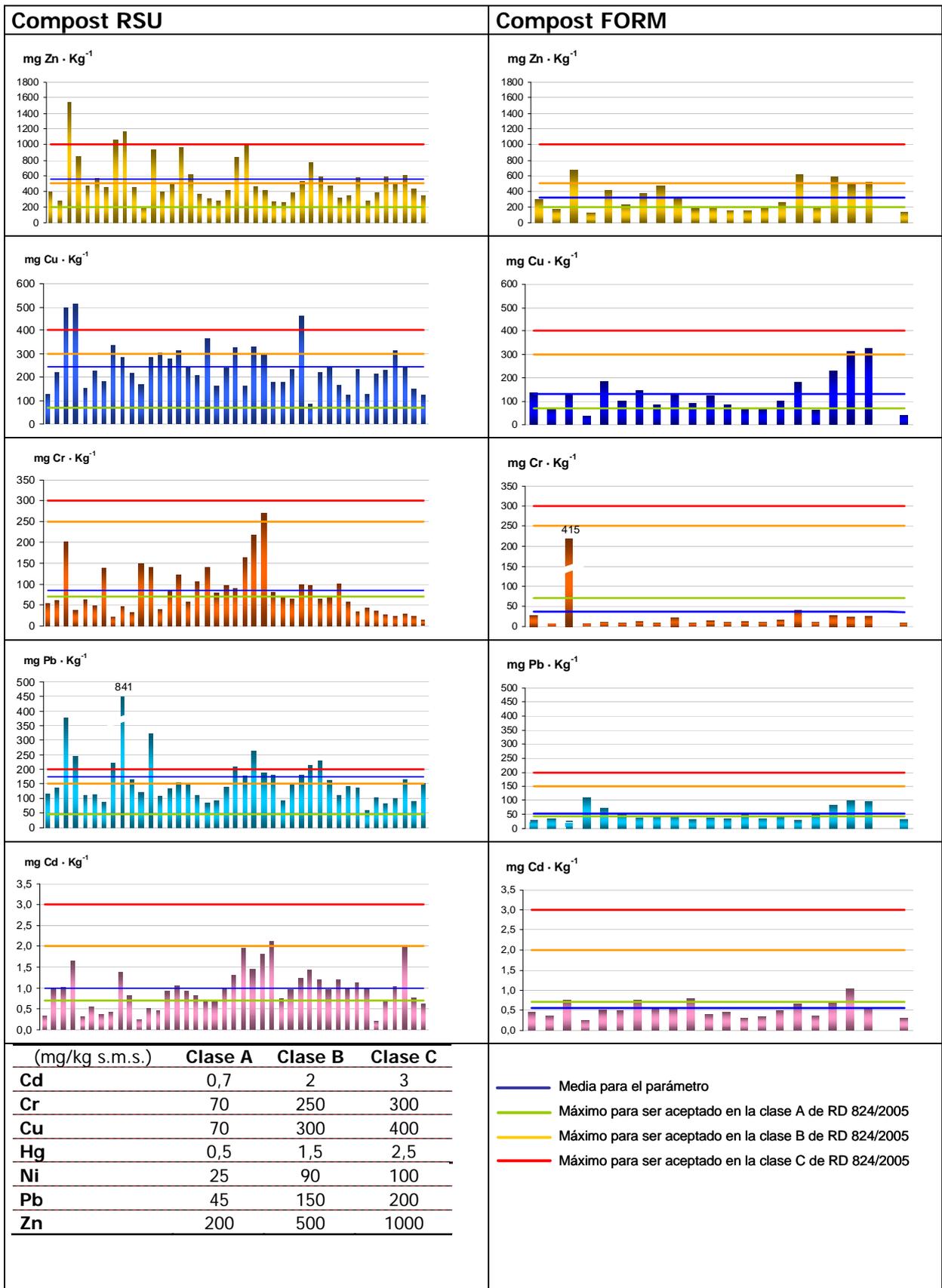


Figure 2.- Content in heavy metal of samples of RSU and FORM compost and levels required by Royal Decree 824/2005

Compliance with the law of different groups of compost samples analysed

Royal Decree RD824/2005 envisages the characteristics required from different types of compost (table 4) and the contents in metal according to quality (figure 2).

In a survey carried out in collaboration with the Instituto Geológico Minero de España, the Ministerio de Medio Ambiente and the Servei de Medi Ambient de la Diputació de Barcelona 86 composting plants were visited (22 of FORM, 36 of RSU, 13 of sludge, 8 of manure, 5 of RV and 7 mixed). They were all analysed following the method used at our centre [19] that includes the parameters set out in Royal Decree RD824/2005 but also others that are considered of interest from an agronomic standpoint. Figure 3 shows the compliance of the different groups of samples for the parameters: humidity, OM, C/N, contents in impropers and granulometry. The generalised lack of compliance of the content in humidity is observed since at most plants a very dry material is produced. Although this facilitates the final screening, its handling and application provokes many problems of dust and may conceal lack of stability. The samples of RSU compost present the highest contents in impropers.

Table 4. Characteristics required for the different types of compost according to RD824/2005

Compost	Vegetable compost	Manure compost	Vermicompost
% H : 30%-40%			
C/N < 20			
% MOT > 35%	% H : 30%-40%	% H : 30%-40%	% H : 30%-40%
Granulometry:	C/N < 15	C/N < 20	C/N < 20
Stones and gravel Ø>5mm less than 5%	% MOT > 40%	% MOT > 35%	% MOT > 40%
Impurities Ø>2mm less than 3%	Absence of impurities	Absence of impurities	90% particles Ø < 25mm
90% particles Ø < 25mm			

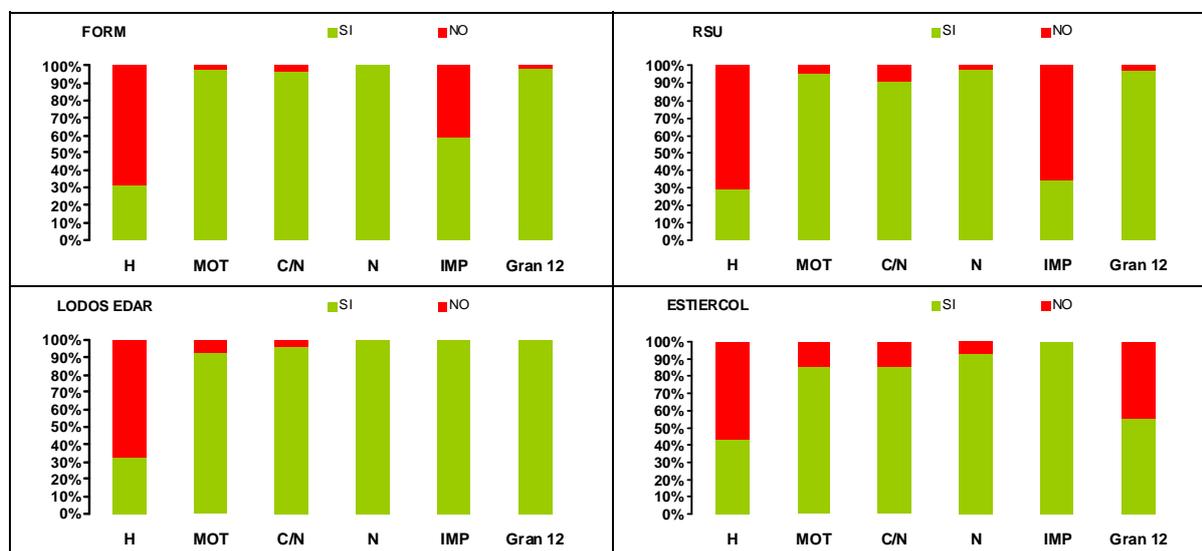


Figura 3.- Legal compliance of analysed samples (H:wáter content; MOT: organic matter; IMP: impurities; Gran 12: tamaño particle size under 12 mm.)

Figure 2 shows the contents in metal of the FORM and RSU compost samples and figure 4 gives the classification of the entire samples, and of the different groups, according to their contents in metal. The better classification of the FORM compost samples is highlighted although attention should be drawn to the fact that there is a low percentage of these samples that correspond to class A.

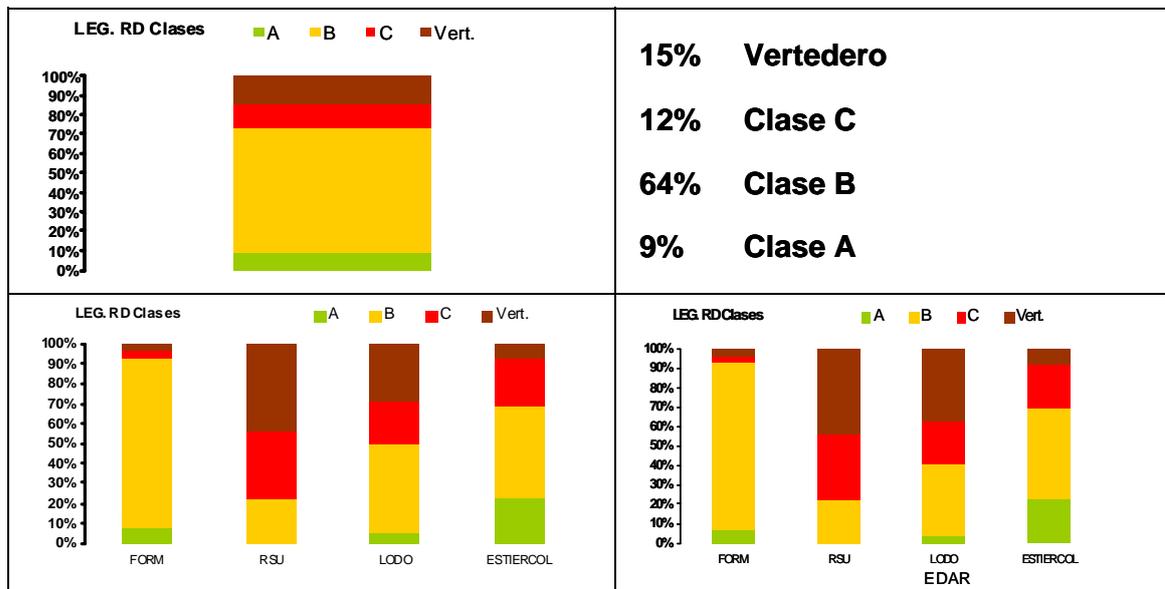


Figura 4.- Percentage of compost under A, B and C class in the different compost types

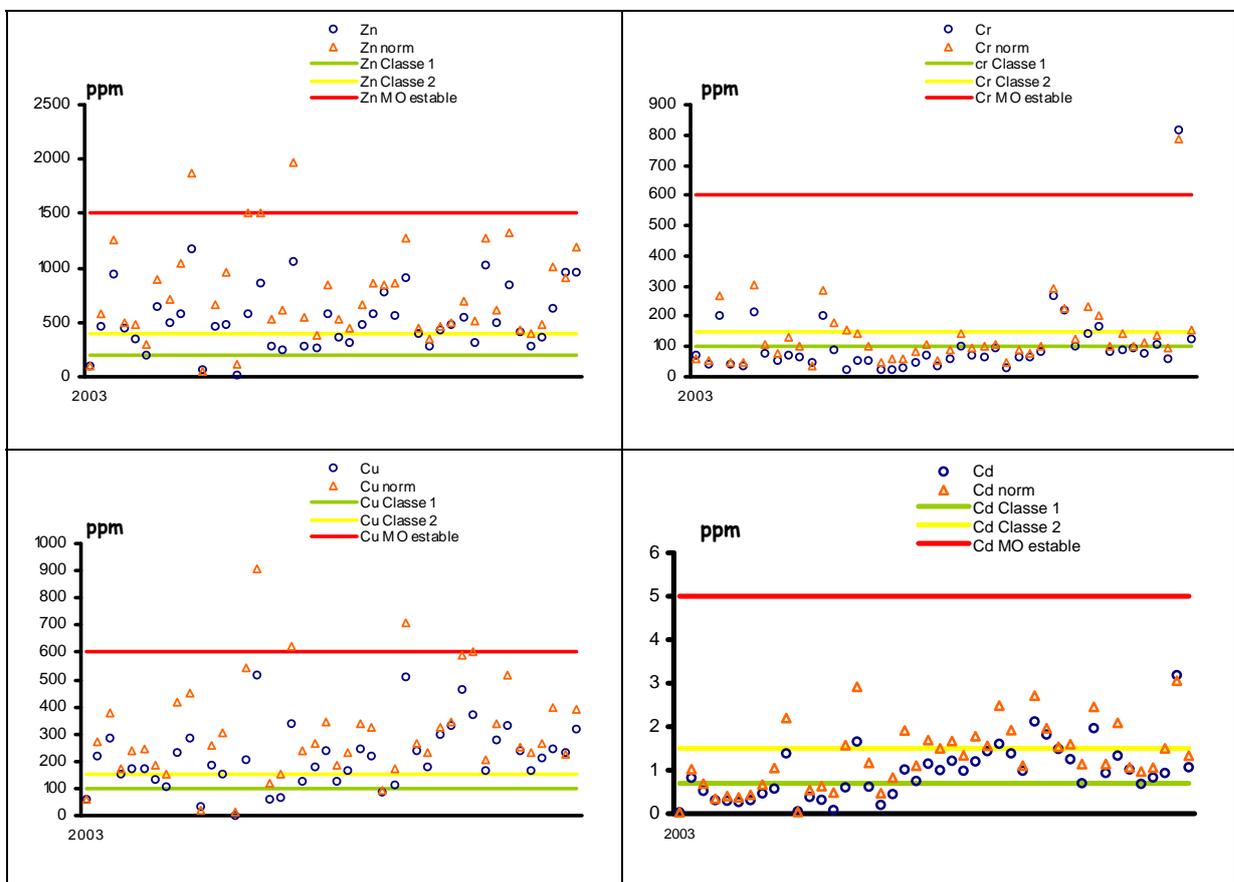


Figure 5.- Content in heavy metal of FORM compost samples expressed in semiconducting and special metal hybride but with the content on OM standardised at 30% [17] compared with the levels proposed in the EU draft [20]

For some time now the European regulation on quality of compost [20] has been pending approval showing lower limits in the content of metal but with the novelty that they are proposed standardised at a 30% OM content.

In figure 5 the graphs show the contents in Zn, Cr, Pb, Cu and Cd for samples of FORM compost analysed [17]. The content in sms metal is shown in blue, whilst the product of

standardising the concentration at 30% of the OM proposed by the EU is shown in orange. The other three lines refer to the maximums proposed for each class in that paper.

Efficiency of the process

How to assess the efficiency of the composting? By the quality of the compost obtained? By the output? By the way the process works? What relationship is there between functioning of the process, quality and output⁶? How does all this affect environmental problems?

It is important to know the characteristics of the compost obtained at the facilities (figures 1 and 2) but it is also important, and very often this is forgotten, to know how this has been obtained; at what cost and at what output? It is not acceptable if the facilities are considered “factories”, that the output is not known and their “economy” is based only on the revenue produced from the entry of materials. The output at which the compost that is shown in the above sections is not known, but a project that was recently carried out in collaboration with the *Agencia de Residus de Catalunya* (ARC) [21] has tried to obtain information in this respect and although the data are still being analysed, it refers to a small part of them.

Thus, in figure 6 the reduction in the content of OM is displayed throughout the process at four plants. Apart from the final result that already shows that the process has been incomplete at each plant, the OM loss rate is very different at each one, a fact that affects the occupation of space, apart from showing that the efficiency of the decomposition has not been the same in all four cases. Figure 7 shows how the degree of decomposition of the OM is affected as well as the content in impropers of the material to be composted, regarding the occupation of space.

Also, if the amount of treated waste and availability of space at each of the plants studied is analysed, important differences in occupation are observed (figure 8) that should be taken into account when assessing the quantity and quality of the compost obtained as well as the processing costs.

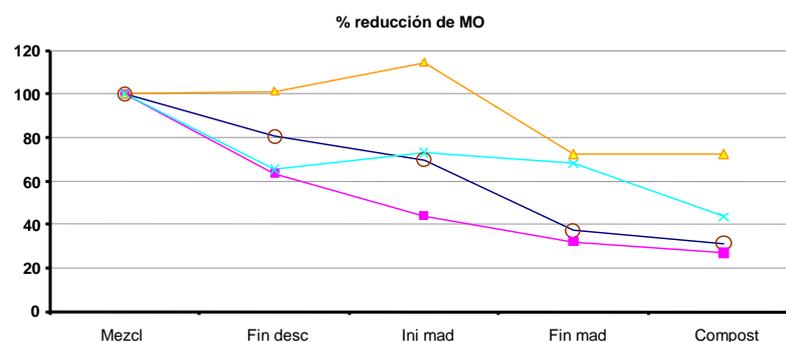


Figure 6.- Percentage of reduction in OM throughout the process [21]

⁶ It should be made clear that the concept of output in composting is different to the one used in most industrial processes because the more stabilised the compost, the lower will be the output. It should be related more with the quantity of rejection produced

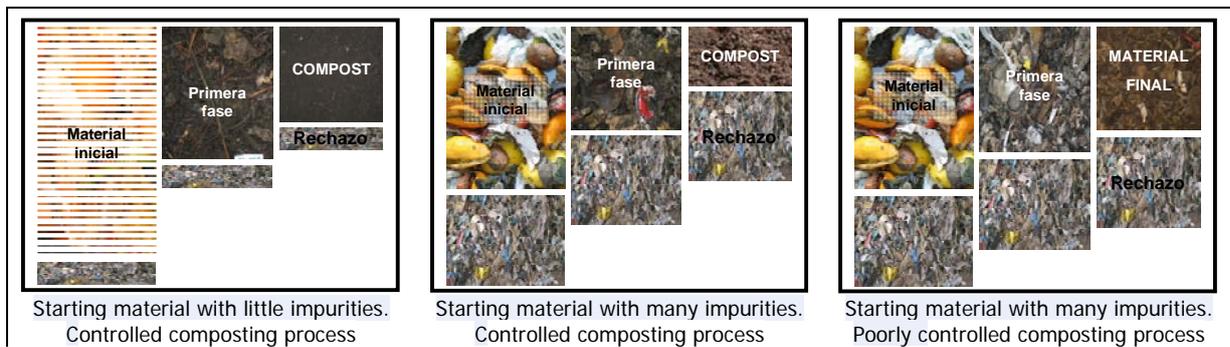


Figure 7.- Estimated effect of the impurities content of the input material and efficiency of the process in the occupation of composting plants

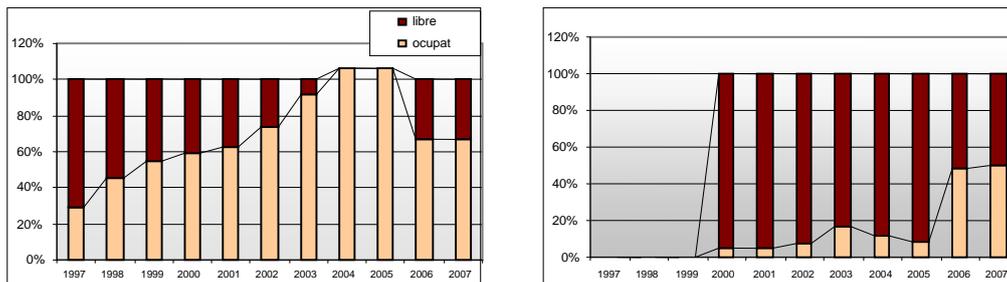


Figure 8.- Different occupation of two composting plants over the years [21]

Relation between content in impropers, occupation of spaces, granulometry and generation of rejections

At the RSU treatment plants the contents in impropers represents a series of operational problems in addition to provoking that the compost cannot, generally speaking, be used for agricultural purposes:

- ✓ Mechanical equipment and manpower is needed for the selection.
- ✓ High rejection levels that carry OM are produced, complicating their handling and disposal at landfill, adding to the management expenses.
- ✓ There is a greater need for space because more equipment is used, because of the space occupied by the impropers during the process (figure 7) and because of the need to store rejections.
- ✓ There is an important increase in the economic and energy consumption because there are higher transport expenses (entry of FO with impropers, output of rejections to the landfill) and processing costs because most operations have to be carried out on material with a high content in impropers.
- ✓ Increase in the number of breakdowns and wear in machinery.
- ✓ They affect the appearance of unpleasant smells since they favour the creation of anaerobic conditions that interfere in the suitable development of the process.

Figure 9 shows the different need for decomposition tunnels depending on the content in impropers of the input material [21]; obviously if it is not possible to reduce the input material or have more tunnels, the more unfavourable situation will affect the days of treatment.

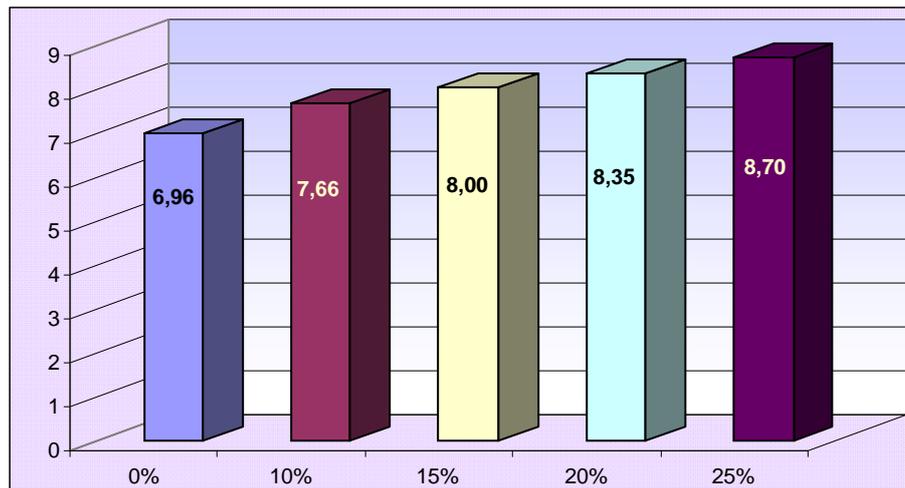


Figure 9.- Effects of the content of impropers on the need for tunnels [21]

Figures 1 and 2 show the different characteristics of the municipal waste compost, depending on whether this comes from RSU or from FORM, highlighting that the former present higher contents of metal and impurities, due to the type of raw material. Besides the contamination, they present lower contents of resistant OM and of N, showing that their processing has not been sufficiently controlled, a fact that may be blamed on plants saturated by the volume occupied by the impropers (figure 7) that renders handling difficult and frequently makes it necessary to reduce the processing times.

When working with municipal waste a considerable number of plants choose to use small mesh size screens in order to reduce the amount of impurities in the final compost. This is suggested in many of the results found in the projects that have been undertaken [10] [21]. Figure 10 presents the results of two of the samples that show this question that will most likely affect the amount of rejections generated in each case.

Marketing and use of compost

In the present composting situation we cannot overlook how the product that is obtained is valued, whether it has the foreseen destination or whether, on the contrary, large amounts remain at the facilities or are taken to the landfill. Unfortunately, the characteristics of the compost are not always the most suitable but there is also a great lack of knowledge about the advantages of using a well manufactured product, especially in the long term. Also due to a lack of knowledge about the product⁷ and its possible uses there are too many bad experiences with processing plants that have made the product lose its prestige.

Composting must not be raised simply as a system for treating waste, but as an industrial process that should be carried out with all the necessary controls, regardless of the type of input material, mindful of the end product (quality and output) and of the dissemination of its use. Associations of mineral fertilisers, despite the important market they have, continue manufacturing new products, disseminating their uses and they even express concern about the environment and new laws, advising good application practices and/or assessing the environmental costs of their production.⁸

⁷ There is no clear definition about compost and its characteristics, according to source; possible users ignore what they may expect about the product and what they may demand.

⁸ <http://www.fertiliser-society.org/Proceedings/US/Prc509.HTM>. Consulted in November 2008.



Figure 10.- Appearance, granulometry and content in impurities of two samples of municipal waste

On the other hand, the marketing policies of compost are almost non-existent; at most biological processing plants all those aspects that influence the composition and output of compost are not being analysed or controlled so far. In a survey conducted (ESAB/ARC) about the marketing of compost in Catalonia [22] it has clearly been detected that the plants that are best valued for their product are those which at the same time have a better control of the process. It also coincides that these are some of these plants that have personnel dedicated to the promotion of compost; in this respect it is important to make sure that this personnel is well trained and informed.

In the case of compost, formats should also be established for the presentation of its characteristics, possible uses and conditions of use, ways of assessing environmental, social and economic costs of its manufacture, as well as be able to reckon up the economic advantages of its use.

Composting and compost as tool in the fight against climate change

This section is introduced in order to discuss that if it can really be considered a tool, it should be so as consequence of a correct management in the conservation of the organic matter of the soil.

The management of organic waste today is treated as a need due to the new trends in the law, the lack of places at which to install new landfills, and the environmental and social problem this waste produces; but the justification of the biological treatment of OM is yet more recent due to its alleged beneficial role with regard to the generation of greenhouse effect gas.

Most likely, if the issue that is raised were to be the problem of conserving the soil, the loss in fertility and OM, the production and quality of the food depending on the type of fertilisation and its cost, action could be taken with regard to all these issues, but reversing the process. Maintaining the levels of OM of the soil, using the most suitable organic waste to do so in each situation and treated correctly, an equilibrium could be reached that could lead to a more rational management of the Organic Waste and mineral fertilisers, to economic benefits for farmers and environmental benefits for society, as well as considering the C sink effect of the soil.

In the paper *"Waste management options and climate change"* published by the EU in 2001 [23] there is information about the economic and environmental costs of the different treatment as well as an attempt to assess the advantages of using compost. Based on this information and taking two compost as example that have been analysed (table 3), the following approximations have been made (tables 5 and 6).

Table 5.- Characteristics of two different quality composts

	%								mgkg ⁻¹			
	H	MOT	MOR	C	C _r	N _{org}	P	K	Zn	Cu	Pb	Cd
M	30	55,7	26,0	27,9	13,0	2,10	0,92	1,17	130	42	22	0,3
I	30	48,0	19,0	24,0	9,5	1,55	0,46	0,67	557	244	173	1

Table 6.- Quantities of different components provided in 1 ton of the two types of compost

	kg t ⁻¹ _{mh}								g t ⁻¹ _{mh}			
	ms	MOT	MOR	C	C _r	N _{org}	P	K	Zn	Cu	Pb	Cd
M	700	390	182	195	91	14,7	6,4	8,2	91	29	15	0,2
I	700	336	133	168	67	10,9	3,2	4,7	390	171	121	0,7

According to the same paper and with references to different authors [24] [25] it is estimated that between 8-6% of carbon from applied compost is maintained even after 100 years after being applied; considering this estimate and taking an 8% for compost M and 6% for compost I, the kgs. of CO₂ sequestered after 100 years for each ton of compost (mh) applied (table 7) are calculated. Although this calculation is only an estimate subject to a high margin of error it is intended to draw attention to the need to assess the manufacture and use of compost from different standpoints. This same table includes the estimated saving in equivalent CO₂ by using the phytonutrients contained in one ton of compost instead of manufacturing them [26].

Table 7.- $C_{eq\ CO_2}$ sequestered after 100 years from the application of 1 ton of compost and saving in the manufacture of nutrients contained

	$C_{sequestered\ after\ 100\ years} * t^{-1}$	$C_{eq-CO_2} * t^{-1}$	C_{eqCO_2} saving in the manufacture of nutrients contained in 1 t of compost.		
			N	P	K
M	15,6	57,2	77,8	3,3	3,1
I	10,1	37,0	57,4	1,7	1,8

Many other aspects (positive and negative) should be assessed when applying compost although they are difficult to quantify. It can therefore be considered that the contribution of OM (in suitable quantities and quality) implies:

- Improvement in the properties of the soil and reduction in erosion (better preservation of the surface organic matter), that furthermore reports in a saving in energy by facilitating work with the soil and improving the use of water.
- Effects suppressing certain pathologies that permit an environmental benefit to be obtained in both energy saving in the manufacture of pesticides and in the reduction in its contaminant effects.

If however the suitable dosage of compost is not applied or its quality is not suitable for the quality required for the soil, the effects would be negative with regard to affecting the agricultural production and loss in value that would be produced from an increase in the contents in metal as consequence of applying contaminated compost.

State of the art in the composting environment

There is no space in this report and the authors do not have sufficient information to carry out a summary of this situation, but we should reflect on these aspects and consider a number of questions before speaking about the future of composting and compost.

In recent years there have been a great deal of studies on composting, quality of the compost and its possible uses, some very interesting and useful, but very often they do not develop new insights into the problem and are not useful for expanding their knowledge or in solving the real problems.

The appearance of a business of considerable dimensions about waste has also led to a proliferation of enterprises that offer technological systems and equipment for treating organic waste. The high expectations created around the capacity of technology to overcome many of the problems that face the facilities have meant that on many occasions the plants become test benches of the manufacturers of equipment and costly investments are made in machinery and treatment systems whose efficiency has not been sufficiently proven, or they do not always respond to the specific needs of each installation or to the characteristics of the waste generated in different zones.

Different focuses are placed on the management of waste depending on whether this is aimed at: reducing the generation of waste and the problem this represents or appraising it and increasing its value. A good management should really include all these possibilities but this calls for a change in philosophy and attitude that compromise all the sectors involved: administrations, producers of commercial sectors, citizens, waste collection businesses and managers of plants. It seems that the problems generated due to a poor management of solid waste are only being resolved by increasing the number of facilities, providing them state of the art technology, increasing the consumption of energy but

overlooking, or relegating to a second level, the knowledge and fulfilment of the core biological factors of composting.

Have the treatment systems undergone changes due to us having learned from our mistakes? Or because we have learned to draw more economic advantages from the treatment of waste? We have the power to transform our environment taking notes about our past experiences and continuing to discover, create, invent and improve, but it is essential that all this be undertaken using common sense and with clearly defined objectives.

There are various sectors of society that are interested, that work and/or that are related with the management of waste but with difficulties to perform a transdisciplinary work and that are often too concerned about their own and immediate interests. Optimisation in the potential that research and technological development may provide in improving biological treatment calls for important efforts to be made to combine experience and innovator efforts with a rational planning.

FUTURE OF COMPOSTING AND COMPOST

The past and present of composting and of compost can be summarised as follows:

- ✓ **Past:** Non-problematic production of organic waste that could be managed locally, maintaining the fertility of the soil and covering the needs of crops.
- ✓ **Present:** Need to manage the large amount of organic waste generated, protect the soil, produce food (quantity and quality) and avoid environmental problems. In view of these needs the reply is not yet absolutely correct because private and economic interests take priority over the need to achieve common objectives for the management of waste.

The future of composting and compost cannot be separated from the management of waste in general and other treatment, and it should thus be considered that different treatment systems may co-exist provided the most suitable one is chosen for each specific situation and considering the most convenient environmental and economic balances.

It will have a future if:

- ✓ The concept of composting facilities is changed: Waste should be treated but for the purpose of manufacturing compost and always giving priority to the biological properties of composting vis à vis an excessive and not always justified use of new technology and machinery.
- ✓ The objectives of composting are clearly established, the minimum characteristics to be demanded from the input material, the sanitary and hygienic conditions of the facilities and the controls of emissions.
- ✓ Fulfilment of the above conditions is guaranteed through the consequent arbitrage of the administration.
- ✓ Society is informed about the problems derived from an uncontrolled consumption and excessive generation of waste (solids or liquids)
- ✓ The minimum conditions are defined for a product to be called compost, at the same time establishing the differences between different origins to be able to advice their more suitable use. Materials can be accepted with different degrees of stability depending on the expected use, but they must always reach a minimum state of maturity.

- ✓ The dissemination of the characteristics of compost must be facilitated, establishing minimum parameters to be fulfilled and informed.
- ✓ The composting plants are clarified and differentiated from those that simply stabilise the organic matter to be able to give it a final destination with a minimum effect on the environment.
- ✓ Avoid or even prohibit assigning the name of compost to products that come from waste treatment that do not fulfil certain minimum requirements or that have not received a correct composting treatment.
- ✓ Facilities are provided for the training of technical experts involved in this matter whether by the administration or by businesses that participate in the different management stages.
- ✓ Compost is placed as a competitive product on the organic fertiliser market offering users suitable information about the use and application of compost and guaranteeing them sufficient regularity in the characteristics of the product to meet their needs and overcome their present reticence.
- ✓ The advantages of the biological treatment of organic waste are disseminated and the participation needed by each level of society
- ✓ Competition between compost of different sources or with other organic materials is avoided, simply established by costs, ignoring the characteristics and advantages or disadvantages of the application of each one.

It is not easy to achieve this because there are many social groups that have to take part in the decision making and fulfilment; efforts should be combined and beneficial synergies created for everyone (figure 11).

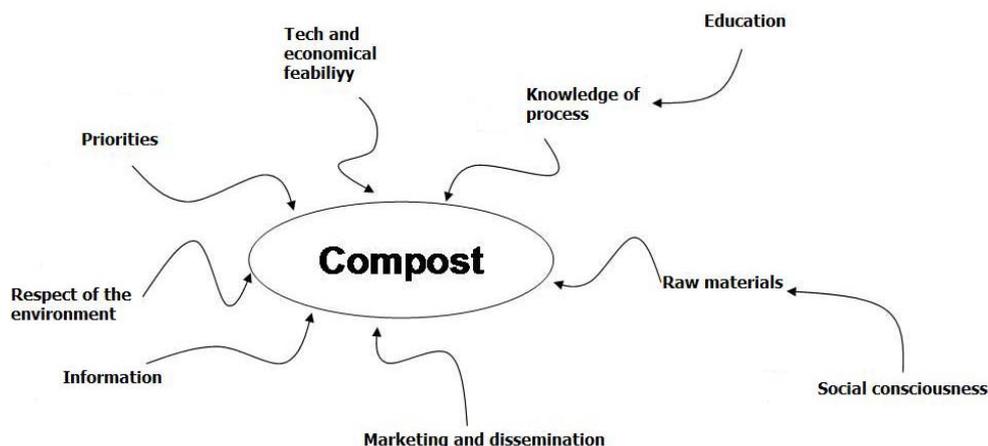


Figure 11.- Aspects to be seriously considered in the future of compost

Managing waste is more than finding the destination and suitable treatment, apart from including generation, collection, transport and treatment, an overall outlook should envisage the engagement of important efforts to reduce and incorporate as base the concept that waste may be a resource and that its sustainable management signifies compromise and interaction between environment, economy and society.

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