POMIS Project: experience and good practice of home-composting in the Region of Eastern Macedonia and Thrace (REMTH), Greece

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Abstract

Home composting offers one of the best management options for at source reduction of organic household waste (OHW). The POMIS project, in the framework of "European Territorial Cooperation Programme Greece - Bulgaria 2007-2013", aimed in optimizing the operation of the Municipal Solid Waste (MSW) management system in the Region of Eastern Macedonia and Thrace (REMTH) in Greece and in the Region of Kardzhali in Bulgaria, by providing emphasis especially on home composting as well on recycling of packaging waste and edible oils recycling. In this work the POMIS project is presented with special emphasis to its contribution on developing and enhancing the practice of home-composting.

POMIS main innovation on home composting is that for a first time at a regional scale in Greece were distributed 1.900 home composting bins across the Region of EMTH. The operators of the home composting bins were mostly members of families and the bins were sited in majority on houses' backyards. There was continuous monitoring of the home-composting bins and full support of the participating households by expert scientists and engineers with on-site visits, telephone calls, completing questionnaires through interviews, organising awareness and information events etc. The main conclusion of POMIS project about the home-composting pilot action is that thorough communication of the basic rules of home composting to the bins' operators can have a remarkable effect on the behaviour of the home composting bins and as a consequence on the production of a mature compost.

1. Introduction

Waste management hierarchy sets at top level concepts like avoidance, minimization and at source reduction of waste and especially of Municipal Solid Waste (MSW). Also, the organic fraction of MSW in Mediterranean countries, like Greece, varies in the range of 40% to almost 50% of MSW on wet weight (w/w) basis [9]. On the other hand, composting is the decomposition of organic materials by aerobic microorganisms resulting in the creation of compost, which is a product rich in organic material. The compost resembles leaf mould and can be used as a natural fertilizer for the plants. Home composting of the organic household waste is characterized widely as best available practice. As a consequence, especially in Mediterranean countries home composting offers one of the best management solutions for at source reduction of source-separated organic household waste (OHW) like putrescibles, kitchen waste, fruit and vegetables leftovers, etc. Thus, a wide practise of home composting will have as a result a significant amount of OHW to avoid the costly management of MSW via the classic management route e.g. collecting MSW, transferring MSW and processing MSW in centralized facilities with a final need of sanitary landfilling of residue.

Various studies confirm that home composting, when properly conducted, can provide a best management option of OHW with a final product of high levels of stability and of a high quality [1-2]. Also, through Life Cycle Analysis (LCA) some studies validate that the environmental impacts of home composting are generally quite low, since despite the emissions of Green House Gases (GHGs) from the composting process there are environmental savings from substituting fertilizer with compost in gardening, avoidance of emissions of classic collection and treatment route especially in low density areas of population, diversion of waste from sanitary landfills, etc [1, 3, 6, 8]. Finally, other studies [4, 5, 7] verify that households as users of the home composters provide a positive feedback in adopting the home-composting practice in their daily activities as common practice. The final compost product is usually of a high quality used as their gardening soil while the majority of difficulties are easily managed and solved. Of course for home-composting there are some requirements like a composting bin, usually plastic from commerce or a handmade bin also, some green-waste as bulking material and free space usually in a garden or backyard.

In this work the POMIS project is presented with special emphasis to its contribution on developing and enhancing the practice of home-composting through a pilot action. The POMIS project, in the framework of “European Territorial Cooperation Programme Greece-Bulgaria 2007–2013” (MIS Code 900101) aimed in optimizing the operation of the MSW management system in the Region of Eastern Macedonia – Thrace (REMTH) in Greece and in the Region of Kardzhali in Bulgaria, by providing emphasis especially on home composting as well on material recycling like packaging waste and edible oils recycling. The POMIS project’s partners were DIAAMATH SA from Greece, Regional Association “For Cleaner Rhodopi” and Municipality of Kardzhali from Bulgaria. In Figure 1 the logo of POMIS project and the logo of the “European Territorial Cooperation Programme Greece-Bulgaria 2007–2013” are presented. The duration of POMIS project was from 1/10/2013 to 30/09/2015.

Figure 1. Logos of POMIS project and “European Territorial Cooperation Programme Greece - Bulgaria 2007 – 2013”.

During POMIS Project a main pilot action was the enhancing of home-composting in REMTH. For this reason a number of 1.900 home-composting bins were distributed mainly in households and were monitored across the Region of EMTH. The valuable aspects of the experience gained and the behaviour of the bins operators are presented in this work.

POMIS project innovations on home composting can be summarized in the following. First time in Greece at a regional scale a large number of 1.900 home composting bins were distributed across the Region of EMTH. The operators of the home composting bins were mostly members of families and the bins were sited in the majority on houses' backyards. Previous experience of home composting in Greece was mainly at local and municipal level with a distribution of small number of bins. As it can be seen in Table 1 the previous experience in Greece in home-composting projects are not compared with the scale of the POMIS project since it is the first time that a Region, with a number of 608.182 inhabitants, is covered with a number of 1.900 home composting bins.

Table 1. Comparison of home-composting projects in Greece.

Region/Municipality	Number of bins	Year or period of project
Region of Eastern Macedonia –Thrace	500	2009
Municipality of Trikala	39	2011
Municipality of Alexandria	250	2010
Municipality of Pavlos Melas	108	2011
Heraklion/Crete ESDAK	170	2011-2014
POMIS project – Region of Eastern Macedonia -Thrace	1.900	2013-2015

A second advancement of the POMIS Project was that there was continuous monitoring of the home composting bins and full support of the participating households by expert scientists and engineers through visits, telephone calls, completing questionnaires by interviews of the householders and organising awareness and information events. Finally, a third originality of POMIS project was that there was a laboratory analysis of compost samples taken across the Region by the Solid Waste Management laboratory, Department of Environmental Engineering of the Democritus University of Thrace so as to assess the quality of produced home compost.

In the following, the methods used for implementation of the home-composting pilot case of POMIS project are described in detail. Then the results of monitoring the pilot action are presented and finally some conclusions and the experience gained are given.

2. Methods

2.1 Distribution of home-composting bins

The home composting bins that were used were 1.900 in number of recent construction, brand new, of high quality recyclable polypropylene and perfectly suited for the rapid recycling of organic waste such as plants, grass, vegetables, fruits etc. The material of the home composting bins was recyclable and highly resistant to temperature changes and UV radiation. The home composting bins consisted of a main body of a conical and square construction with four planar side walls. Each side wall had a numerous ventilation-holes while on bottom an exhaust flap for the finished compost. At the top of the bin there was a lid for the easy supply of feedstock. The lid was divided in two parts so that it could open from the center outwards. The bins' dimensions were 72cm x 72cm with a height of 80cm. The volume of each home composting bin was 330 litres. In Figure 2 a home composting bin of the POMIS project is depicted.

Figure 2. Indicative photos of the used home composting bin of POMIS project.

The home composting bins were distributed among the interesting municipalities of REMTH to the target group of citizens that showed interest. There were collaborations with the municipalities that expressed interest and respective information and awareness events were organized and realised. In the respective municipalities and during these events the bins were distributed to the interested citizens and presentations of the POMIS project took place with information on how to best practice home composting and how to install and use the home composting bins. In the following Table 2 the number of home composting bins that distributed in each municipality and the respective information events are shown.

Table 2. Distribution of home composting bins and respective information and awareness events in Municipalities of REMTH.

S/N	Regional Unit of Eastern Macedonia & Thrace	Municipality	Number of bins	Date of information and awareness events
1	DRAMA	DRAMA	234	05/03/2015
2	DRAMA	DOXATO	104	17/02/2015
3	DRAMA	PROSOTSANI	52	20/11/2014
4	DRAMA	PARANESTI	52	19/01/2015
5	DRAMA	NEVROKOPI	52	19/03/2015
6	KAVALA	KAVALA	234	01/12/2014
7	KAVALA	PAGGAIO	130	04/12/2014
8	KAVALA	NESTOS	78	19/02/2015
9	KAVALA	THASOS	78	26/02/2015
10	XANTHI	XANTHI	130	08/12/2014
11	XANTHI	AVDIRA	52	11/12/2014
12	RODOPI	KOMOTINI	156	12/11/2014
13	EVROS	ALEXANDROUPOLI	182	10/12/2014
14	EVROS	ORESTIADA	184	19/11/2014
15	EVROS	DIDYMOTEICHO	52	03/12/2014
16	EVROS	SOUFLI	52	03/12/2014
17	EVROS	SAMOTHRAKI	78	18/11/2014

In Figure 3 indicative photos of informing and awareness events that organized in REMTH during POMIS project are depicted.

Figure 3. Indicative photos of informing and awareness events in REMTH during POMIS.

Moreover, in the framework of POMIS project awareness and information events took place also in five primary schools in the five main municipalities of REMTH: Drama, Kavala, Xanthi, Komotini and Alexandroupolis, as well in a primary school of Kardzhali about providing information on recycling to a target audience of school students. Also in the framework of the POMIS Project three (3) workshops took place in the city of Komotini in Greece and in the two cities of Momchilgrad and Kardzhali in Bulgaria with a target audience of engineers and civil servants of the respective municipalities. In the following Figure 4 indicative photos are seen on informing and raising awareness event for recycling of packaging, edible oils and home composting in the 11th Primary School of Alexandroupolis.

Figure 4. Indicative photos of the used home composting bin and of an informing and awareness event in REMTH during POMIS project.

2.2 Monitoring of home-composting bins

Following the distribution of the home composting bins there was the extensive phase of monitoring the wide network of the 1.900 home composting bins. There was continuous monitoring of the home-composting bins and full support of the participating households by expert scientists and engineers through on-site visits in the households, telephone calls, completing questionnaires through personal interviews of the users of the bins, etc.

First a preparation phase was necessary. During the preparation phase telephone contacts by the expert scientists and engineers with the recipients of home composting bins took place, in order to visit the installation points (households, schools etc) of the bins. The telephone contacts were taking place the same or the previous day of the visiting day and included information about the aim of the visit, which was advisory, and clarification of the exact installation point of the bin. Then the visit to the installation points of the compost bins was taking place. Secondly, during the visit in the installation point, there was advising on the proper use of the bin. More frequent advice was the need of creation of holes and stirring the materials contained in the home composting bin, in order to create gaps for channelling air

and therefore oxygen within the pile, which is necessary for the degradation of the organic material, the avoidance of insect concentration and release of unpleasant odours. Also another common advice was the avoidance of putting citrus material inside the bin, because they hinder the living conditions of microorganisms due to the acidity of materials. Then the moistening of the material in case of low level of moisture or adding material to reduce the moisture level in case of high levels of moisture, as the appropriate level of moisture is an important factor for the composting process. Also another suggestion was to put only a few large items inside the bin to create gaps and therefore allowance of air channelling. Also there was encouragement to the users for putting more quantity of materials inside the bin, to help increase the temperature inside the pile and therefore to accelerate the composting process during the difficult weather conditions of winter. In Figure 5 there are indicative photos of home-composting monitoring in REMTH during POMIS project.

Figure 5. Indicative photos of home-composting monitoring in REMTH during POMIS project.

Another important part during the visits was the completing of questionnaires for data extraction and then the entry of the data in a database. The questionnaires included information on the consistency of use of the bin, about any problems from the operation of the bin and the qualitative characteristics of the material contents of the bin and the produced compost. More specifically in the questionnaires there were fields about: Personal information such as name, surname, sex, age etc., whether the bin is placed at home, manor or school, the education level of the responsible operator of the bin, the frequency of use of the bin and the type of materials, the size of the waste, the proportion and the temperature of the materials, the volume, the humidity, the colour and the odour inside the bin, the homogeneity, the colour and the odour of the compost. In Table 3 there are the main parameters from questionnaires of home composting bins monitoring.

Table 3. Main parameters from questionnaires of home composting bins monitoring.

Part 1: General Owner Information				
Name, Surname, Address, House/manor, number of members, age of members, education level				
Part 2: Consistency of User and incoming waste				
1. Frequency of use (scale 1 to 3)	1. Approximately twice/week	2. Approximately once/week	3. Seasonally (clarification)	
2. Status of bin				
3. Type of waste (mark with X what applies)	Vegetables, Bread, Fruits, Coffee, Eggs, Oils, Meat, Branches, Leaves, Grass, Soil, Manure, Paper-boxes, other (describe)			
4. Size of waste (scale 1 to 3)	1. Small/appropriate	2. Medium not the best	3. Large/inappropriate	
Part 3: Quality characteristics of bin content				
1. Proportion of ingredients (scale 1 to 4)	1. Satisfactory	2. Many green	3. Many brown	4. Existence of several inappropriate
2. Temperature (scale 1 to 2)	1. Satisfactory	2. Cold-inactive		
3. Volume (scale 1 to 3)	1. >50% of bin's volume – Satisfactory	2. ~50% of bin's volume – medium	3. <50% of bin's – small	
4. Humidity (scale 1 to 4)	1. Dry-inactive	2. Low	3. Satisfactory	4. Excessive
5. Colour of content (scale 1 to 3)	1. Light brown	2. Dark brown	3. Black	
6. Odor of bin (scale 1 to 3)	1. Does not exist	2. Exist but does not disturb	3. Intense, disturbing	
Part 4: Quality characteristics of produced compost				
1. Homogeneity (scale 1 to 3)	1. Satisfactory	2. Medium – There are large pieces	3. Inhomogeneous	
2. Colour of compost (scale 1 to 3)	1. Light brown	2. Dark brown	3. Black	
3. Odour of compost	1. Does not exist	2. Exist but does not disturb	3. Intense, disturbing	

During the visit there was recording of important observations, such as the presence of excessive quantity of citrus materials inside the bin, putting of too many large items in the bin, that are degraded difficult, deficient stirring of the material pile, which results to oxygen deficiency, the absence of significant amount of materials (half full bin), recording of damaged bin parts due to strong wind or human factor. Also there was encouragement of those users who have not started the composting process to install the bin and put it into operation. In addition during the first visit there was the provision of personal assistance for the fitting and installation of the bin and advice for the proper use of the bin. Furthermore during the visit pictures of the home composting bin were taken from every possible aspect so as to ensure views of the materials inside the bin, the installation point of the bin, the observation of adequate or non-adequate level of sunshine, the sticker of POMIS Project and the recording of any damaged parts of the bin. Also photos were taken with the lower door of the bin open in order to ascertain the maturation level of the composting process and whether there is compost production.

After the visits there was registration of questionnaires' data in a database for statistical results, editing the database of visits at home composting bins and archiving photographic material from visits at home composting bins. Moreover for the enhancement of the communication and networking there were formed two social media networks in the world wide web and especially in the social networks of Facebook and LinkedIn.

2.3 Laboratory analysis

For the purpose of the evaluation of the home composting pilot action there were sampling and laboratory analysis of produced compost samples. The aim was to review the quality of the produced compost from the operation of the home composting bins. A total of 100 samples of compost were taken in four (4) sampling excursions or 25 samples per sampling excursion. The samples were obtained from the five Regional Units of REMTH that were Drama, Kavala, Xanthi, Rodopi and Evros. The individual laboratory analyses included: measurement of the dry mass contents (moisture), measurement of the organic mass contents (volatile solids) and pH determination of the samples. Also there was determination of chemical composition Carbon, Nitrogen and Hydrogen using elemental analysis. Measurement of microbial respirometric activity using static solid phase manometric respirometers, for the assessment of static respiration index and the cumulative carbon dioxide production, measurement of microbial respirometric activity using dynamic solid phase respirometers, for the assessment of dynamic respiration index and the maximum carbon dioxide generation rate. Also there was determination of maturity status, after calculation of the germination index and finally measurements of total content of six heavy metals, in selected samples. The heavy metals measurements were for Pb, Ni, Cr, Zn, Cu and Cd. The laboratory analyses were realised in the laboratory of the Department of Environmental Engineering, of Democritus University of Thrace. In Figure 6 photos of the sampling and the samples' analysis at the laboratory are depicted.

Figure 6. Photos of sampling and samples' analysis at the laboratory.

3. Results and discussion

One important result that was evidenced by the monitoring of the network of 1.900 bins is that after following a few basic rules for the proper use of the home-composting bin, by the operators, the production of mature compost is guaranteed without nuisances. The four basic rules for a proper use of the home composting bin were: 1. caution on input materials used in the bin, (only bio-waste and no other plastic, meat, or dairy etc.), 2. preference on small size

of input materials, 3. need for periodic agitation, and 4. regulating the humidity inside the home composting bin. The behaviour of the bins' operators is of great importance on the production of mature compost.

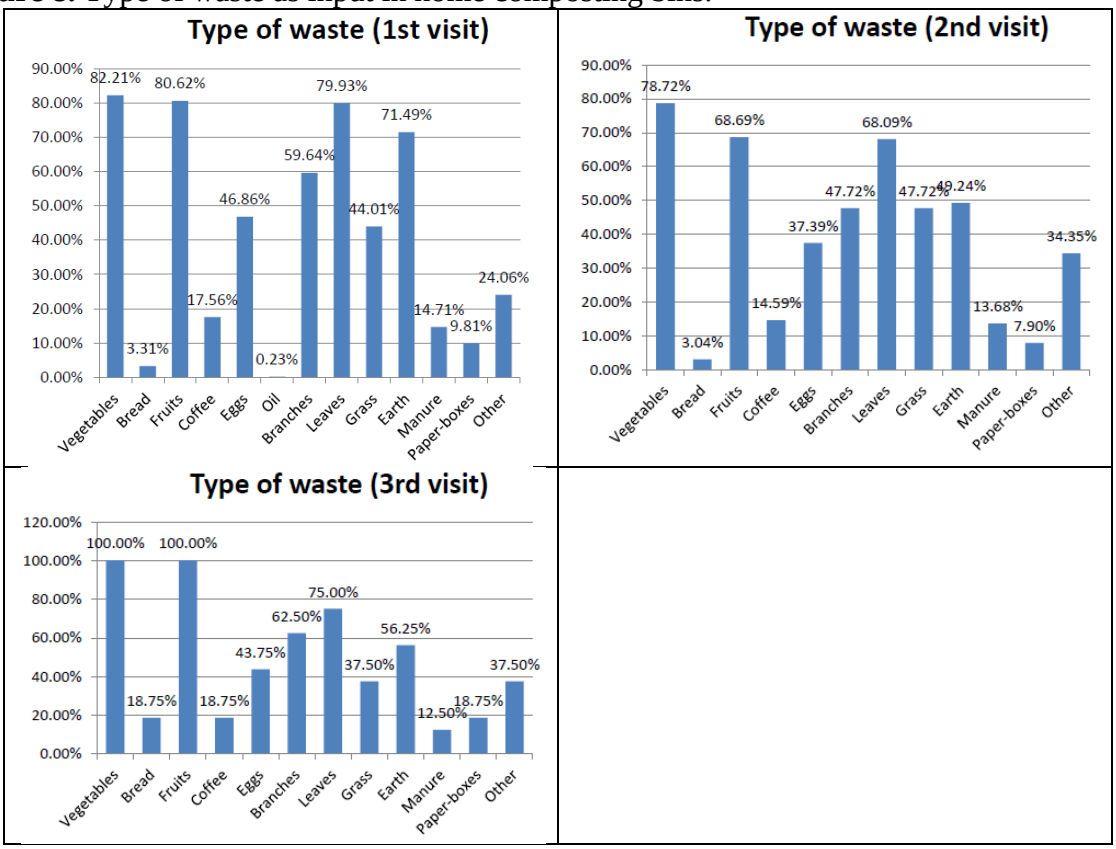
An indicative example of a specific bin and the experience of three monitoring visits are presented. The bin is located in the Regional Unit of Xanthi, in the Municipality of Xanthi, and specifically in the village of Petrochori with the number 1154. Comparing the photos taken during each visit (Figure 7) provides a striking image of the progress of compost production. The first visit took place on 23/03/2015 when the weather was quite cold and the bin was not fully filled so the rate of composting was low and there was no compost produced (Photo a). The second visit took place on 21/07/2015 when the weather conditions were improved and the temperature level was increased. Moreover, the householder of the bin had fed more materials into the bin and improved the frequency of the material stirring and the level of humidity by adding water when it was necessary after the instructions provided during the first visit. All these factors resulted in an increase of the composting rate and compost production of dark brown colour (Photo b). Finally, during the third visit, on 08/27/2015, also under hot weather conditions, the quality of compost was improved and the colour was black. During this visit, collection of compost sample for chemical analysis took place (Photo c).

Figure 7. Photos of three consecutive visits (a, b,c) to a home composting bin.

From analyzing data from the questionnaires there are some results regarding the educational level of the users, the types of waste used for composting and the humidity of the materials inside the bin. Regarding the educational level of the users of the bins it is significant to take into account that the 54.25% of the people are of higher educational level although a 19.39% decided not to reply to this question.

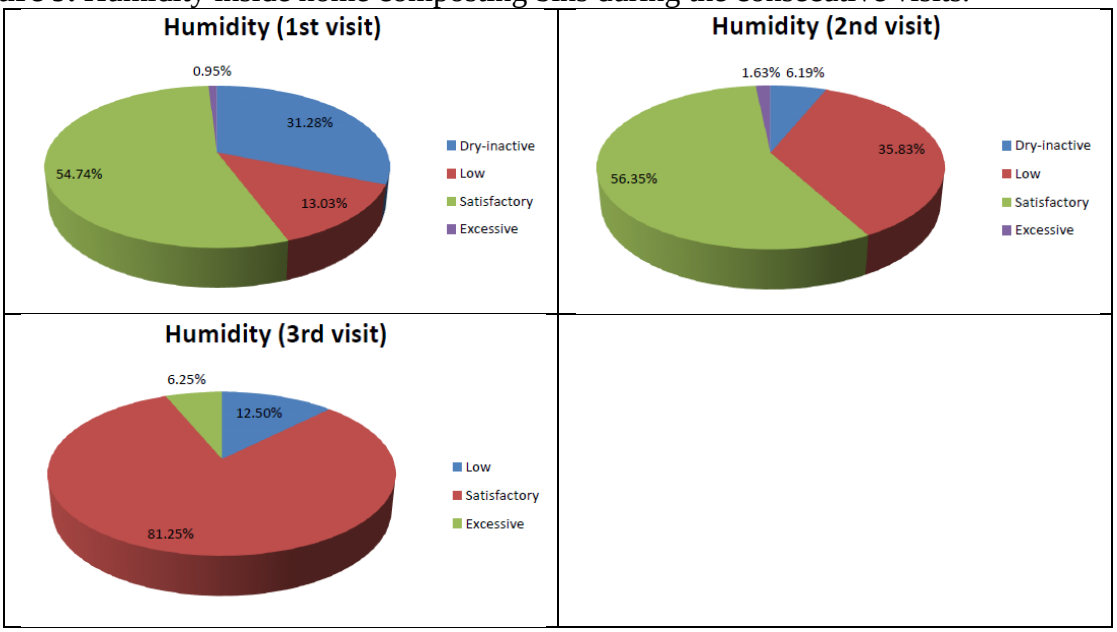
Examining the data from the first, the second and the third visit the types of waste used per bin are illustrated to Figure 8. At the first visit where 877 bins investigated, vegetables were the top choice (82.21%), followed by fruits (80.62%), leaves (79.93%), earth (71.49%), branches (59.64%), eggs (46.86%), grass (44.01%), etc. At the second visit where 329 bins investigated, vegetables were the top choice (78.72%), followed by fruits (68.69%), leaves (68.09%), earth (49.24%), grass (47.72%), branches (47.72%), eggs (37.39%), etc. At the third visit where 16 bins investigated, vegetables and fruits were the top choice (100.00%), followed by leaves (75.00%), branches (62.50%), earth (56.25%), eggs (43.75%), grass (37.50%), other materials (37.50%) etc. As a conclusion, the most common waste used by the households for composting process are fruits, vegetables and leaves.

Figure 8. Type of waste as input in home composting bins.



Regarding humidity it is worth mentioning that humidity is a significant factor that accelerates the whole process of composting. In the sample examined during the first visit, it was observed that the humidity was satisfactory at 54.74% of the cases. A significant amount of them (31.28%) were dry, thus inactive and in 13.03% of them the level of humidity was low. Only at 0.95% there was excess of water. At the second visit, the humidity levels were satisfactory by 56.35%. However, a 35.83% remains at low level humidity and the composting process is respectively delayed. However, there is a significant decrease of the dry-inactive bins for about 25%, a fact that indicates that some recipients of bins started improving the humidity levels of the bins, after the instructions provided during the visits by the experts. At the third visit, the humidity levels were satisfactory by 81.25% and this was a progress. This was a result of the thorough communication of the expert scientists and engineers in charge for the pilot implementation who provided guidelines to bins' users, as far as the humidity and water use is concerned. Only a 12.50% remained at low level humidity. In Figure 9 the progress in humidity levels can be seen.

Figure 9. Humidity inside home composting bins during the consecutive visits.



Also, results from the laboratory analysis were very good and indicatively it can be said that the home compost was found to be both stable and mature in almost all cases, while the heavy metal concentrations were far below the regulated limits. Also, home composting can result, after at least 3 months of treatment period inside the home-composting bin. More specific results of the measurements and special figures are to be published in a future work.

Of course there were some problems occurred in some of the home composting bins. Nonetheless these problems were of minor importance and only at a few cases. The problems were of various causes. For example there were phenomena of destruction of home composting bins by strong winds, fire because of input of ash that had fired coal or because of human factor. Also there were minor cases of stealing of home composting bins. Besides there were difficult weather conditions, excessive rain period and low ambient temperatures during winter that delayed the composting process. Finally some communication problems with few of the owners of home composting bins (unreliability) hindered the monitoring process.

On the other hand there are major and significant benefits such as reduction of the volume of solid waste ending up in landfills and avoidance of air pollution, GHG emissions and resource depletion. The GHG emissions avoided are due to reduced trucks routes across the Region of EMTH since there is need of less weight of MSW to be collected. So there is an optimization of the operation of the MSW management system in the Region of Eastern Macedonia – Thrace (REMTH) as it was set as the main goal of the POMIS project.

4. Conclusions

POMIS innovations on home composting can be summarized in the following. First time at a regional scale in Greece a number of 1.900 home-composting bins was distributed across the Region of EMTH. The operators of the home composting bins were mostly members of families and the bins were sited in the majority on houses' backyards. Previous experience of home composting in Greece was mainly at local and municipal level with a distribution of small number of bins. Secondly there was continuous monitoring of the home composting bins and full support of the participating households by expert scientists and engineers through visits, telephone calls, completing questionnaires by interviews of the householders and organising awareness and information events. Thirdly, there was a quality analysis of

compost samples taken across the Region by the Solid Waste Management laboratory, Department of Environmental Engineering, Democritus University of Thrace, from which it was found that the produced compost was stable and mature without high heavy metal concentrations.

The conclusions of POMIS project about the home-composting action are on the one hand the invaluable experience gained and on the other hand the significant benefits earned. About the experience gained it can be said that the thorough communication of the basic rules of home composting to the bins' operators can have a dramatic effect on the behaviour of the home composting bins and as a consequence on the production of a mature compost. Basic rules for a proper use of the home composting bin were: caution on input materials and only bio-waste, small size of input materials, periodic agitation and regulation of humidity. About the benefits earned there was a reduction of the volume of OHW ending up in landfills, avoidance of air pollution and reduction of GHG emissions as well minimisation of resource depletion.

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