Integration of a home henhouse and a composter for the decentralized management of the organic fraction of municipal solid waste (OFMSW): the composter-henhouse

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Abstract

This study explores an innovative *in-situ* composting system: the composter-henhouse. The composter-henhouse includes a small henhouse and a compost bin which is shared collectively amongst multiple users. The advantage of this system is that users contribute jointly with their own organic fraction of municipal solid waste. Inherently, hens feed on these organic residues and the action of its beaks and claws contribute to the composting/vermicomposting processes. The produced eggs are distributed among the users, thus, receiving an effective incentive to keep on the separation-recycling process at home. This study presents the results of a pilot test on the functioning of a composter-henhouse that was developed in Noain (Navarre, Spain). In total, 28 voluntary families actively took part of the test. Evidence on high participation/involvement rates, an adequate compost process and hen comfort suggest a successful implementation of the composter-henhouse.

Introduction

The disposal of municipal solid waste is a major concern all over the world as it is the beginning of various environmental problems. For instance, everyday in Spain approximately 63,000 tons day^{-1} of residues (municipal solid waste) are generated; this amounts to about 1.3 kg·day^{-1} of solid waste for every citizen in Spain. Kitchen and green biowastes comprise 45% of that weight. In the European Union the policy that regulates waste management is based on three principles: waste prevention, recycling and reuse and the improvement of the final disposal. In order to achieve a sound method for waste prevention, consumer decisions are being influenced to demand greener products and better manufacturing methods. If the waste cannot be prevented, then practices such as farmyard animal feeding and *in-situ* compost production are promoted to recycle the organic fraction of daily wastes. The processing of the organic fraction of the municipal solid waste (OFMSW) *in situ* using home or communal composting systems as well as for animal feeding (specially hens), have demonstrated to be very efficient management systems [1]. These systems suppose the decentralized valuation of the materials, avoiding its collection, transport and treatment in big, sophisticated, waste treatment facilities. Also, their use entails innumerable economic, environmental and social advantages. Nevertheless its creation is limited for different reasons. To guarantee the best conditions for the biological process, composting demands time to perform maintenance operations, such as shredding of wooden materials, watering, turnings, etc. In many cases citizen participation is voluntary without any kind of material or monetary incentive, and if it is not properly done, it generates potentials annoyances by process problems. Notwithstanding, not all the compostable organic wastes have the potential to be food for hens and other animals (e.g. paper tissues, wooden material). Beside this, henhouse management demand a great deal of commitment, and the assumption of the fact that an important cultural barrier has to be overcome, even in many rural areas where the activity has already been forgotten.

It is necessary to develop a decentralized management system of OFMSW that endures through the challenges and limitations that home composters and henhouses present. It is particularly necessary that the system yields an effective-fast incentive that encourages people to prevent waste generation, while at the same time, is adjustable to local-institutional budgets

Material and Methods

In order to accomplish the latter objective, that is to develop a culturally appropriate and effective management system, diverse experiences were analyzed. All the examined experiences had been established in the North of Spain and all were about in-situ management of OFSMW [2]. The selected sites shared collectively the composter and it was used by multiple users that contributed with their household residues. Then, semi-structured in-depth interviews to key respondents were conducted. Technicians, users and in-charge person of each experience were chosen. Afterwards, the experiences were analyzed by brainstorms on home composting, vermicomposting and henhouses experiences. The result of these sessions pointed out the need to merge communitarian compost bins with henhouses to bring an advantageous conclusion for both systems. Two composter-henhouses were designed and constructed and were trailed for 1 year. After a year of evaluation an improved proposal was designed and its results are herein reported.

Results

A pilot test of the composter-henhouse, with the improved design, was put in motion on the 8th of January 2013. The Composter-Henhouse consists in an open composter placed inside a small henhouse of up to 12 laying hens and one cockerel. The henhouse fulfils all the indispensable technical requirements in organic farming production. All the collected kitchen and garden refuses were put in the composter. The composter is accessible for the animals and the residues contribute significantly to their diet. By the frenetic and tireless activity of the beaks and claws of the fowls, the refuses that were not consumed were cut into pieces and turned. The human-labour used to mix and turn the organic matter is spared of as it is already done by the chicken. A parallel module or composter for the maturation phase of compost guarantees the presence of earthworms that would improve the biological process and contribute to the diet of the hens. A remarkable characteristic of this system is the distribution (on a rotation basis) of the everyday egg production to a different participant or user of the composter-henhouse. It guarantees that is going to be an important monitoring of the henhouse and that most of the neighbours will participate voluntarily in the experience.

The installation, organization and management of the facilities are detailed below and the summary of the preliminary results are here presented.

Description of the installation employed for the composter-henhouse.

The installation was built in Noain, Navarre, inside the "Parque de los sentidos" (The Garden of Five Senses). In this place a significant program on environmental education has been developed by a non-profit foundation which helps people who are in risk of social exclusion. Additionally, the park has its own staff members that would supervise and that can act accordingly, if needed, during the trial process. The henhouse has two yards of 40 m^2 and a wood-roofed area of 18 m^2 with a single-sloped roof. The grassed yards are east-oriented and the covered area lays west-oriented. In the protected area three wooden compost bins of 1.2 m^3 can be found with single-person entrance on the south. Figure 1 show a wide angle of the composter-henhouse, whilst Figure 2 is a close-up view of the inside of the roofed area.

Management of the composter-henhouse.

Twenty-eight families (approx. 80 inhabitants) from Noain accepted the commitment to voluntarily participate in the project. They had to take their kitchen biowastes, at least, twice a week to a specially designated bin that was situated at the entrance of the park. They also agreed to be in-charge of the henhouse duties once a month that is, to be the chicken-keeper and master-composter once a month. The duties include weighting the bin with the organic residues, carrying it to the place where the composter-henhouse is and pouring its insides in the first compost bin. Also, they have to check for inappropriate materials, verify or correct the status of the facilities and make sure there is enough water/feed for the hens. After their work is completed they can pick up all the eggs that were laid that day and keep them for their own. All the labours would be recorded on a factsheet and supervised by the staff.

As the compost bin is accessible, hens could freely walk inside and reach the organic residues that feed them. Whilst they feed the action of its beaks and claws remove, turn and blend together all the material, improving and contributing to the composting processes. In case it is necessary, food for fowl is provided occasionally to assist their nutritious needs. After eight weeks, when the first composting bin is fully-filled, the second composter is then opened and the material on the first is turned to this one, which is hold closed to limit hens accessibility to its content. From now on, users leave their residues only in the first bin. At this point, compost maturing begins and earthworms take a part in this phase. Earthworms can access both compost bins as the only isolation between them is a mesh. Hens would feed on in the organic residues or earthworms and any other insect that lives on the compost bin. The access to the grassed yards would be on rotational basis to guarantee it will not be degraded and to prevent overgrazing, zoonotic diseases.
Occasionally, if it was necessary, users could apply pruning and gardening residues as bulking material. Also, watering and compost turning are allowed to guarantee the best conditions for the composting process. As soon as the first composting bin fills up, then it is time to empty the second composting bin. By this time, the vermicomposting process is expected to have finished and so the outcome will be dried, sieved and distributed among the participants. If there is any compost left over, then the Park would keep it and use it within their gardens. If by any reason in the second compost bin the compost has not achieved it maturity, then the third compost bin would aid to extend the maturation process for as long as two months.

Preliminary results.
Up to the date that this version is being written, the project has been operational for only two months. On this period, several factors are being measured such as level of participation (kg of contributed OFMSW, its quality, user opinion, suggestions and questions made during this time), the compost process development (compost temperature, encountered problems, etc.), and produced eggs and hens wellbeing.
Until now, the results are very satisfactory. In a few days, 28 families signed up for the program. None of the families has declined and there is a waiting list of families that would like to try this experience. So far, no complaints have been recorded and there is a general feeling of satisfaction with the project. During this period, participants have brought a daily mean of 10 kg day^{-1} of OFMSW coming from their kitchens. This is the equivalent of approximately 127 g$\cdot$ day^{-1} per habitant and this figure denotes a high level of residue recovery (a mean of about 20% of the amount OFMSW generated per citizen). Evidence on high participant involvement is supported by the fact that kitchen residues contain an insignificant amount of inappropriate materials (e.g. the plastic bag that was used to carry the residues from each household).
The composting process is working adequately. Mean temperatures at 20 cm depth are of about 50ºC. (mean temperature measured per week), with peaks of 65ºC from time to time. After two months, 578 kg of kitchen OFMSW have been collected and treated and also more than 110 kg of pruning and gardening residues from the park. Throughout this period, the first compost bin has been fully filled and the initial composting phase has finished with the resultant being a highly decomposed and homogenous material. The material has already been transferred to the second composting bin, and it was temporarily shut with a wooden lid. Earthworms will be inoculated in two weeks to improve the efficiency of the maturity phase. Users have kept on feeding the first composting bin. During this initial stage a total of 350 eggs have been produced and 20.5 kg of fowl-feed have been consumed. The quality of the eggs has not yet been measured, but final users have expressed high satisfaction. Extra labour, apart from the users work, has only been used for three compost turnovers and bulking material addition, being employed for all these actions an equivalent of 1.5 man-hours.
On a first approach basis, the objectives have been met as high participation rates have been observed. Each family is responsible of the separation, transport, management and control of about 360 g $\cdot$ day^{-1} of kitchen residues that are equivalent to 3.7 ton $\cdot$ yr^{-1} of OFMSW. The direct reward that each family receives is about 9 fresh eggs each month and the possibility of being a hen-keeper for a day. The production cost of the eggs is minimal (3 € $month^{-1}$ on fowl-feed) and would mean the payoff of the initial investment made for the composter-henhouse and the cost of the hens (5 € hen^{-1}). So far, a very high degree of contentment has been noted, none has declined and no complaints have been received.

Moreover, an important amount of people is registered on the waiting list for further expansions of the project. A high commitment on *in-situ* residue management has also been encouraged.
In addition to the benefits on residue management, the composter-henhouse has also prompted several advantageous effects on the surrounding area. Up to now, the project has been a successful driving force of social cohesion and neighbour unity between the participating families. Temporal absences due to vacations are easily dealt with the aid of the participants. In the case of the garden, the project is a fruitful resource of leisure, outreach and educational activities. For example, the whole experience has stimulated the interest of garden visitors to watch the hens wandering around the composter area. And, it is a valuable teaching experience, especially for children, helping them to understand better the food origin, raising residue awareness and understanding in-situ recycling, among others.

Figure 1. Wide angle view of the composter-henhouse.

Figure 2. Close-up view of the composter-henhouse.

Conclusion and perspectives

In this experience, almost without marketing, a high participation rate was achieved. Volunteers that are involved in decentralized systems of OFMSW are highly committed in the task of *in-situ* management, all of that with very little municipality investment, reducing environmental impacts of wastes and aiding in the task of biowaste prevention and reduction.
It should also be noted that further improvements will be applied to the composter-henhouse area, especially to enhance the potential social benefits of this experience.

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