International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 12, December - 2013

An alternative to biomass burning - Composting

Mohammad Muzamil
M.Tech Scholar, Indian Agricultural Research Institute, New Delhi-110012, India

Abstract

Wide destruction caused by the global warming compels the humanity to reduce the anthropogenic pollution. Agriculture, being the backbone of every economy, generates large amounts of agro-wastes. With new legislations created by the global community as well as sovereign nations to enforce a blanket ban on burning, responsible for pollution providing a suitable alternative via composting. Composting ensures the efficient disposal and nutrient enrichment of the exhausted soil to maintain the sustainability of the production.

Introduction

With the burgeoning population and the necessity of providing the food to every living soul, the diversion of shifting traditional agriculture to mechanization and application of large amount of chemical fertilizers, pesticides and herbicides for safeguarding the crops has become inevitable. Globally, biomass ranks fourth as an energy resource, providing approximately 14 % of the world's energy needs and 40.5 billion tons of biomass produced in the terrestrial ecosystem provides an estimated 6.8 t/yr per person. Biomass is categorized as an efficient renewable source with some of the advantages of fossil fuels, as its ability to be converted to liquid fuel via ethanol or electricity via gas turbines or fortifying the soil via compost. Currently, approximately 50% of the world's biomass (approximately 600 quads worldwide) is being used by humans for food, construction. Holding the responsibility to feed the alarming population, lands were exploited to produce enough food materials with a consequent increase in biomass. The organic matter content in soil gradually decreased with cultivation, and sustainability of the production depends on the periodic application of different sources of organic residues [3]. Given that humans harvest about 50% of the world's terrestrial biomass, each person is utilizing 3.4 t/yr. This 3.4 t/yr includes all of agriculture, including livestock production and forestry. The remaining 3.4 t/yr per person supplies the other 10 million species of natural biota, their energy and nutrient needs.

Conventional methods of Biomass handling

The biomass is generated once the crop had completed its life cycle and the necessary human consumable portion has been harvested. The biomass energy potential depends on both competition between biomass resource and alternative energy technologies and primary energy sources. The collection of the biomass or agro-waste and its utilization is the most crucial problem faced by the Indian farmers. The common practices adopted to get rid of biomass involves

i. Direct burning
ii. Industrial operations
iii. Livestock feed

However, hazardous and inefficient burning emissions and health concerns from growing urban populations has prompted to reduce the open field burning. Incorporation of straw into the soil and supplying the agro-waste directly to industrial purposes was found to be the most common alternative. The mixing of the biomass has a higher cost than open-field burning, increased disease and weed carryover and reduced effectiveness of fertilizer. Moreover, it also has increased atmospheric emissions of methane and nitrogenous compounds.

The current trend of utilising high yielding varieties with high doses of fertilizers and pesticides had destroyed the natural balance, maintained by the decomposition of leaves, crop residues and branches. The world community, successfully, for short span attained milestones, by increasing the agricultural production to feed large population without giving any significant attention towards the deterioration of the soil and atmospheric conditions. The influence of the operations at one place may be felt at other side of the globe via global climatic disturbances, (Picture 1). However, the deceleration in the productivity alarmed and warned of serious repercussions on the global food security. Realizing the necessity of maintaining the 'soil health' to ensure sustainability and survivability, the need to fortifying the exhausted resources back to the soil grabs the attention. This gap is often filled by applying chemical fertilizers. Chemical fertilizers, however, are expensive to purchase and for most small-scale farmers, it is not viable. The contamination of the ground water resources and attachment of fertilizers with chronic diseases makes the composting a suitable alternative.

Picture 1: Burning of biomass in agricultural fields

Viable Alternative- Composting

Composting is a natural process which involves the aerobic biological decomposition of biodegradable materials under controlled conditions [6]. In composting, ammonia (NH_3) is largely emitted when organic matter is actively decomposed [5]. Composting is regarded as a fully sustainable practice, since it aims at both conservation of the environment, human safety and economically convenient production [9]. Adding compost to sandy soils increases the water retention capacity i.e. water remains longer in the soil to be utilized by the plants, particularly in periods of drought. It also enhances the activity of the micro-organisms introduced with it and stimulates those micro-organisms already resident in the soil. The compost prepared from the farm residues is essential for maintenance of soil quality and crop productivity. Composting technologies are classified as:

I. Open systems

A. Windrow composting

B. Aerated static composting

II. Contained systems

A. Continuous or intermittent composting systems-vertical flow (silos)

B. Continuous or intermittent composting systems-horizontal flow

i. Rotary drums
ii. Agitated bins or bays
   a. Circular
   b. Rectangular
   c. Continuous tunnels

C. Batch composting systems
   i. Open bays
   ii. Fixed batch tunnels
   iii. Mobile batch tunnels

Traditional methods of compost preparation involves stacking the material in pits to decompose over a long period with little agitation and management. This approach led to the preparation in six to eight months with tedious workload for farmers. On the other hand, Rapid Methods make use of the special treatments to expedite the aerobic decomposition process and bring down the composting period around four to five weeks. Besides, there are other recently introduced approaches like 'Vermicomposting', which though bring down the process duration to a good extent as compared to the conventional methods and producing a far-superior quality product, but unfortunately have a lower turnover and longer time taken as compared to other Rapid Methods.

Modern Approach

The prerequisite of the compost preparation is the availability of the land. The time duration in between the harvesting of one crop and planting the second is often utilized for this purpose. The latest method involves turning the crop residues in quick succession to reduce the preparation time, Picture 2. The turner, employed for reducing the drudgery of the workers, mixes the composting materials, enhances passive aeration and provides conditions congenial for aerobic decomposition. Composting operations may take up to six to seven weeks. The method is known as pile and/or windrow composting.

Windrow composting consists of placing the mixture of raw materials in long narrow piles or windrows which are agitated or turned on a regular basis. The turning operation mixes the composting materials and enhances passive aeration. Typically the windrows are initially from 3 feet high for dense materials like manures to 12 feet high for fluffy materials like leaves. The width varies from 10 to 20 feet. Cellulolytic fungi like *Aspergillus awamori* ,

ISSN: 2278-0181
Vol. 2 Issue 12, December - 2013

Trichoderma viride, *Pheanerochaete chrysosporium* and *Aspergillus nidulans* are commonly utilized for enhancing the rate of decomposition. The equipment used for turning determines the size, shape, and spacing of the windrows.

Picture 2: windrow turner for mixing materials uniformly

Bucket loaders with a long reach can build high windrows. Turning machines produce low, wide windrows. If the windrow is too large, anaerobic zones occur near its centre which release odours when the windrow is turned. On the other hand, small windrows lose heat quickly and may not achieve temperatures high enough to evaporate moisture and kill pathogens and weed seeds.But, the cost ofcomposting of animal manures can be considerably higher than the direct utilisation of raw manures. Therefore, composting is justified for manures that need to be partially sterilised [7], and also when compost of high quality is produced, to offset the production costs. The strength and weaknesses of windrow composting are as follows:

Strength and weaknesses of windrow composting

Feature	Illustrations
Temperature control	The temperature of the agro-waste and other parameters varies considerably throughout the windrow, the composting process is far from optimal and is normally quite slow.

Aeration control	The efficiency of natural convection aeration relies upon the correct shape, size and consistency of the windrows.
Moisture control	The composting waste tends to dry out as composting proceeds and precise replacement of this moisture is difficult.
Manpower requirement	There is little opportunity for automation, Labour requirements for setting up, turning, monitoring, and breaking down windrows can be significant.
Composting time	The duration varies from 12 – 20 weeks and depends upon the agro-waste used and the potential use of the finished compost.
Siting of facility	Because of potential problems with odour release, the composting site should be considerable distance away from residential buildings.
Capital cost	This is normally one of the least capital intensive of the composting options. The major capital requirements are for concrete, front end loaders, turners and screens.
Processing cost	This is normally one of the cheapest composting systems available in terms of processing cost per tonne of feedstock.
Product quality	Compost quality is fairly low due to variation in compost structure, chemistry and microbiology. It may be suitable for less demanding applications.
Bio-aerosol control	Significant quantities of bio-aerosols can be released during turning.
Homogeneity	The varying temperature, moisture along with remixing introduces significant heterogeneity.
Structure control	Turning the windrows allows the reformation of air spaces within the composting waste.
Particle size	The turning reduces the particle size and exposes new surfaces for composting.

Odour control	Odour problems can be reduced by covering the windrows with specialized sheeting or by placing the windrows in a building with an air extraction and treatment system.
Area requirement	Sufficient areas are required for windrow composting.

Attempts to mechanize the windrow composting

The development of the specialized turners, attached to farm tractors or front loaders or self- propelled for turning the agro-waste, with windrow height of 0.9 m high for dense materials to 3.6 m high for fluffy materials and width of 3-6 m, greatly reduces the time and labor involved, mix the materials thoroughly and produce more uniform compost [8]. The development of artificial aeration system accelerates the composting process and reduces the odors associated with the decomposition [4]. The blades installed on the rotor of the windrow turner with peripheral speed between 4.54 to 5m34 m/s, stalk length of less than 50 mm and moisture content of less than 37.6 % produces fine quality compost [10]. The time required for compost preparation can be substantially reduced by maintain optimum speed of 0.2 m/s, rotor speed of 240 rpm, with four turnings per month [1]. The cost of the composting process amounted to 4200 Euro per year, making the cost of cured compost 0.63 Euro. kg^{-1} [2].

Conclusion

A close proximity exists between the replenishment of the soil via composting to maintain the soil health, enrich with the exhausted resources, improve the resource credentials of the soil for sustained production on one hand and to protect the environment, natural flora fauna, scarce resources on the other hand. The composting can serve a viable alternative for costly and hazardous fertilizers without any considerable reduction in the productivity. Moreover, the growing awareness about the importance of ‘fertilizer-free’ products will add substantial boost to the already booming sector of composting in public, private as well as cooperative sector.

Reference

[1] Abd El-Mottaleb A.F. 2006. Effect of some operating parameters onthe performance of compost turning machines, *Misr Journal of Agricultural Engineering.*,**23** (1): 40-54.

[2] Alfano G., C. Belli, G. Lustrato and Ranalli, G. 2007. Pile composting of two-phase centrifuged olive husk residues: Technical solutions and quality of cured compost Waste Management, Volume 27, Issue 9, 2007, Pages1092-1098.

[3] El-Maddah, E.I. 2000.Effect of some amendments on some physical and hydrophysical soil properties. *Journal of Agricultural Sciences,* Mansoura Univ., **25**(7): 4765-4775.

[4] Hatem, M. H.; and Gay, A. E. (1994). " composting of municipal solid waste " Misr, J.Agric,Eng., 11 (2) : 548 – 558.

[5] Kuroda, K., Hanajima, D., Fukumoto, Y., Suzuki, K., Kawamoto, S., Shima, J., Haga, K. 2004.Isolation of thermophilic ammonium tolerant bacterium and its application to reduce ammonia emission during composting of animal wastes.Biosci.Biotechnol.Biochem.**68**(2), 286–292.

[6] Misra, R.V., Roy, R.N. and Hiraoka, H. 2003. On-farm composting methods. Rome: FAO.

[7[Parkinson, K., I. Gibbs, S. Burchett, and T. Mtsselbrook. 2004.Effect of turning regirtme mtd seasonal weather conditions ott ttitrogett and phosphorus losses during aerobic comttpostimmg of cattle inarrine. Umoresource –Technology 91(2):171-178.

[8] Rynk, R., M. van de Kamp, G.B. Willson, M.E. Singley, T.L. Richard, J.J. Kolega, F.R. Gouin, L. Laliberty, Jr., K. Day, D.W. Murphy, H.A.J. Hoitink and W.F. Brinton.1992. *On-Farm CompostingHandbook.* NRAES, Cornell University, Ithaca, New York.186 pp.

[9] Seki, H. 2000. Stochastic modelling of composting processes with batch operation by the Fkker – Plant equation *Transactions of ASAE.,* **43** (1): 169 –179.

[10] Yousef, I.S. 2001.A study on mechanization of compost turning and mixing.*Misr Journal of Agricultural Engineering*., **18** (1): 45-58.