Chapter 6

Solid waste management for rural and urban sustainability

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Introduction

Solid waste management, discussed in this chapter, is related to target 12.5, which aims to substantially reduce waste generation by means of prevention, reduction, recycling, and reuse by 2030. Taking the peculiarities of the Brazilian Agricultural Research Corporation (Embrapa) into consideration regarding the development of technological solutions for the rural sector and the Company's social commitment to promoting environmental well-being for the whole society, the contributions addressed in this chapter are discussed under two aspects: a) Embrapa as a Brazilian governmental organ acting to encourage the adoption of sustainable practices in the agricultural production sector; and b) internal procedures in implementing the Company's Environmental Management Plan, which began in 2010, and has already become a benchmark in the public business sector.

Context

Unsustainable production and consumption standards, besides intensifying the exploitation of natural resources for production of goods used by society, are compromising the future of mankind, because, in rural areas, this process results in forest impacts and soil and water resources depletion. Dumpsites or floodwaters, where more than 60% of daily waste is deposited in Brazil (Ribeiro; Ziglio, 2006), are part of Brazilian urban landscapes. The countryside, in turn, is a big organic and inorganic waste generator (Fessenden, 2015), which can be recycled or reused in the city. Likewise, organic urban waste, which represents more than 50% of the waste generated in the cities (Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais, 2016), or even inorganic ones, has great potential for application in the field (Pires; Mattiazzo, 2008).

Waste generation reduction is part of the guidelines for changing consumption patterns, focused on Agenda 21 under various approaches, among them is “minimizing the generation of wastes “ (Agenda 21, 1995). One of the strategies recommended and disseminated by the Ministry of the Environment (MMA) is applying the 3Rs principle: reducing (raw materials and energy use and waste in generating sources), directly reusing products, and material recycling. Embrapa operates based on the 3 Rs, for it conducts research studies that include using agricultural products waste in crops and in agroindustrial processing (seeds, straws, husks) and even construction and timber waste (sawdust) that are used to correct soil acidity and create energy or directly applied on the soil to improve fertility and generate income for the farmer. In this way, Embrapa provides information, designs research and technology, supports events, and conducts training courses for different audiences aiming at waste prevention, elimination, recycling, reuse or reduction. The Company is also very concerned about creating technologies that contribute to reducing water and energy consumption, as well as reducing greenhouse gas emissions. Information provided in publications is generally presented as part of booklets and manuals on good practices, which present procedures and facilitate the understanding of technicians and farmers on diverse production segments, including cattle and swine production, aquaculture, poultry, fruit growing, and extractive forestry production, among others.

Based on the assumptions that Embrapa research collaborates with technological solutions and contributes to designing public policies on solid waste and to promoting sustainability in rural and urban environments, the objective of this chapter is to address problems and solutions related to waste production, particularly rural solid waste (RSW) (from livestock and crops) , which, along with urban solid waste (household, industrial or service waste), has been one of the major environmental problems of recent decades. In this chapter, contributions of Embrapa are presented in terms of technologies and technical advice in order to reduce solid waste production, as well as initiatives that contribute to achieving target 12.5, which seeks a substantial reduction of waste generation through waste prevention, reduction, recycling, and reuse, especially those from agricultural activities.

Actions of Embrapa to support public policies regarding solid waste management

Environmental sustainability, which is a priority guideline for MMA, includes topics such as deforestation, forest code, climate change, biodiversity protection, genetic heritage, and sustainable agriculture. In 2010, MMA embraced the urban sustainability challenge and sought to implement the Política Nacional de Resíduos Sólidos (National Solid Waste Policy – PNRS), taking on the challenges of the so-called brown agenda, in which garbage and sewage are the main problems (Brasil, 2012). Due to its mission and objectives, Embrapa had already been acting in line with public policies for environmental sustainability, and has also started to support initiatives for the PNRS implementation, for there is a logical connection between environmental issues and urban policies.

Internally, as of 2010, the Company laid down guidelines for implementing environmental management in all its decentralized units, thus defining the five main aspects of integrated environmental management, namely: 1) environmental education; 2) common waste management and water and energy use optimization; 3) laboratory waste management; 4) experimental field waste management; and 5) adjustment of Embrapa experimental farms to environmental legislation (Penha; Tomé Júnior, 2010). Implementing environmental management resulted in developing solid waste, laboratory and experimental field waste plans in Embrapa Units throughout Brazil.

Externally, Embrapa has representatives in committees and working groups to design public policies for solid waste management. In this context, there are some initiatives, such as the partnership between Embrapa Acre and the Municipal Environment Department of Rio Branco (Semeia), through which Embrapa research, technology transfer, and environmental education activities support the implementation of the Municipal Integrated Solid Waste Management Plan of Rio Branco. Among other actions, it involves assessing the efficiency of composting processes in the solid waste treatment unit, as well as the use of organic compounds and substrates for agriculture and landscape projects in the city of Rio Branco, in the state of Acre. In Rondônia, since 2016, the local Embrapa Unit takes part in a technical group coordinated by the Chamber of Commerce of Rondônia (Fecomércio), whose purpose is promoting debates and contributing to develop the Municipal Plan for Solid Waste Management of Porto Velho.

Agricultural waste management

Recycling and reusing

Several agricultural practices and processes related to recycling and reusing organic waste have been improved and developed at Embrapa Units, in order to convert them into co-products, thus contributing to the economic and environmental sustainability of production.

Embrapa Agrobiology has developed technology for producing organic fertilizers and substrates used in landscape projects and seedlings production. They are based on 100%-vegetable, renewable, and abundant raw materials, such as castor bean meal with sugarcane bagasse or napier grass straw. Their quality is higher than that of similar products available in the market. They are free of biological contamination and they are low cost. They can be produced on small farms and also on large scale, in an industrial plant, as they are based on a simple manufacturing process. The step-by-step process for making 100% vegetable composting is available in the video *Produção de Húmus com o Uso de Gongolo* (*Humus Production Using Millipede*, available only in Portuguese), made available by Embrapa on YouTube[1].

Earthworm culture or vermicomposting is the process of converting (household or agriculture) organic residues into organic compound (humus or vermicompost). Embrapa Agrobiology has developed a bamboo bed that demands low investment and makes the process cheaper and ecological because of the materials used. Besides that, it enables better aeration and milder temperatures for earthworms, adapting well to both small and urban farmers. Another technology developed by the abovementioned Unit is a device to produce organic compounds based on millipede activity. Millipedes are a promising alternative for composting organic waste such as grass, woody materials, and even cardboard. Compost from millipedes can be used in seedlings production and its quality is higher than that of commercial compounds, especially for vegetable production. On the Internet, video information and posts aimed at children and adolescents are available (Correia et al., 2014).

Witch's broom is the main disease of the cupuaçu tree (*Theobroma grandiflorum*), causing up to 70% reduction in plant productivity. To avoid dispersion of the *Moniliophthora perniciosa* fungus in the production area, witch's broom remains are usually burnt. Researchers at Embrapa Roraima assessed the composting of cupuaçu trees prunings and verified that the process eliminates the disease-causing pathogen and generates an organic compound that can be safely used as substrate for seedling production and plant fertilization (Lima-Primo et al., 2017).

[1] Available at: <https://youtu.be/9EffxSrKzHQ>.

Waste from green coconut husk (fibrous mesocarp) accounts for about 70% of all litter produced on Brazilian beaches. Embrapa Tropical Agroindustry, in partnership with Fortalmag Metalworking, developed a set of equipment for husk processing. Coconut powder is a biodegradable, renewable, and very light material. Due to its physical structure, it has high porosity and high potential for moisture retention. The fiber can be used as raw material for manufacturing pots and plates for planting (replacing tree ferns), vehicle upholstering and biodegradable blankets. As an innovation, Embrapa has promoted the use of the product in applications that comply with product ecodesign principles, such as interior panels and decorative pieces (Mattos et al., 2011).

Waste for acidity correction and soil conditioning

Conditioners are substances that, once added to the soil, help to improve their chemical, physical, and biological characteristics, thus increasing its ability to support plants. This is the case of biochar obtained from controlled burning, or pyrolysis, of different animal or vegetable compounds, which contributes to the increase of organic matter in the soil. Transforming an environmental liability into a beneficial input to wood and food production is the goal of a research developed by Embrapa Agrosilvopastoral (located in the state of Mato Grosso), which consists of testing the use of biochar (made from sawdust, vegetable remains, chicken bedding, and urban litter) as soil conditioner (Faria, 2017).

Construction and demolition waste (CDW) generation and storage is an environmental problem, accounting for more than 50% of the total solid waste generated in medium and large urban centers. In partnership with Prohab São Carlos/state of São Paulo, Embrapa Instrumentation developed a methodology for the use of recycled construction and demolition waste (R-CDW) as acidity correctors and soil conditioners (Lasso et al., 2013).

Embrapa Soils (located in the state of Rio de Janeiro), in partnership with Calderon Consulting, has developed a fertilizer that can be produced using organic waste from agroindustries, animal farming, agricultural remains, etc. Because it is sustainable, this technology has been classified as a green patent. The fertilizer is a modern, efficient product with a good cost-benefit ratio. The partner industry intends to supply grain, vegetable and cattle raising farmers that need pasture recovery.

Reusing agroindustrial waste in animal feeding

Agroindustrial waste can be used in ruminant feeding. Besides helping to reduce the environmental impact, residues use in domestic animals feeding may be an option to reduce animal products costs. Embrapa Rondônia carried out a study to evaluate the presence of agroforestry processing industry residues in dairy cattle feeding. In addition to technical information, results included scientific information on food technology, nutritional characteristics of agroindustrial by-products, and dairy cattle performance.

Embrapa Dairy Cattle studied barley residues use in cattle feeding. The greatest limitation of moist barley is its energy content, especially for high milk producing cattle (over 25 kg/day). For cows producing less than 20 kg of milk per day, moist barley may be a good alternative, depending on price and availability. Usually, barley residue content should not exceed 20% of the dry matter (DM) intake. That is, for cows ingesting 20 kg of DM a day, only 4 kg should come from barley, and the other 16 kg from the diet.

Final considerations

The principle of solid waste generation reduction (target 12.5 – SDG 12) is based on taking attitudes and making decisions on accessing consumer goods at individual and collective levels. The abovementioned technological solutions for the agricultural production sector indicate possibilities. Therefore, reaching this target involves not only developing and adopting research-based technological solutions, but also raising environmental awareness and taking consumer ethical attitudes. In this case, raising awareness, through environmental education, about the controlled use of natural resources in industrial production and consumption reduction is an urgent matter. In this sense, taking proactive attitudes is not exclusive to a particular segment, so joining efforts of all (government, industry, commerce, and citizens in general), especially in reducing waste generation (because reusing and recycling are alternatives to waste treatment that do not halt the need to reduce consumption and, consequently, waste generation) is a must.

Encouraging civic participation, in order to proactively contribute to this target, should take place in all areas of (formal and non-formal) education, and research studies that can help to reduce this impact should also be in harmony with sustainable consumption. In this regard, disseminating more good practices contributes to appreciating socio-biodiversity, improving renewable natural resources use, reducing harvest and post-harvest losses, adopting good management practices to reduce soil losses, and reducing food losses.

In both urban and rural domains, the potential of Embrapa to contribute, within the limits of its attributions, in a context in which several institutions are teaming up to provide solutions to society, is noticeable. It takes place not only by the dissemination of information in technical-scientific events, but also by contributing to public policy design, by participating in committees that manage natural resources, by organizing events and training courses and marketing products to make science reach ordinary citizens.

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