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Destination of the Solid Waste Generated at the Agricultural Products Wholesale Market in Brazil

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***Abstract*—**The Brazilian Agricultural Products Wholesale Market fits well as example of residues generating system, reaching 750 metric tons per month of total residues, from which 600 metric tons are organic material and 150 metric tons are recyclable materials. Organic material is basically composed of fruit, vegetables and flowers leftovers from the products commercialization. The recyclable compounds are generate from packing material employed in the commercialization process. This research work devoted efforts in carrying quantitative analysis of the residues generated in the agricultural enterprise at its final destination. Data survey followed the directions implemented by the Residues Management Program issued by the agricultural enterprise. It was noticed from that analysis the necessity of changing the logistics applied to the recyclable material collecting process. However, composting process was elected as the organic compounds destination which is considered adequate for a material composed of significant percentage of organic matter far higher than wood, cardboard and plastics contents.

***Keywords*—**Composting, environment, recycling, solid waste.

I. Introduction

THE concept of solid residues management has changed in the last decades. In the past, public administration has devoted little attention to the proper solid residues destination, limiting to actions of purely disposal.

National policies for solid residues in Brazil is ruled by the federal law 12.305/10 and introduces new concepts identified as the responsibility – amplifying the actions as selective collection, establishing recycling cooperatives and environmental education. That law establishes that everyone is responsible in providing a sustainable destination to the generated residue. By the year of 2014 private and public administrations should implement the law and the municipalities should present a Management Plan for Solid Residues by August of 2012.

The Brazilian Agricultural Products Wholesale Market holds the eighth position among the large wholesale vegetable markets in Brazil in terms of fruit and vegetable commercialization and it is considered the largest flower and ornamental plants commercializing post in Latin America. The enterprise occupies a total area of 600 mil m2 and 150 mil m2 of building space, receiving about 20.000 costumers per day.

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Residues Management Plan of the Brazilian Wholesale Agricultural Products Market is being prepared by a committee created by the enterprise administration, involving technical personnel and engineers, a Cooperative of Garbage Collectors, a Non-Governmental Organization named "Reference in Cooperation and Association" as well as the organization which represents the Whole Sale Market Association and Association of Flower Production and Commercialization.

In the year of 2011 the referred agricultural enterprise commercialized over 670.000,0 of metric tons of fruit and vegetables corresponding to US$ 500 million and about 72 000 of metric tons of flowers and ornamental plants corresponding to US$ 60 million. The agricultural enterprise is divided into pavilions where the wholesalers commercialize the products in shops and the retailers and the free market producers commercialize directly with the retailers.

Recyclable material as plastics, wood, glass, metals is collected by the Cooperative of Collectors located in the warehouse. There are 29 cooperated individuals which guarantee the family income by selling the recyclable material. The agricultural enterprise also keeps a cooperation agreement with the Secretary of Public Services of city to recycle organic material to forward fruit, vegetable and flower residues to the Compost Plant to transform the organic residues into fertilizers.

The objective of this research work was (1) to evaluate the solid residues generated by the agricultural enterprise during the last ten years (2) to characterize the percentage in mass of each type of material showed in the residues as specified by the NBR 10.007/2004 norm.

II. Theoretical Background

World residues production divergence depends on the regional wealth of the country in consideration. In the year of 2003 the average residue production in the European Union was estimated in 1.6 kg/habitant/day meanwhile in the USA and Japan that figure reached the value of 3.0 kg/habitant/day. However, low developing countries present values of 0.35 to 0.45 kg/habitant/day of solid residues [13] In the Brazilian state capitals the situation does not change, as example, São Paulo city produces 11 thousand of metric tons of solid residues per day, meanwhile Porto Velho city presents a value close to 260 metric tons of solid residues per day [2].

Solid Residues conditioning in garbage landfill turns very costly to the public administration because it demands large

areas located outside of the city and prevention of aquifers contamination [1] [14]. After the activities closure the garbage landfill will exhibit a passive environment which will bring to the equilibrium for future generations [3].

Organic residues composting process is one of the oldest methods of nutrients recycling. It is a biological process to transform the organic matter existing in the humus material which can be employed as organic fertilizer to the agriculture, green vegetable production, gardens as well as in the recuperation degraded areas [11][4].

However due to its natural characteristics, the final product might take weeks or months to be generated, beyond space requirement [7] [8]. The composting can be accelerated by means of catalyzers to reduce the required time and consequently the necessary area but keeping the process quality [5].

The recycling paper process generates residues that are usually placed in embankments. However, these residues present some constituents that can correct soil acidity and act as a source of nutrients, such as calcium. On the other hand, these residues also have heavy metals, which can cause negative environmental impacts [16].

The main changes to be made are: education of the units and cleaning staff about segregation, reformulation of the routine on removing residues, teaching the cleaning staff for the correct usage of landfills and change of the areas for residues [15].

III. Procedure

A. Materials

The Brazilian Agricultural Products Wholesale Market, Brazil is developing a Solid Residues Management Plan applicable to 750 of metric tons per month. Around 80% of that amount corresponds to organic material and remaining corresponds to recyclable fraction. Permanent pavilions, free market places, potato, garlic and anions pavilions, pré-processing pavilions number 1 and number 2, the flower market, administration areas, service areas, the Cooperative of Recyclables as well as the lagoon of sewage treatment are identified as residues generating units.

Solid Residues Management Program permits 30% of residues reduction at the agricultural enterprise which is based on actions scheduled for short, medium and long term and controlled by de Federal Law number 12.305 of august 02 / 2010, establishing the objectives, instruments and directions relative to residues integrated management, including dangerous ones, defining the responsibilities of the residues generating people as well as of the public administration.

As determined by the Law the activities which generate solid residues of any kind, are responsible for containing, storage, collection, transportation, treatment, final disposition and for the environmental stabilization after activities closure as well as for the recuperation of the degraded area.

Following, it is presented important definitions, technical norms, legislations and other issues related to residues which gave support the preparation and the understanding of this research work.

The NBR 10.004/04 norm defines solid residues as "Residues presented in solid semi solid state, generated from industrial, domestic, hospital, commercial, agriculture activities, sweeping..." [9].

B. Classification of Solid Residues

Solid residues are classified in several forms which are based on certain characteristics or properties, as physical nature, chemical composition, potential environmental risks to the environment, origin, as displayed on Table I.

a) Physical Nature

Dry and Wet Residues

TABLE I
Classification of Solid Residues

NBR 10.004/04 – Classification of Solid Residues	
By Physical Nature	- Dry - Wet
By Chemical Composition	- Organic Matter - Inorganic Matter
By Potential risks to the Environment	Residues Class I - Dangerous Residues Class II – not Dangerous Residues Class II A - Inerts Residues Class II B – Not Inerts
By the Origin	- Domestic - Comercial - Public - Health Service - Special Residues - Bateries - Fluorecent Lamps - Lubricating oils - Tires - Agricultutal Pesticides Pack - Building Construction Left Over - Industrial

Dry residues are recyclable material as metals, paper, plastics, wood, glass, porcelain, cork, paraffin, etc. Wet residues and rejecting material include food leftover, vegetable skins, bathroom residues, fruit and vegetable bagasse, straw.

b) By the Chemical Composition following the norm PNRS (PL203/91)

Organic Residues

This item includes residues of animal or vegetable origin as food leftover, fruits, vegetables, flowers, plants, seeds, leaves, meat and bones leftover, papers, wood, etc. The major part of organic residues can be used in composting to generate soil fertilizers and correctives, contributing to the nutrients and improving agricultural production.

Inorganic Residues

This classification includes all the material of non-biological origin or produced by human activities as plastics, metals, glass, which require long degradation period when disposed directly in the environment without previous treatment.

c) By Potential Risks to the Environment

The NBR 10.004 – Solid Residues from 2004, of the ABNT (Brazilian Association of Technical Norms) classifies solid residues as follows [9].

Class I Residues – Dangerous

These residues present isks to human health as well as to the environment, exhibiting one or more of the following characteristics: harmness, inflammability, corrosivity, reactivity, toxicity and pathogeinicity. Ex: batteries, used oil, painting and pigment residues, health service residues, inflammable residues, etc.

Class II Residues – not dangerous

This class includes not dangerous residues as ferric and non-ferric metal spares, paper and cardboard, polymerized plastics, rubber and other non-dangerous residues.

Residues included in the Class II A, non-inert materials are not classified in the I and II B group, which can exhibit properties as combustibility, biodegrability and water solubility, mud generated at water and sewage treatment process, paper, food leftover.

Class II B residues, the inert materials, they do not exhibit any water soluble component, as example, bricks, rocs, stones, certain plastics and rubber.

C. Study Methodology

The agricultural enterprise composting process is based on the characterization analysis. The characterization is carried by means of weighing the organic compounds and of the other components present in the total amount of residues. The residue has to present a value over 85% of organic matter to be accepted for composting.

The presence of undesirable materials as plastics, wood and others harm the natural fermentation process to guarantee the good quality of the compost and also the quantity of organic matter and nutrients balance.

In this research work one sample was taken from each truck of each travel at each day of the week, going from the agricultural enterprise to the Landfill Garbage, on the Composting Area. [6].

Sampling process was carried by the agricultural enterprise personnel. The truck was loaded, weighed and sent to the Composting Area which was previously regularized.

After residues adequate unload the pré-homogeneization and sampling process was carried by means of a shovell machine as recommended by the norm NBR 10.007 da ABNT.

IV. Results

The agricultural enterprise develops a recycling activity which process around 750 metric tons of residues per month generated at the enterprise, including actions of selective material collection and environmental education.

Solid residues diagnosis and characterization were based on the Solid Residues Management Program issued by the Brazilian Agricultural Products Wholesale Market and carried by the cleaning company which is associated to the Secretary for Waste Removal of the Local Municipality, aiming to identify an appropriate final destination.

Residues were identified and quantified according to the place of generation and separated in two groups: residues of vegetable leftover (organic) and inert residues (wood, plastics, metals and others). Following, the residues were classified according to the NBR 10004/04 norms. Packing, collection, temporary storage, loading and final destination of the residues generated at the agricultural enterprise were described as well. Table II presents the characteristics of the solid residues generated at the agricultural enterprise.

TABLE II
Residues Generated at the Agricultural Enterprise, based on the NBR 10.004/04 Classification

Classification	Residues From agricultural enterprise
By Physical Characteristics	Dry and Wet
By Chemical Characteristics	Organic and Non Organic
By Origin	Comercial, Public and Agriculture
By Class	Class I – Dangerous agricultural defensives and fertilizers packs Class II – not Dangerous

Table III shows the volumes of waste the agricultural enterprise and placed in the landfill of the municipality, the years 2003, 2004 and 2005.

TABLE III
Annual Quantity Of Waste In Metric Tons

Month	Annual Quantity Of Waste In MetricTons		
	2003	2004	2005
January	920	760	999
February	800	785	780
March	830	836	800
April	725	770	720
May	510	610	670
June	510	560	600
July	470	558	560
August	460	520	580
September	520	575	629
October	590	600	730
November	620	700	720
December	860	910	850

In December of 2006, with the support of the Garbage Landfill Coordination – Department of Urban Garbage Removal of the Local Municipality, the first physical characterization of the agricultural enterprise Residues, which were made possible through the implementation of a Residue Management System, which results are presented on Figure 1.

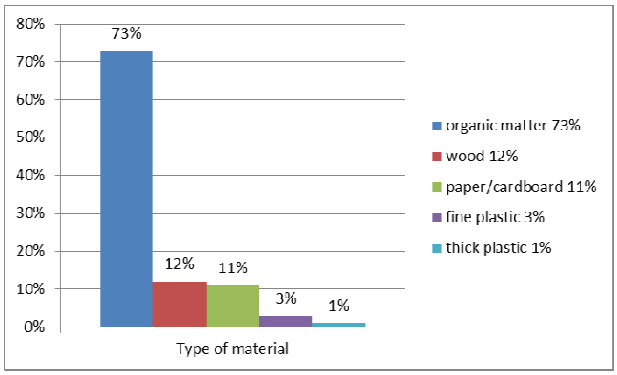

Fig. 1 Graph displaying the physical composition of residues generated at the agricultural enterprise. December of 2006

It can be observed the amount of organic matter reaches ¾ of the total residues, being higher than wood plastics and paper. The Cooperative of Recyclables was created to improve the separation of the residues, which logistics can be improved by implement new organizational structure.

In that year (2006) the Educational Environmental took place simultaneously with the Compost Program integrated with the Cooperative of Recyclables.

The second physical characterization of the residues occurred in June of 2007 coordinated by the Department of Urban Garbage Removal of the Local Municipality, which results are presented on Figure 2.

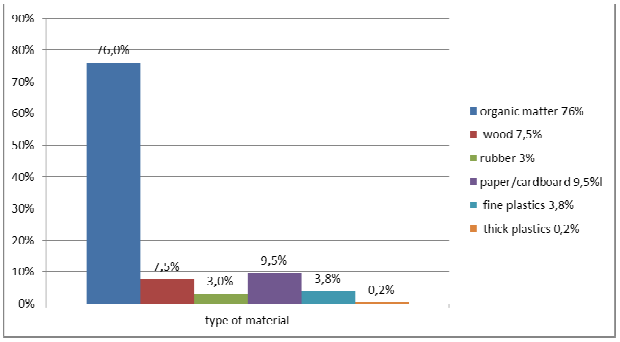

Fig. 2 Graph displaying the physical composition of residues generated at the agricultural enterprise. June of 2007

The organic matter content increased by 3% if compared with Fig. 1 data. Wood and cardboard percentage decreased by 4.5% and 2.5% respectively. Other residues are encountered at small percentages as lather and inert. A gain of 18 metric tons per month was attributed to the Cooperative of Recyclables.

The Garbage Landfill Coordination – Department of Urban Garbage Removal of the Local Municipality signed a technological agreement for organic residues composting of the agricultural enterprise in November of 2007.

The third physical residues characterization was carried by the Landfill Coordination in March of 2008. The period preceding the analysis was very fruitful considering environmental education and the Cooperative intensified the separation of wood and papers from the residues. Results are presented on Figure 3.

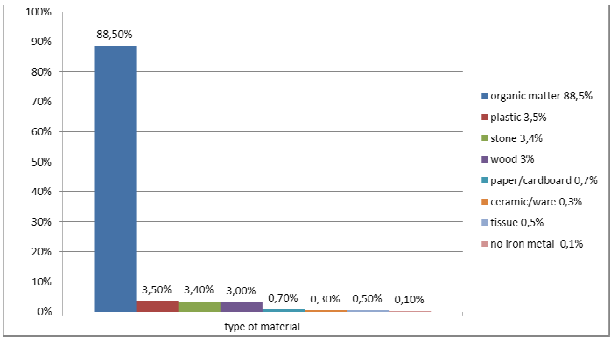

Fig. 3 Physical Composition of the agricultural enterprise Residues. Data Collected in March of 2008

The percentage of organic matter reaches the value of 88,5%, which is 12.5% higher than the previous analysis. New materials were also identified as metals, ceramics, glass, fabrics and stones, however wood percentage was reduced in 5.5% and paper in 8.8%.

It should be emphasized organic matter reached an acceptable level to start the composting phase, which was carried at Composting Area near the Garbage Landfill in March of 2008.

In the month of 2008 the agricultural enterprise Cleaning Operation was modified, altering the collecting schedule and part of the recyclable material was not collected. A high amount of the recyclable material contaminated the organic matter in the containers, which was rejected for composting by the Composting Area of the Garbage Landfill quality control.

The fourth characterization was then requested by the agricultural enterprise administration in May of 2009, which resuts are displayed on the Figure 4.

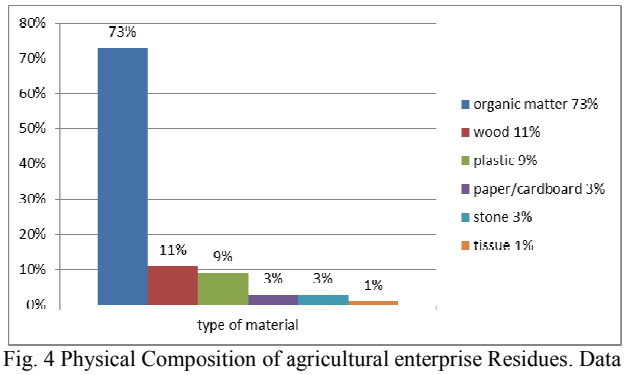

Fig. 4 Physical Composition of agricultural enterprise Residues. Data Collected in May of 2009

The analysis carried in May of 2009 confirmed the contamination referred before, noting that the percentage of organic matter was reduced in 15.5% if compared with the previous one. Wood, plastics and cardboard experienced a new increase in 8%, 5.5% and 2,3% respectively.

By given priority to the cleaning sector which was not extended to the selective collecting actions, recycling process lost efficiency. The organic matter percentage presented again a new increase, showing contamination by recyclables as the Figure 5 shows the fifth characterization carried in October of 2010.

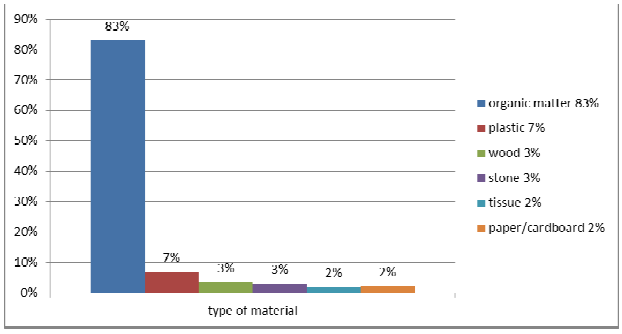

Fig. 5 Physical Composition of the Residues. Data Collected in October of 2010

The percentage of organic matter was observed to increase in 10% in respect to previous determination, reaching 83% of the total residues amount. However that figure shoul reach 85% for composting process acceptance. Wood, plastic and cardboard percentage decreased in 8%, 2% and 1%, respectively.

The Environmental Education Program of the agricultural enterprise was intensified. A new perspective for residual collection was adopted and the selective collection received incentives. Recycled wood quantity increased again, reaching the level of 90 metric tons per month. Collected organic matter quantity is higher than the previous ones showing lower recyclable material.

The sixth characterization took place in April of 2011 which results are presented on Figure 6.

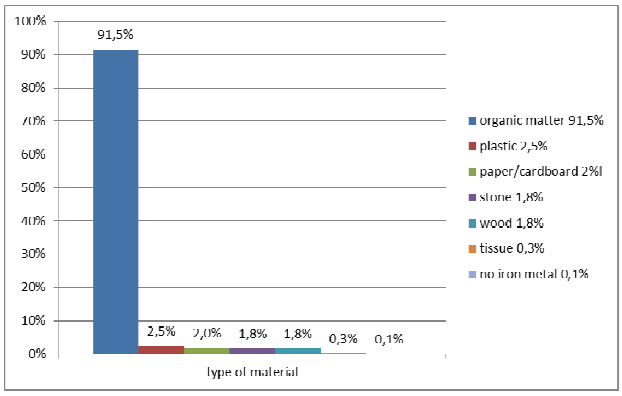

Fig. 6 Physical Composition of the agricultural enterprise Residues. Data Collected in April of 2011

Collected organic matter reached 91.5% exhibiting an increase of 9.5 % if compared with the former determination. Reduction of recyclable material, as 4.5 % for plastics, 1.2 for wood and 1.7 % for fabrics.

At each material characterization the selective collection suffers little alterations, due to agricultural production as well as to social activities oscillations. Significant variations suffer influence of the social conditions, inadequate working conditions for the Recyclable Collectors.

The seventh characterization took place on April of 2012 which results are displayed on Figure 7.

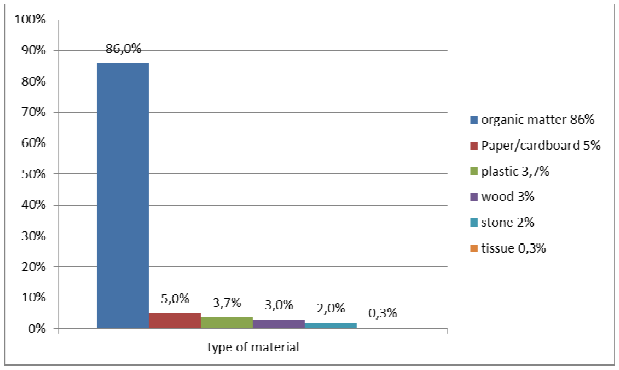

Fig. 7 Physical Composition of the agricultural enterprise Residues. Data Collected in April of 2012

The organic matter percentage is noticed to be of 86%, which is 4.5% lower if compared with the former characterization. However paper, cardboard, plastics and wood showed percentage larger than the former one in 3%, 1, 2% and 1, 2%, respectively.

V. Conclusion

Based on what it has been exposed before, the following conclusions can be drown. The implementation of the Permanent Environment Education is of high priority, which should be offered to the wholesalers, distributors, and costumers aiming the initial goal of residues reduction, a second objective of reuse and the final one identified as to forward the non-organic residues to the recycling process.

The implementation of a selective collection is suggested as well. Collecting procedure should facilitate the separation of wet residues from the dry ones. Collecting containers should be systematically placed at the platforms in order to facilitate material discarding as well as the separation at the residue generation time.

Residues produced at the agricultural enterprise shows mixed up components right at the generating source which induces elevated costs associated to the material disposal. Any alternative selected to reduce rejecting material will be not successful without the adoption of selective collection.

The Selective Collecting Program should be reviewed to allow the Collectors Community which already exists in the agricultural enterprise to take advantage of the recyclable material benefits by income generation, social inclusion, meanwhile organic residues discarded by the agricultural enterprise Food Cooperative are forwarded to the composting process.

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