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IMPACT OF FOOD WASTE ON CLIMATE CHANGE

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Abstract: *Food waste represents an issue that needs to be solved in order to achieve sustainable development and reduce its environmental impacts. Intensive utilization of resources sustained many decades of growth in wealth and wellbeing in Europe. Today, efforts are being made to get efficient use and development of resources, thus complying with the EU vision for 2050: all resources will be sustainably managed, waste will be managed as a resource and climate change milestones will be reached etc. In this work we focus on the actions of sustainable food production and consumption necessary to diminish the impacts of food waste on the environment. It is considered that food wastage arises from an inefficient use of ecosystem services but also can be considered as an important contributor to climate change. The greenhouse gas (GHG) calculations in the early stages of decision making process, for different waste management strategies, could provide us the quantification and comparison of GHG emissions for different categories of food waste and allow the understanding of the efficiency of proper waste management on GHG emissions. In this paper we have applied a specific tool to calculate GHG emissions generated by food waste considering three waste management scenarios developed for Iasi city, Romania, based on the targets established by legislation.*

Keywords: environmental impacts, food, GHG, waste.

1. Introduction

Food waste is considered one of the most sensitive issues at global level. A significant amount of food waste is produced by consumers in the higher income countries, while the population from other countries are suffering from the lack of food (sub-Saharan Africa) [1, 2]. Approximately 1.3 billion tonnes per year of food are lost or wasted globally [3-5], while 89 million tonnes of food are wasted each year in the European Union. About 222 million tonnes of food are wasted every year by the consumers from the industrialized countries [1]. According to [4], fruits and vegetables loss has the highest percentage (44%), followed by roots and tubers (20%) and cereals (19%), while the lowest percentage is registered for meat (4%), oilseeds and fish and seafood (2%) (Fig.1).

It is well known that, from initial agricultural production to final household consumption, food is wasted or lost [5]. The activities responsible for food loss in the supply chain are: farming and husbandry (agriculture), drying, sieving,

milling, grinding, mixing, cooking, moulding etc. (food processing and manufacturing), markets, grocers, bakers, supermarkets (retail), household, restaurants, cafes, institutions (consumption) [6]. The food waste quantities from manufacturing, households, retail and food services produced in EU27 are illustrated in Fig. 2.
Fig. 3 presents the food waste discarded from manufacturing, household, retail and food services in EU27 and Romania in 2010.

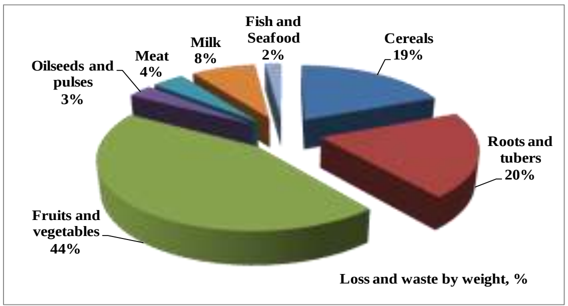

Fig. 1. Food losses for different commodities (100%=1.3 billion tonnes) [4]

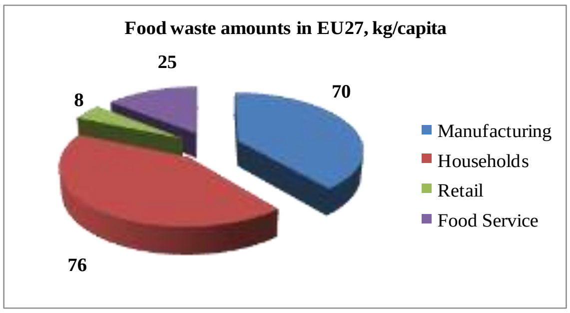

Fig. 2. Food waste quantities produced in EU27 in 2006 [7]

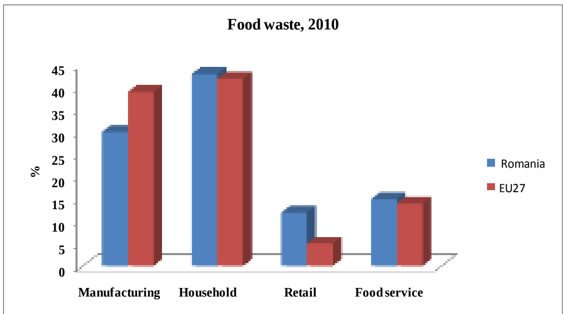

Fig. 3. Food discarded in EU and Romania (according to [8])

At the household level, the food waste generated: avoidable (slices of bread, apples), possibly avoidable (bread crusts, potato skins) and unavoidable food waste (egg shells, banana skins) [7].
According to [9] the quantities of food discarded from households differed between 5% -30%.
The negative environmental impacts, but also social and economic impacts of food waste are becoming increasingly apparent as the food waste amount is growing, while global food security is becoming more pressing [6]. Considering the food waste importance and the impacts on the environment, in this paper we have developed three scenarios considering two food waste treatments (composting and anaerobic digestion) that have been evaluated in terms of climate change.

2. Policy and regulations

According to [10] there are 52 EU legislative acts impacting on food waste including: 29 Regulations, 10 Directives, 3 Decisions and 10 Communications. The complexity of the food waste challenge is reflected by EU legislative framework. Legislation is potentially implying: food waste generation, food waste management, food waste reduction, food use optimization etc. [10].
The European Commission sets out a 50% food waste reduction target for 2020 [11]. European Parliament proposed in 2012 a 50% prevention target on avoidable food waste by 2025 [12].
At European level there is a number of directives on waste management, the first one was established in 1975 Waste Framework Directive (75/442/EEC) which aims: to harmonize national measures concerning waste, to encourage the preparation of waste management plans, to prevent generation of waste and encourage recycling. Other general guidelines have been established as well: hazardous waste

(91/686/EEC), waste transport (259/93EEC), incineration of hazardous waste (94/67/EEC), waste incineration and existing facilities (84/369/EEC and 89/429/EEC), waste disposal (99/31/EC) etc. [13].

These represent the most important directives for waste management planning at the municipal level [14]. The European legislation on waste has been adopted by the Romanian legislation, and finally the National Waste Management Strategy (NWMS) was founded to set waste management objectives. They aim at creating the framework for developing and implementing an integrated waste management and the National Waste Management Plan (NWMP) representing NWMS implementation plan [15].

To ensure sustainable development in terms of solid waste management it is necessary that society wastes to be managed in an efficient manner, environmentally effective, economically affordable, and socially acceptable [16].

3. Current situation

In 2011, the composition of household waste in Romania was as follows: paper and cardboard 9.3%, glass 3.62%, metals 2%, plastics 8.6%, organic waste (biodegradable) 57.82%, wood 1.7% and others 16.9% [17].

In Iasi, the household waste composition included paper and cardboard (7.68%), glass (4.35%), plastic (6.17%), metals (1.78%), organic waste (biodegradable, food waste) (47.15%) and others (32.87%) [18].

It can be observed that organic waste is the fraction with the highest percentage followed by paper and plastic. In Iasi a total of 120 containers were placed for the collection of organic waste or bio-waste [18]. In recent years, municipal biodegradable waste percentage dropped from 64% in 1998 to approx. 48% in 2012. According to the Regulation 1999/31/EC on the landfill of waste, transposed at national level by GD 349/2005 on waste disposal, with subsequent amendments, the targets for the reduction of dumped biodegradable waste, relative to the total amount (expressed in weight) produced in 1995, are: July 16, 2010 - to 75%; July 16, 2013 - to 50%; July 16, 2020 - to 35% [18].

The amount of biodegradable waste generated in the year 1995 in Iasi county was of 115,659 tons and, therefore, according to the corresponding targets the waste quantity dumped should be diminished by: 16 July 2010 - 28915 tons; July 16, 2013 - 57830 tons; July 16, 2020 - 75178 tons [18]. There is only one composting station in Iasi County (10000 t/year capacity) and no other facilities for the treatment of biodegradable waste, which implies that currently, biodegradable waste and similar are eliminated shared with all waste by land filling [19].

The project “Integrated waste management system in Iasi County” also plans to build a mechanical-biological treatment plant [19]. The capacity will be of 95000 t per year and the plant will consist of a mechanical treatment step and biological treatment: aerobic decomposition, maturing platform for further biodegradation [19].

4. Food waste and (GHG) greenhouse gas emissions

An amount of 180 kg per person food is wasted in the EU according to [11]. It is considered that 17% of direct greenhouse gases emissions are caused by food and drink value chains. A significant amount of food is still suitable for human consumption [11], meaning that over 60% of food waste is avoidable [20]. It is estimated that, over the whole life cycle of food wasted, almost 1.9 t CO_2 eq./t are emitted in Europe [20].

Three scenarios for waste management were developed considering the targets imposed by the legislation mentioned above: in the first scenario (S1), it was considered a recycling rate of food waste of 25%; in S2 the recycling rate was of 50% and in the last scenario (S3) the recycling rate of food waste was set to 65%. An annual waste quantity of 694 kg solid waste/cap/yr with 40% food waste was considered.

To calculate GHG emissions of scenarios we used SWM-GHG Calculator, a tool developed by IFEU Institute Germany [21]. This tool calculates the total GHG emissions in CO_2 equivalents. The calculation method follows the Life Cycle Assessment (LCA) method, but it is not a LCA study fully fledged [21].

GHG emissions for the recycled waste fractions are calculated based on the mass of waste recycled and a GHG emission factor.

The average electricity demand for composting is calculated as 30 kWh/t organic wastes and for diesel demand - 1.5 L/t organic waste [21]. The country specific electricity mix was chosen. CO_2 emissions from electricity generation was of 337 g/CO_2 eq./kWh, which only refers to direct CO_2 emissions from fuel combustion [21].

The results are illustrated in Figs. 4-5. The GHG emissions caused by food waste composting are indicated by the first bar from the figure (emissions – debits), the emission savings are represented by the second bar (avoided emissions or credits, negative values) and the net results signify the difference between debits and credits. It can be observed that emission savings increase with the waste recycling rate. The results obtained provide additional information for the decision making process.

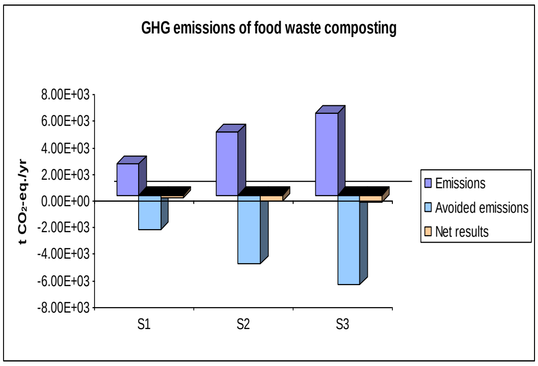

Fig. 4. GHG emissions from food waste composting

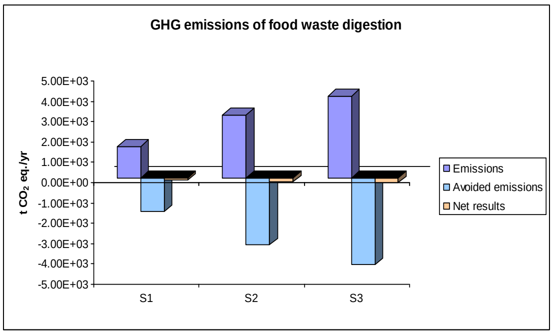

Fig. 5. GHG emissions from food waste digestion

5. Conclusions

In this paper, three scenarios were developed considering different food waste recycling rates and evaluated with SWM-GHG Calculator from climate change perspective. The results obtained with the SWM-GHG Calculator provide an accurate quantitative approximation of the GHG impacts of different strategies. The results show that waste recycling rate has a significant influence on emission savings. Also the values of emissions from composting are higher than those from anaerobic digestion. In further studies the LCA methodology will be applied to evaluate food waste not only in terms of climate change but also considering other impacts categories such as: acidification, eutrophication, abiotic depletion, photochemical ozone formation etc. The LCA provides detailed information about food impact on climate change and not only. Also, the whole food waste cycle will be taken into consideration and the results will be compared. Different scenarios will be developed considering other treatment methods such as mechanical-biological treatment, aerobic/anaerobic biological treatment for waste valorization as raw materials etc.

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