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THE TRIPLE BOTTOM LOOP

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Abstract: **This paper will establish a relationship between Sustainable Chemistry and the Triple Bottom Loop concept. This concept presents that the sustainability factors; Environment(Planet), Economic(Profit) and Equity(People) should operate in a symbiotic relationship with feedback effects. The paper recommends that organisations should see sustainability as a continuous process and not like a start to finish project. Examples of how Sustainable Chemistry has delivered a Triple Bottom Loop was included using the process of brewing beer. This process generates a waste called Brewery Spent Grain (BSG). This waste has been tested to be nutritious and of valuable characteristics and thus it is not disposed but rather put into several uses of economic and environmental benefits like animal feed, ingredient for bread and biscuit, brick and paper manufacture.**
Furthermore, the sustainability factors should be integrated as in a Venn diagram and not as being of unequal contribution or importance as portrayed by nested dependencies This way, organisations, societies and individuals can achieve a 360 degree effectiveness.

Keywords: **Sustainability, Sustainable Development, Sustainable Chemistry, Triple Bottom Loop, Brewery Spent Grain.**

1. INTRODUCTION

Brewery Spent Grain (BSG) is a waste obtained from the production of Beer and it is insightful that what is considered waste in the production process of beer can be considered as a raw material to generate other products.

This brewery waste is utilized in Bread Baking and considered suitable for consumption in humans and animals owing from a 21 days experiment on white mice (Ajao, 2006).

Hence a critical review of sustainability principles and consequently the Triple Bottom Loop model. This is a modification from the Triple Bottom Line concept and it emphasis the fact that pursuing sustainability is a continuous process not an end state.

This paper will relate Sustainable Chemistry to the Triple Bottom Loop and how it contributes to the overall effectiveness of organisations, individuals, and the society at large.

Sustainability is preserving the present without jeopardizing the future; this principle of sustainable development is employed in organizational business processes and the society. This might imply the development of new energy resources that are economically competitive and environmentally friendly for it to deliver sustainability value (Okonkwo et al., 2010).

''Sustainable development intends to insure primarily the viability of our world in the long run and create a harmonious balance between economic development, the preservation of ecosystem and the improvement of our quality of life. Natural resources are to be distributed and used in a socially equitable fashion. Sustainability development meets the needs of the present without compromising the ability of future generations to meet their needs'' (BACAS, 2004).

The sustainability principle cuts across every sphere of life and it appears the application of this principle is all we need to achieve all round effectiveness; individually, organisationally and the general society.

2. WHAT IS SUSTAINABLE CHEMISTRY

According to the Organisation for Economic Cooperation and Development (OECD), *''Sustainable chemistry seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally*

benign chemical products and processes. Sustainable chemistry stimulates innovation across all sectors to design and discover new chemicals, production processes and product stewardship practices that will provide increased performance and increased value while meeting the goals of protecting and enhancing human health and the environment'' (OEDC.org, 2015).

In the same vein, ''Sustainable Chemistry is chemistry that is environmentally friendly, minimises waste generation and energy use, and preferentially uses renewable raw materials such as agricultural products instead of fossil resources such as crude oil or natural gas (BACAS, 2004).

Essentially sustainable chemistry is about getting high returns or getting more done with little resources. It entails reducing the environmental impact of processes and products, optimizing the use of finite resources and minimizing waste (SusChem.org). Consequently supporting the idea of pollution prevention as it is better to avoid waste than treating it after it is formed (Trends in green chemistry, 2016).

3. THE TRIPLE BOTTOM LOOP PRINCIPLE

The Triple Bottom Loop is derived from the triple bottom line principle which creates Environmental, Equity and Economic benefits on which sustainable chemistry equally operates by providing great motivation for the development of sustainable products and processes (Trends in Green Chemistry, 2016).

However, the three values that are created from employing sustainability principles should not be on a line but on a loop with interdependencies and feedback effects. Implying that an organisation will continue to pursue sustainability as long as it exists. Sustainability is not reached until the process goes through all the three dimensions with equal attention and commitment and an assured system of continuity.

In manufacturing for instance, the finished product or waste from one industry will be a raw material for another there by making use of the scarce resources for economic improvement. In other words ''*improving material and energy efficiency'' (OECD, 2002).* Thereby reducing the time and cost for production of raw materials since a waste from one production process can form a raw material for another.

In other words, according to (OECD, 2002) Sustainable Chemistry:

- *''Decreases or eliminates the costs of hazardous waste treatment and potential industrial liability*
- *Provides technologies that are economically competitive for and advantageous to industry*

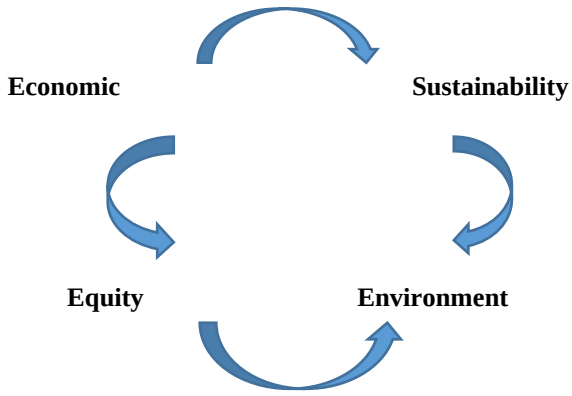

Fig 1. The Triple Bottom Loop Model

3.1 BENEFITS OF THE TRIPLE BOTTOM LOOP MODEL

- Minimises waste/threats and improves efficiency
- Increases the likelihood of achieving organisational goals and objectives
- Generates lessons learned from the feedback loop
- Aids sustainable growth
- Improves stakeholder's perception
- Improves employer brand and consequently attracts great talents, resources and collaborations
- Creates opportunities and optimises the organisation's capability to explore same

4. EXAMPLES OF SUSTAINABLE PROCESSES IN CHEMISTRY

Chemists have employed these principles and have created notable developments.

Okonkwo et al., 2010:62, mentioned a few of these developments that have emerged from sustainable chemistry consequently creating the ''Triple Bottom Loop'':

- *''A continuous process and apparatus converts waste biomass into industrial chemicals, fuels and animal feed. Another process converts waste biomass such as municipal waste, sewage sludge, plastic, tires and agricultural residues, to useful products, including hydrogen, ethanol and acetic acid.*
- *A cost effective method of producing ethyl lactate, a non-toxic solvent derived from corn.*
- *Feedstock recycling of plastic wastes into valuable chemicals useful as fuels or raw materials.*
- *A fermentation method for the production of carboxylic acids.*
- *The demand for non-ionic surfactants is growing. A new example of this is alkyl glycoside, which is made from saccharide. This product can be used as a replacement for alkylaryl sulphate anionic surfactants in shampoos. Sodium silicate can be used as a more environmentally benign replacement for phosphorus containing additives in washing powder. Three coconut oil soap bases for liquid cleansing applications have been developed. One of this products has a very light colour and low odour making it suitable for introducing dyes and fragrances.''*

5. DECONSTRUCTING DIFFERENT MODELS OF SUSTAINABILITY

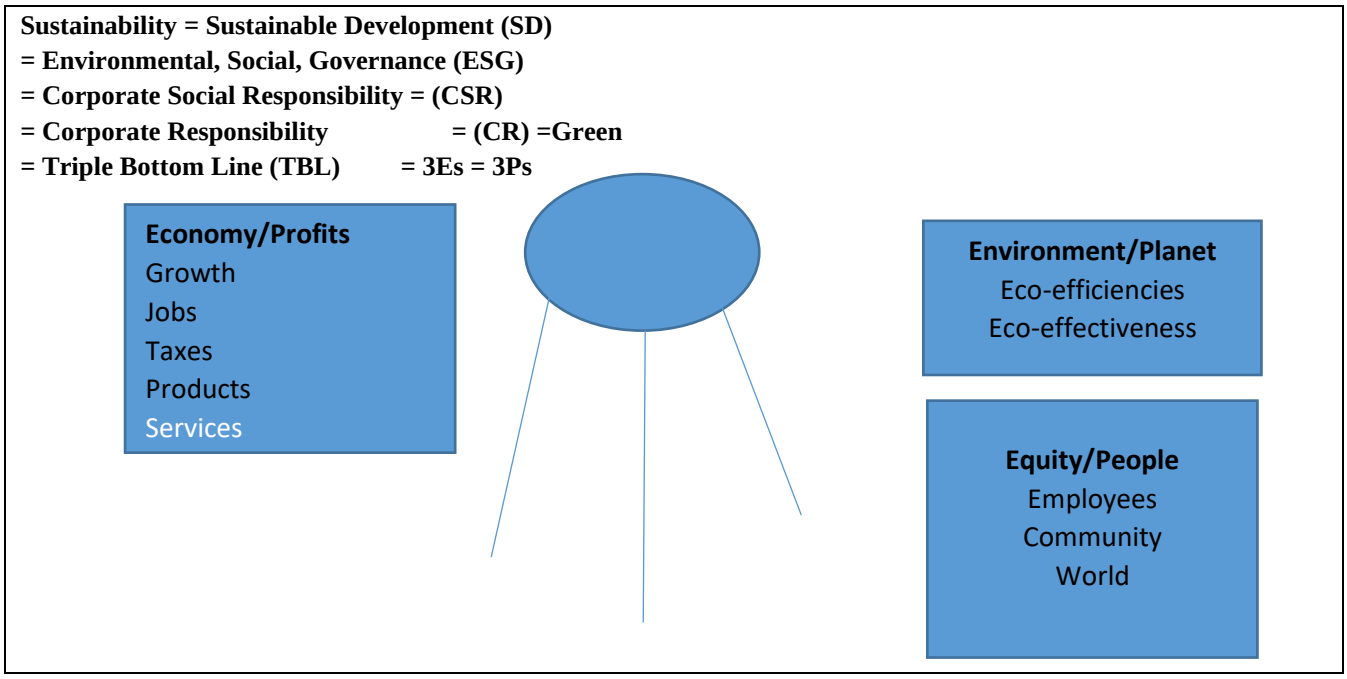

Fig. 2 Corporate Sustainability Three Legged Stool Bob (2012:11)

(Bob, 2012) described sustainability with a 3 legged stool this is illustrated in Fig. 2 consisting of 3Ps; the Profit leg describes the financial performance and wellbeing of an organisation, the Planet leg emphasises the reduction and treatment of waste produced through the use of resources such as energy, water, raw materials and so on in business processes such as manufacturing etc. while the People leg focuses on how organisations perceive and relate with their employees, vendors and the society in terms of good working environment, business ethics and Corporate Social Responsibility (CSR). From the three legged stool representation Bob, 2012 projects that an organisation or a society is unstable if one leg of the stool is weak or damaged.

More explicitly, (Bob, 2012) equated the 3Ps to 3Es viz; Economy, Environment and Equity. These 3Es are associated to the Triple Bottom Loop.

Conversely, the sustainability model is also described by a Venn diagram;

Fig 3. Triple bottom line *Southmountain.com*

The Venn diagram shows that People (Equity), Profit (Economy) and the Planet (Environment) must integrate to provide sustainability one aspect should not be projected more than the other. These three dimensions (3Es) need to be integrated and not represented as if they exist independently (Allen and Ervin 2007).

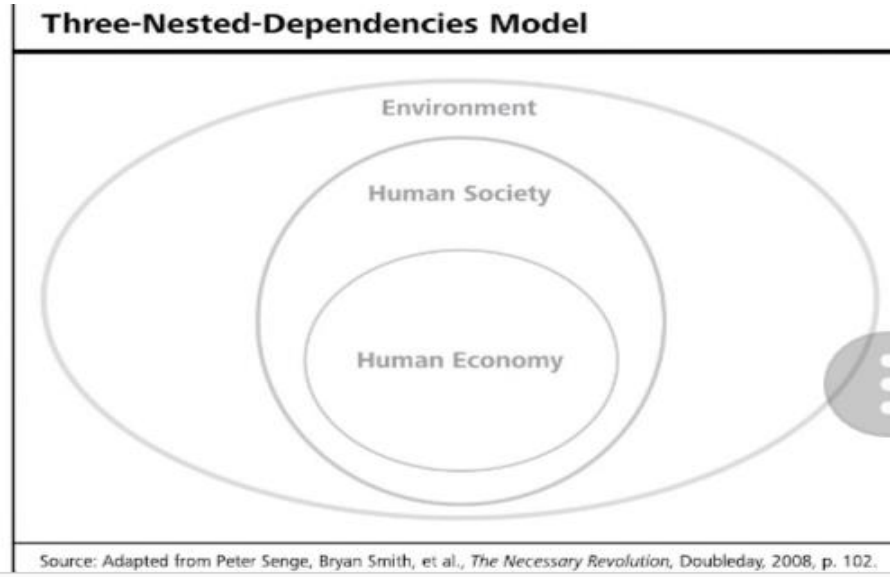

Fig. 4. Nested Dependencies model of sustainability

According to Bob (2012), the nested dependencies model project the Triple Bottom Line concept in a way that economic considerations should be traded off or balanced against environmental and social impact; this is not an accurate perspective, the economic and equity (social) relationship should be synergetic and the existence of both is nested in the environment. If the environment and its resources are not maintained or managed and improved, economic and social (Equity) stability will be a mirage.

In other words, the Triple Bottom Loop, can only be achieved by embracing the principle of commonality and shared behaviour.

6. GENERATION OF BREWER'S SPENT GRAIN - THE TRIPLE BOTTOM LOOP

Brewer's Spent Grain (BSG) which is a major waste/by-product in beer production from the Brewing industry can be captured and re-used in a number of ways thereby creating Environmental, Social and Economic benefits – the ''Triple Bottom loop''.

Barley is used as a raw material in beer production (Kendal, 1994).

Find below a schematic representation of the process to obtain BSG from natural barley (Mussatto and Roberto, 2004)

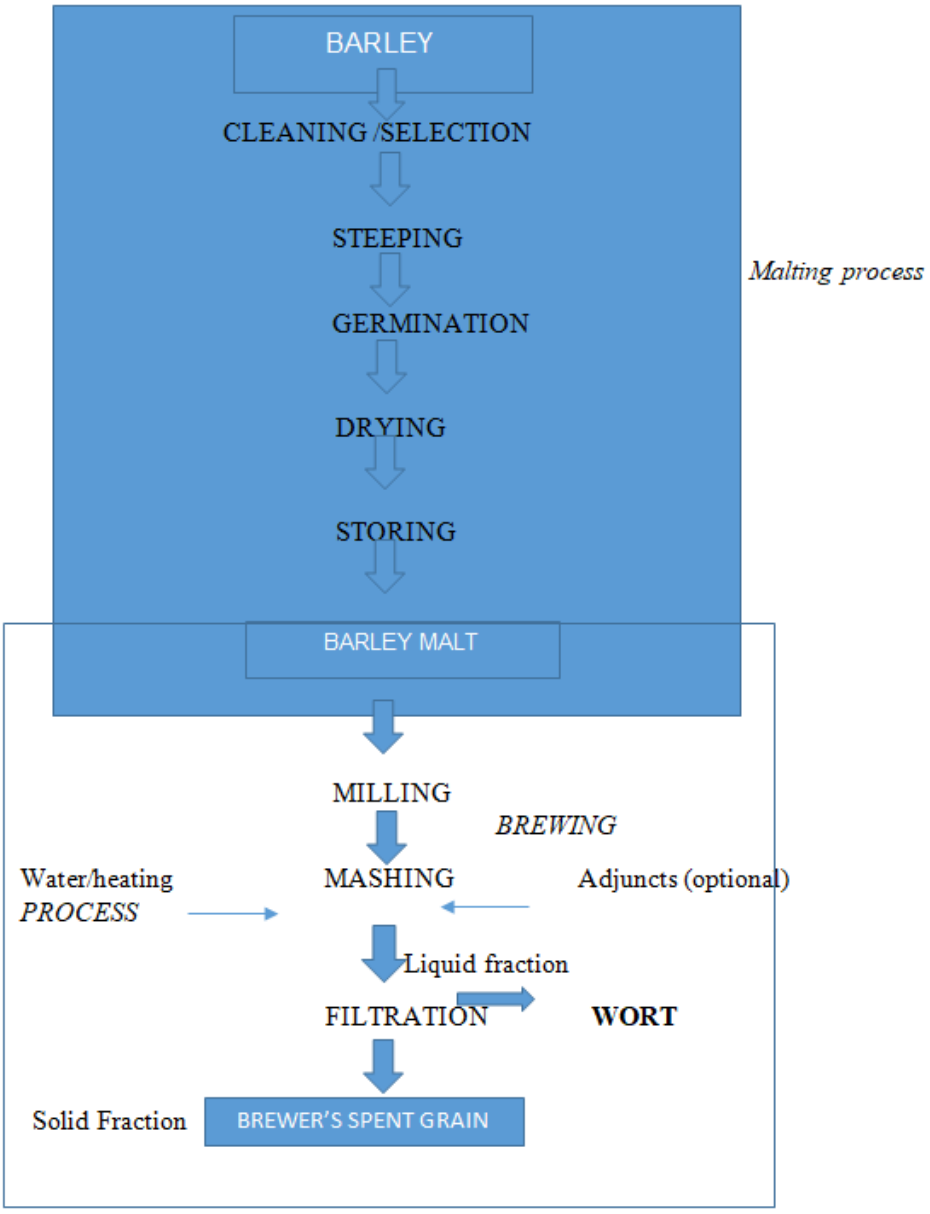

Fig 5. Solid Fraction

7. CHEMICAL COMPOSITION OF BREWER'S SPENT GRAIN

Brewery Spent Grain is useful in numerous ways and its suitability is as a result of its chemical composition and physiological properties. Table 1 below shows the chemical composition of BSG as determined by Kanuachi et al. (2001) and Mussato & Roberto (2005).

Table 1. Chemical composition of Brewer's Spent Grain (BSG)

Component (% dry wt)	**BSG** Kanuachi et al. (2001)	**BSG** Mussato & Roberto (2005)
Cellulose	25.4	16.8
Arabinoxylan	21.8	28.4
Lignin	11.9	27.8
Protein	24.0	15.2
Lipid	10.6	Not determined
Ash	2.4	4.6

8. UTILIZATION OF BREWER'S SPENT GRAIN (BSG)

8.1 As Food Ingredient

8.11 Animal Nutrition

BSG is used as animal feed and can be combined with nitrogen sources like urea to provide essential amino acids; it is said to increase milk production in dairy animals without impairing fertility (Belibasakis and Tsirgogianni 1996; Reinold, 1997; Sawadogo et al., 1989). Pigs, poultry and fish also benefit from the high protein and fibre content and animals with BSG supplements have better growth performance, owing to the essential amino acids and protein content (Mussatto and Roberto, 2004).

8.12 Human Nutrition

Since BSG has a high nutritive value and can be obtained cheaply, it is has been assessed for the production of whole wheat Bread, Biscuits and snacks; although it needs to be converted to flour because it is too granular (Hassona 1993; Miranda et al., 1994). When added to mice diet it relieved constipation and diarrhoea, this was attributed to glutamine rich-protein and non-cellulosic polysaccharides (Arabinoxylan) contained in the brewing waste (Mussatto and Roberto, 2004).

8.2 As a brick Component

BSG can be used in brick making in place of sawdust and it improves their dry characteristics without compromising colour or quality (Mussatto and Roberto, 2004).

They are considered suitable for use as building material due to their high fibrous content (non-cellulosic polysaccharides and lignin) (Russ et al., 2005).

8.3 Paper Manufacture

BSG has been explored and considered good for paper manufacture (Ishiwaki et al., 2000). Examples are paper towels and business cards products which were said to be of finer texture when compared with others produced without BSG (Mussatto and Roberto, 2004).

9. CONCLUSION

The benefits of sustainability principles cannot be over emphasized and this article has established the fact that all the three dimensions of sustainability; making profits, preserving our environment and human capital management are interwoven and one sustainability factor is not complete without the other. To achieve a Triple Bottom Loop, sustainability principles should be integrated into the organisation's business process in a cyclical process with feedback loops. This will enhance the benefits of sustainability principles and deliver immense value and sustainable growth to the organisation.

Industrialists are encouraged to incorporate the principles of achieving a ''Triple Bottom Loop'' in their production process cycle, from raw material sourcing to by product disposal. This principle should be absorbed into all business processes in order to derive the associated benefits.

As an organisation makes profit, or increases her economic value by creating jobs, paying taxes, providing goods and services; they must simultaneously ensure environmental balance through Eco-Efficiencies, Eco-Effectiveness and at the same time giving priority to the people viz: employees, vendors, supplies, the community, etc.

More importantly, the triple bottom loop principle brings balance and stability to an organisation or society, one sustainability factor does not exist without the other. Thus emphasising commonality and shared behaviour in a continuous process.

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