© IJCIRAS | ISSN (O) - 2581-5334
August 2018 | Vol. 1 Issue. 3

LIFE CYCLE ANALYSIS OF FOOD PRODUCTS

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Abstract

Life cycle analysis is a technique utilized for assessment of impact of processes, products or an activity regarding their environmental load/burden during its life cycle. Now-a-day, LCA users are not specific to a single field, instead are multi-dimensional/multi-disciplined, who want to do an evaluation of their processes, products in terms of life cycle context. This study presents the studies of LCA on industrial and agricultural food products, modern day advancements in LCA and applicability on food products. Literature survey indicates that the in the LCA of food products, the hotspot is the agricultural production, and LCA can help in identification of more sustainable opportunities. As a result of recent modifications/developments in LCA, LCA usage is increasing in agricultural and industrial food products. Literature survey also suggests that LCA alone is not providing satisfactory results, coupling with other techniques/tools result in providing more comprehensive and steadfast information to ecologically cognizant strategy creators, producers and customers/consumers in selection of sustainable manufacture methods and products.

Keyword: Life cycle analysis, Environmental load, steadfast information, Ecology, Sustainable manufacture.

1.INTRODUCTION

Among world`s largest industrial sectors, the food industry is a bigger name there. This also reflects that this industry is a larger energy consumer. Greenhouse gases emissions have increased due to increased usage of energy has resulted in increased global warming, possibly the severe problem, human being facing these days. Processes of production of food, its preservations, and distribution require high amount of energy, eventually resulting in total CO2 emissions. In the settled countries, the demand of consumers is to provide them with food of high quality, produced from a process, having less environmental burden 1. Awareness is increasing that while the selection of food products in future, the consumer will be more conscious about environment 2. Thus, it is necessary to assess environmental impact and resources utilization in the production of food and its distribution for sustainable development. LCA is a powerful technique for evaluation of environmental load by processes, products or activity throughout its lifetime, also termed as Cradle to Grave Analysis.

Evolution of life cycle assessment took place in 1960`s and several efforts have been done for the development of its methodology since 1970`s, got special attention in the field of environmental sciences in 1990`s. Regarding this concept, many terms are quoted i.e., eco-balancing (Australia, Japan, Germany), resource and the environmental profile analysis of (USA), environmental profiling &the cradle to grave analysis. The Society of Environmental Toxicology and Chemistry (SETAC) plays its role in the enhancement of responsiveness and considerate of LCA concept. In North of America, SETAC and the US Environmental Protection Agency (USEPA) funded workshop along with numerous projects for development and promotion of an agreement upon an agenda regarding conduction of LCA and impact assessment. Other international organizations also played their role in enhancing awareness of LCA.

Due to these exertions, consent obtained regarding the inclusive agenda on LCA and a definite method for inventory 3. For industrialists, specialists and individuals, LCA method is proving as a powerful tool. 4. Purpose of using LCA can be described as follows:

1. Alternative processes, products comparison
2. Products/services comparison in terms of life cycle.
3. Documentation of the life cycle parts posing significant improvement possibilities.

2.METHODOLOGY

Life cycle assessment methodology is described as follows:

2.1. Goals and scope definition

2.2. Analysis of life cycle inventory

2.3. Assessment of impact

2.4. Actions& interpretation

2.1. Goals and Scope Definition

Goals and scope definition step is most crucial and important step in the LCA as study is done in accordance with the reports, developed in the stage. Goals defines aim of study, intended applications, targeted audience, unit of function while scoping defines boundaries, assumptions and limitations of the study 5. Boundary of the system is depicted by the flow diagram comprising of all the inputs and outputs. Operations contributing to the activities, processes & products fall within the boundaries of the system. Functional unit purpose is to provide with the reference unit for normalization of the inventory data.

Category of environmental influence and investigation targets are the variables on which functional unit depends. Often, basis for functional unit is on the under-studied quantity. In most cases, product nutritious and fiscal values and area of land underutilization are also being considered for FU.

2.2. Life Cycle Inventory Analysis

As compared to other stages of LCA, this stage is the lengthiest, highly work demanding as it involves collection of data. This stage can be optimized with respect to time, if efficient databases are present, and if dealers and clients are enthusiastic to help. Several databases related to LCA exist and can be brought together by means of LCA software. LCA databases can be equipped with the following data`s:

- Withdrawal of raw materials
- Materials dispensation
- Commonly used products i.e., plastic, cardboards etc.
- Disposal
- Transport

Databases can be helpful in providing data for such processes that are not specific to the product i.e., a generic data on electricity generation, coal production etc. For data related/specific to a product, a particular site-specific data is vital. This data should comprise of entire inputs and outputs of a particular process under observation. Inputs generally comprise of the following:

- Raw materials
- Water
- Energy (Non-renewable and renewable)

Outputs generally comprise of the followings:

- Products and co-products
- Emissions to air (CO_2, CO, SO_x, NO_x)
- Solid waste generation (Municipal waste generation [MSW])
- Water and soil (BOD, COD, TSS)

2.3. Impact Assessment

This stage aims to comprehend and assess impact on environment on the basis of inventory analysis as basis, keeping in view the defined goals and scope for the study. In this stage, results obtained from inventory analysis are allocated to various impact groups on the basis of various types of impacts that could be done on environment. In the LCA, following elements are part of the assessment of impact:

- Classification
- Valuation
- Normalization
- Characterization

Regarding classification step, it deals with assigning and initial accumulation of the life cycle inventory analysis data into joint impact categories. Characterization deals with analysis of the extent of probable influences of separately inventory flows in respective influence on environment. Example includes modeling of the probable impact of CO_2 and CH_4 on global warming. Characterization step helps in providing a way for comparing the results of inventory analysis within each group. Normalization step articulates probable impacts in the ways that could be compared. Example includes CO2 and CH4 global warming impact comparison. Valuation is the analysis of the comparative importance of the burden on environment identified in impact assessment previous stages. This stage can also be termed as weighing. Impact groups include following:

- Local Effects (Working conditions, nuisance, Effect of solid and hazardous wastes etc.)
- Global Effects (Ozone Depletion, Global Warming etc.)
- Regional Effects (Photo-oxidant formation, eutrophication, acidification etc.)

2.4 Interpretation and Actions

LCA purpose is to make conclusions that can be helpful in supporting a decision or can be helpful in provision of an LCA`s actively comprehensible results. For life cycle inventory assessment, inventory and impact analysis are done simultaneously, or in case of life cycle inventory analysis, only inventory analysis is considered. Substantial issues related to environment are recognized for conclusions and recommendations in accordance with goals and scope defined. This is a methodical tool for identification, quantification, checking and assessment of the info collected from the results of the assessment of inventory of life cycle. Communication of these results is also an important step. This stage can incorporate quantitative and qualitative measurements for improvement; examples include product modification, designing of new processes and activities, usage of raw materials, industrial dispensation, customer usage and waste managing.

LCA analysis

Increasing disquiet about sustainable manufacture of food and consumption provoked various activities of research regarding food`s manufacture and its distribution system incorporating agricultural production. Also, food products trade continues to rise internationally. LCA methodology is increasing attention for products, processes and activities. Several LCA studies have been carried out agricultural products, industrial manufacturing processes and finished food products quality, incorporating bio-diesel and bio-ethanol.

LCA for industrial food products

Several researchers have carried out research on most important industrial food product i.e., Bread. The studies incorporate traditional and organic production methods of crop to milling strategies, processes of bread manufacturing, packing and washing means. A situation joining biological manufacturing of wheat, industrialized refining techniques and workshop for bread production is described as the most beneficial way of bread manufacturing. A stronger difference between industrialized and domestic product restraints than between traditional and organic ways.

In comparison of organic and traditional methods, former method required more area of land. Analysis of the results was done on the bread`s mass basis (kg). Primary manufacturing and transportation phases were observed as highly important for maximum impact groups. The stage for processing i.e., baking, is important for photo-oxidant generation and use of energy 5, 6.

For beer manufacturing process, highest emission reported in case of production of wort, followed by purification, packing, fermentation and storing. It has been observed that production of bottles, followed by packing and production of beer, is the subsystem causing maximum emissions.

LCA for Agricultural products

Among world, rice is one of the biggest products. Life cycle analysis suggest following phases:

- Rice production
- Rice post harvesting

For assessment of greenhouse gases emissions, paddy production was studied by Breiiling et al. in Japan. Study suggests that emissions are dependent on the following parameters:

- Dimension of farms
- Site of farms
- Rice selection [7]

Life cycle of locally manufactured parboiled rice production at small scale was done by Roy et al. Results suggested that process variation causes variations in impact on environment for production of parboiled rice, but when study was compared for parboiled rice production as compared to non-parboiled rice production, the former production possess maximum environmental burden.

Life cycle assessment was also done on meals inventory and was reported. Meals under study include rice, paddy, soybean, cooked rice, meat etc. Assessment revealed that in case of protein rich products, maximum CO_2 emissions take place followed by carbohydrate rich products[8].

3.RESULTS AND DISCUSSION

Important feature of LCA related to agriculture is making use of functional unit. Normally used functional units include finishing product mass (in kg), food product`s energy matters (in kJ), area (in ha) and livestock unit. Total revenue and meals are also made part of it.

Despite agricultural industry is making maximum use of LCA techniques, still some inefficiencies exist in these studies. As compared to organic agriculture, the traditional agriculture makes more utilization of fertilizers and pesticides. However, organic agriculture requires more area of land than traditional agriculture.

For the case of genetically manufacturing agriculture, emissions reduction takes place in comparison to conventional agriculture. Thus, multiple functional unit can help in improved interpretation and understanding the impact on environment, efficiency and farm house revenue. Recent advancements show rapid increase in production of bio-ethanol.

Adjustment of market to this improved plea has widen beyond the raw materials supply to this area along with livestock industries. This results in varying prices of food, farmhouse revenue and administration expenditures.

Modifications in farming area are already ongoing since interest is developing in sources of renewable energy for reduction in impact on environment i.e., pollution and reduction on imported oil dependency, thus causing decrease in prices and more production.

CONCLUSIONS

LCA methodologies have been proved to be useful for evaluation of impacts on environment and product`s food safety or a manufacturing scheme. Study suggests the reduction in product`s environmental burden can be done by choosing an alternate path for production, handling, distribution and patterns of consumption, thus improving food safety, security and can be helpful in improvement of worldwide trade. In the food manufacturing structure, if multiple outputs are present, the system becomes complex, so detailed research is required to apply LCA methodology, it`s fundamental processes and prediction of disparities in emissions. Although significant improvements have been made in LCA methodologies, more universal standardization is required i.e., single guide development, would allow direct assessment of various case studies and widen real applications.

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