Presentation date: September, 2021
Date of acceptance: October, 2021
Publication date: November, 2021

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AN OVERVIEW

OF THE CONCEPTS OF CLEANER PRODUCTION IN THE AGROINDUSTRY

UNA VISIÓN GENERAL DE LOS CONCEPTOS DE PRODUCCIÓN MÁS LIMPIA EN LA AGROINDUSTRIA

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Suggested citation (APA, 7th edition)

Pacheco Martín, D., López Bastida, E. J., Schultz, R. K., & Gil Unday, Z. (2021). An overview of the concepts of cleaner production in the agroindustry. *Revista Universidad y Sociedad*, 13(6), 176-182.

ABSTRACT

Cleaner productions are still in force today as preventive strategies of origin in terms of the impacts produced by economic and productive activities carried out by man that involve agroindustrial processes and procedures. Therefore, the objective of this article is to make a brief review of the theoretical foundations that lead to the concept of cleaner production (CP) for its application in agroindustry. For this review, concepts, and positions of authors from different regions of the world, both developed and underdeveloped, were analyzed. After the short review, it was concluded that cleaner production is the continuous application of an integrated, preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to people and the environment.

Keywords: Cleaner production, environment, pollution, sustainable development, agroindustry.

RESUMEN

Las producciones más limpias continúan hoy vigentes como estrategias preventivas de origen en cuanto los impactos que producen las actividades económicas y productivas realizadas por el hombre que involucran procesos y procedimientos agroindustriales. Por lo que el objetivo de este artículo es realizar una pequeña revisión de los fundamentos teóricos que llevan al concepto de producciones más limpias (P+L) para su aplicación en la agroindustria. Para esta revisión se analizaron conceptos y posiciones de autores de diferentes regiones del mundo, tanto desarrolladas como subdesarrolladas. Luego de la pequeña revisión se llegó a la conclusión de que determinó que la producción más limpia es la aplicación continua de una estrategia ambiental preventiva integrada aplicada a los procesos, productos y servicios para aumentar la eficiencia general y reducir los riesgos para las personas y el medio ambiente.

Palabras clave: Producciones más limpias, medio ambiente, contaminación, desarrollo sostenible, agroindustria.

INTRODUCTION

Thirty-four years ago, the main environmental problems identified in the 1987 Brundtland Report, Our Common Future, were the result of poverty in one part of the world and unsustainable consumption and production in the other, a situation that has not changed. At that time and still in force, the aim was to improve the quality of the environment, safeguard biodiversity and protect human and ecosystem health.

In this sense, a movement began to define environmental management systems and tools that would guarantee the introduction of Sustainability Development (SD) in the different socioeconomic and political sectors. One of the challenges is that SD is an objective for a wide range of target groups (population, consumers, and companies, among others) (Hens, et al., 2018), Then, there was an urgent need to find a way to adapt this to each sector. Thus, in 1990 the definition of cleaner production (CP) arises as "***the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment"*** (UNE,1998) and is aimed at companies, industry (processes, products) and services.

By 1992 during the Rio Conference (United Nations, 1992) ***concept of CP was presented and developed and its objective was to reduce the environmental impact of industry. It was based, among other things, on the ideas of the*** aligned management of the 3P concept (pollution prevention pays): 1) Condition of Payment; 2) Means of Payment; and 3) Term of Payment, for the case of the SD.

Agreeing with Almeida, et al. (2015), during the last years, the vision of CP has changed considerably, in terms of scope, content and range of sectors applying this approach. In addition, the objectives have changed: from the reduction of pollution and waste generation, mainly during production, to the design of products with lower environmental impacts, as well as a more responsible consumption passing through different sectors that have developed their own CP approaches.

Agroindustry has also incorporated them, and today we talk about sustainable agriculture, ecological health care, fertilizers and pest control, food quality, waste reduction and reuse.

The objective of this research is to review the theoretical basics that lead to the concept of CP for its application in agroindustry.

MATERIALS AND METHODS

For this mini review of CP concepts, concepts and positions of authors from different regions of the world, both developed and underdeveloped, were analyzed, referring to the concepts and objectives in order to determine their vitality, as well as their concreteness for America and in particular for Cuba. Therefore, it considered bibliography from the origins of the concept up to the present time according to availability and access to information.

RESULTS AND DISCUSSION

CP is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency and reduce risks to people and the environment (United Nations Environment Programme, 1998).

This original definition of CP has been adapted/modified/expanded and standardized in different ways; Table 1 provides a summary of the most frequent definitions, as well as the systematization of its essential ideas according to Hens, et al. (2017, 2018) modified.

Table 1. Definitions of CP. Concepts and analysis.

Systematization of essential CP ideas (Hens, et al.,2017, 2018) in agreement with modified.	CP concepts and analysis
It is a strategy, not a technical formula, and it is more than an isolated audit. It extends from the social responsibility of the one who produces a service or a product to the one who consumes it. coinciding with Glavic & Lukman (2007); and European Commissions (2017).	CP is the conceptual and procedural approach to production that requires all phases of the life cycle of a product or process to be addressed with the objective of preventing or minimizing short- and long-term risks to humans and the environment. A total societal commitment is required to implement this integrated approach and achieve the goal of a sustainable society (European Commissions, 2017). According with Hens, et al., (2018), this CP concepts it explicitly states that all phases of life cycle analysis must be addressed. The social responsibility between companies, institutions, and society is addressed: it does not clearly state that CP is also about increasing resource efficiency, but only mentions the reduction of risks to people and the environment; the objectives are formulated much more broadly to cover all three pillars of sustainability: economic, social (including health and safety) and environmental. CP is a systematically organized approach to production activities that has positive effects on the environment. These activities encompass minimizing resource use, improving eco-efficiency and source reduction, in order to improve environmental protection and reduce risks to living organisms. It can be applied to processes used in any industrial sector and to the products themselves (cleaner products) (Glavic & Lukman, 2007).
It is preventive, it is a constant opportunity to minimize waste and emissions at source (Almeida, et al., 2015)	CP is the continuous application of an integrated and preventive strategy applied to processes, products, and services in pursuit of economic, social, health, safety and environmental benefits (Almeida, et al., 2015). For his part Hens, et al. (2018), is of the opinion that in this concept the objectives cover the three pillars of sustainability: economic, social (including health and safety) and environmental. Economic benefits are introduced.
It contains environmental, economic, and social improvements (Almeida, et al., 2015)	CP is a preventive, company-specific environmental protection initiative. It aims to minimize waste and emissions and maximize product performance (Almeida, et al., 2015). Hens, et al. (2017), considers that this concepts it limits CP formally to the processes of any industrial sector and to products.
There is always potential for improvement, there is always room for improvement. Technologies should always be cleaner, the ideal goal being a technology that does not produce any pollution. So, it is possible to approach from the Deming cycle: Plan, Do, Check, Act (United Nations, 2008)	Continuous application of integrated and preventive environmental strategies to processes, products and services to increase efficiency and reduce risks to humans and the environment (United Nations, 2008). In this concept Hens, et al. (2017), it explicitly includes resource efficiency, which is a key element of the transitions to green industry and economy. The term Cleaner Production and Resource Efficiency (CP+RE) was introduced. CP is a preventative approach to managing the environmental impact of business processes and products. CP uses changes in technology, processes, resources or practices to reduce waste, environmental and health risks; minimize environmental damage; use energy and resources more efficiently; increase business profitability and competitiveness; and increase efficiency. Attracts the attention of Hens, et al. (2018), the use of energy and resources in a more efficient way; increasing the profitability and competitiveness of companies; and increasing efficiency. CP is manufacturing in which waste minimization and prevention practices are continuously applied. These practices include (1) conservation of raw materials and energy, (2) elimination of toxic inputs, and (3) reduction of toxic outputs (Güler, 2015).

Although not stated in the definition, the scope of the analysis should extend from the manufacture and use of a product to its disposal as waste, and from supply to the contamination produced when extracting and processing raw material inputs and semi-finished products. CP must consider the entire life cycle (the so-called cradle-to-grave analysis) (Hens, et al., 2017; Chakraborty, 2017)	Cleaner technologies are those that extract and use natural resources as efficiently as possible at all stages of their life; that generate products with or without potentially harmful components; that minimize emissions to air, water and soil during product manufacture and use; and that produce durable products that can be recovered or recycled to the extent possible (European Commissions, 2017). In this definition, the following is used once again to efficient use of natural resources, reduction of the generation of harmful components, minimization of emissions to air, water and soil, production of durable products that can be recovered or recycled to the extent possible, and limitation of energy consumption. In this respect notes that CP is directly related to the concept of sustainable development, specifically in the industrial sector (Hens, et al., 2017). CP contributes to the sustainable industry development through efficient management of natural resources, use of renewable energy, increased efficiency of environmental processes and other strategies, while producing quality products (Chakraborty, 2017).
It refers to processes, products, and services as fields of application and to the accounting of natural resources in these (Chamorro, 2015).	To contribute to the preservation of the environment, it is necessary a "cleaner production" that conserves raw materials, water, and energy, minimizes toxic and hazardous raw materials, and reduces the toxicity of emissions and waste at source during the production process (Chamorro, 2015). Green accounting provides quantitative data on environmental performance and money and is essential for "cleaner production Linkage to green economy is introduced in the definition, considering it essential for CP (Hens, et al., 2018).

Note: The first column of the table shows the systematization of the ideas of the CP concepts analyzed by Hens and their modifications. There are a total of 6 essential ideas and for each of these essential ideas in the second column appear the concepts of CP by different authors and their analysis.

According to Hens, et al. (2017, 2018), for about 20 years the definition of CP has remained basically the same, but gradually more attention has been paid to resource efficiency, the social dimension of sustainability (supporting the development of people and communities, e.g. providing jobs and protecting the welfare of workers and local communities), and the economic dimension (increasing production efficiency, cost reduction, business profitability and competitiveness), while the environmental aspect remains central. To date, CP is considered the business strategy for contributing to the three dimensions of sustainable development.

Agroindustry is the economic activity that includes the production, industrialization and marketing of agricultural livestock, forestry and biological products. This branch of industry is divided into two categories: food and non-food. The first is responsible for the transformation of agricultural products for food consumption; this transformation includes the processes of quality selection, classification (by size), packaging and storage of agricultural production. The non-food branch oversees the transformation of these products that serve as raw materials, using their natural resources to make different industrial products. Thus, agroindustries are an extension of agriculture (Fadhil, et al., 2017).

According to Siregar (2006); and Fadhil, et al. (2017), agroindustry is a solution for agricultural products, which means that agricultural products need to be processed to a certain level to generate added values. So, CPs are an option of preventive strategies that allow to fulfill those added values covering social, environmental, and economic dimensions.

Agriculture has been one of the sectors most affected by environmental pollution. In the search for solutions to this pollution, the concept of agroecology arises, understood as the application of ecological science to the study, design and management of sustainable agroecosystems as the maximum expression of CP in the agricultural sector (Altier & Toledo, 2011).

At the same time, several Cleaner Production Centers (CPCs) appeared in Latin America between 1995 and 2000, with the participation of Brazil, Mexico, Costa Rica, Guatemala, El Salvador, Nicaragua and Cuba. The objective is to offer methodologies, accessories, and guidelines for CP implementation. Each of the countries has instruments and policies that have allowed the CP issue to be introduced in their national agenda (Roa, et al., 2016).

As said by the methodology for the establishment of CPC, implemented by the United Nations Industrial Development Organization (2017), CPC are hosted in pre-existing institutions, which offer support and backing to the new entities (United Nations, 2008). Table 2 shows the advances that have been developed as part of CPC management applicable to the agroindustrial sector in Latin American countries.

Table 2. Advances that have been developed as part of CPC management applicable to the agroindustrial sector in Latin American countries.

CPC in Latin American countries	Instruments created for agroindustry
National Center for Cleaner Production and Environmental Technologies (CNPMLTA), Colombia	National Policy on Sustainable Production and Consumption (2011)
Center for Cleaner Production (CPML), Nicaragua	Central American Environmental Innovation Award Decree 22-2006, National CP Policy (Published in ***La Gaceta*** No. 68 of April 5, 2006) Nicaraguan Technical Standard for the Certification of Consultants (NTN 25003-06)
Costa Rica	National Policy on Cleaner Production (2006) National Policy on Sustainable Production and Consumption (2010) Excellence Award (National Quality Award) National Standard INTE 12-01-06: Management System to prove C-neutrality (2011) National Standard INTE 37-01-01: Voluntary Agreements of Cleaner Production in Policy on Low Emission Production and Sustainable Consumption (2013) National Policy on Chemical Security (2013)
Bolivia	Environmental Regulations for the Industrial Manufacturing Sector (RASIM) Bolivian Standard 61002 “Cleaner Production Systems - Requirements” and Bolivian Standard 61004 “Cleaner Production Systems - Guide for the implementation of NB 61002”, based on the CP Excellence Model. CP Fund for financing CP projects. Eco-Efficiency Award, as an incentive for industries to implement CP.

Among the responsibilities promoted by the CP concept are: compliance with current environmental legislation; supply and demand of safe products; sustainable consumption; competitive positioning of agricultural companies and production systems; and reduction of environmental impacts during the service provision process (European Commissions, 2017; Gil Unday, et al., 2018; Calero de la Paz, et al., 2020).

The principles of sustainable agriculture, the conservation of biodiversity, the reduction of agrochemical use, the use of good agricultural practices, the development and application of biofertilizers and biopesticides, the rescue of traditional agricultural practices, the revaluation of the family agricultural economy, and the socio-economic development of the community, among others (Report of Cuba to the United Nations Conference on Sustainable Development Rio +20, 2012) are priorities in Cuba’s environmental management policies.

Since 1992, the Cleaner Production Program has been established as part of the United Nations Environment Program (United Nations Environment Programme, 1998). Among the main actions carried out applicable to agroindustry, the regulations established for this purpose stand out, such as the integration of the concept of Sustainable Development to Article 27 of the Constitution of the Cuban Republic, the establishment in 1993 of Decree 179 referring to the protection, use and conservation of soils and the approval of Law 81 of the Environment in 1997 (Red Latinoamericana de Producción más Limpia, 2017) which includes as a general principle, the adoption of preventive approaches in environmental management.

This principle is the basis for CP strategies. In 2001, the National CP Network was created and established in Cuba within the framework of the International Development Program, promoted by the United Nations Industrial Development Organization, with the support of the Government of Austria. The National CP Network started to operate with three focal points: The Environment Agency (AMA, Spanish acronym), the Research Institute for Sugarcane Derivatives, and the Research Institute in Food Industry (Red Latinoamericana de Producción más Limpia, 2017). In mid-2003, the Research Institute in Tropical Fruit Growing was incorporated, and at the end of that year, the Center for Genetic Engineering and Biotechnology.

Of these, the main function of AMA is to carry out environmental diagnostics and technical advisory services for the development of environmental management systems, productive business and services; while the others are responsible for carrying out complete CP advisory services, rapid advisory services and technical support to various agroindustrial sectors (Cuba. Ministerio de Ciencia, Tecnología y Medio Ambiente 2012; Red Latinoamericana de Producción más Limpia, 2017).

In this way, a favorable progress can be seen in the implementation of good CP practices with the objective of decreasing the polluting impact to soil, water, and atmosphere in different sectors of the country (United Nations Industrial Development Organization, 2017), extensive to the meat agroindustry with encouraging results in its implementation (Gil Unday, et al, 2018). This advance is proved by:

» Preparation and publication of the document "CP in current policies and practices in Cuba" (2003), which describes and analyzes the environmental regulatory framework in which CP is inserted

» Implementation by the Cuban Ministry of Science Technology and Environment (CITMA, Spanish acronym) of the National Plan for the Introduction of CP in Corporate Environmental Management (2005 on).

» Preparation of approved governmental programs such as the National Program to Combat Environmental Pollution (2008-2015) and the National Program for Sustainable Consumption and Production and Efficiency in the Use of Resources (2010-2015).

» Participation in the elaboration of the National Policy for Food Industrialization, which is in the process of being reviewed by the Council of Ministers and is part of the country's new economic policy.

» Participation in the elaboration of the Policy for the Management of Solid Waste generated in the Food Industry, which is part of the National Policy for Solid Waste Management.

CONCLUSIONS

The definition of CP has been modified and adapted according to the scenario where it is applied. However, there is an agreement on its preventive approach and on considering it the business strategy to contribute to the three dimensions of sustainable development.

CP is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to people and the environment.

The agricultural sector has been one of the most affected by environmental pollution. The most relevant impacts are the impact on water reserves, greenhouse gases, loss of biodiversity and, of course, climate change. The regulations in force in Latin America and Cuba for CP are applicable to agroindustry.

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