Chapter 4 The bioeconomic approach for the management of public policies against climate changes in the agricultural sector

Capítulo 4 Enfoque bioeconómico para la gestión de políticas públicas frente al cambio climático en el sector agrícola

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Abstract

The contemporary market is based on an economic system whose objective is economic growth as an indicator of well-being, however, it has been shown to fail for achieving the satisfaction of the most basic needs of the human population. Present study describes the historical conception of the causes that originated the ecological economy, as well as the social motivations that led to considering it as a sustainable development alternative based on the understanding and application of energy, flows from the perspective of the laws of thermodynamics that saw their conception in sciences such as physics and chemistry. This approach to economic development based on the understanding of the need to value natural resources and the environmental effects of the economic process represents the evolution of the assumptions established by contemporary neoclassical economics. Along with the main objectives of traditional economy of satisfying human needs, present study shows the bioeconomy as an alternative to study the satisfaction of both economic and environmental objectives for a sustainable agricultural and livestock production.

Bioecomy, Agriculture practices, Sustainability

Introduction

The economy is assumed by a group of individuals under different undergrounds looking for the satisfaction of a human need, for this reason, among its outstanding characteristics is that it is a component of a socio and political facts, by the opposite environmental characteristics cannot be studied into the social sciences. If the needs were not existing or the ways for satisfying the needs were limited or unlimited, then the economy would lack in consistency, since it would only might solve phenomena with un-lacking resources, then, economy would not solve dilemmas between the consumption agents.

As a science, the economy includes specific research methods to understand and explain part of the components of the systems to promote a favorable social development that can be modified by economic factors. However, since from the capitalist point of view, the existence of living species are the promotors and the reasons of the economy phenomena, therefore the accumulation of wealth is part of the primordial purpose of the production. In fact, for the capitalism, the plural concentration of wealth and the satisfaction of the the needs derived from economic models can be possible by the joining of the science and technology to reach the accumulation and satisfaction objectives, without any comprehension or consideration for the natural resources used to maintain the production (Barberá, 2007).

Despite of the releasing of the greenhouse gases (GHG), the increment of the temperatures, the changes of the precipitation reduce the potential availability and yield of crops (Medina-Cuéllar *et al.*, 2018a, 2018b; Ibarola-Rivas *et al.*, 2019) attempts against the security of living species. Then the production focused exclusively in generate and satisfy novel needs, and in the wealth, accumulation proposed by the actual economy is not sustainable. Then, considering factors as the efficient usage of the resources will play a fundamental role in the future economical development.

The bioeconomy emerges as an alternative to satisfy both economic and environmental objectives for a sustainable agricultural and livestock production (Medina-Cuéllar *et al.*, 2021). The priority of the bioeconomy should be the economic growth of traditional and novel industries based on the natural resources availability, through the creation of value chains that would increase the value-added of market products.

Since the objective of the bioeconomy is the insertion of the economical activities in the natural and human ecosystems, and their long-time sustainability, models applied to agronomical activities have been derived to obtain present effect-causes associations that can be holistically explained by the variables that affect the yields (Goudrian and Van Laar, 1994; Van Straten, 1999; Van Straten, 2008) and to generate short and long-time predictions under different environmental sceneries (Jones and Kiniry, 1986; Medina-Cuéllar *et al.*, 2014, 2018, 2021). Some agricultural products and yields can be used as bioeconomic indexes, therefore bioeconomic models have been derived to associate the yields with the availability of the environmental resources (Medina-Cuéllar *et al.*, 2018a, b, 2021).

Present study describes the historical conception of the causes that originated the ecological economy, and the bioeconomy, as well as the social motivations that led to considering it as a sustainable development alternative based on the understanding and application of energy, flows from the perspective of the laws of thermodynamics that saw their conception in sciences such as physics and chemistry.

References for acronyms and abbreviations

BLUES	Best Unbiased Estimators
BLUPS	Best Unbiased Predictors
CO_2	Carbon dioxide
CH_4	Methane
GHG	Greenhouse gases
H	Hydrogen
N	Nitrogen
NDF	Neutral Detergent Fiber
SUCROS	Simple and Universal Crop Growth Simulator
USA	United States of America

1. Economy as a science

The economy is a science, although it comes from an empirical law, implies facts that size into a theory and that can be applied on the specific methodology made for the economic research (Tamayo, 2004). The possibility of an holistic the understanding of the economic phenomena among the present and past observed variables, requires of the selection of a sample of events from a considerable number of possible events that should be significant for the established theory, the selected observations most be according to concepts that depend on hypotheses and follow the scientific method. The experimental sciences can be isolated to the components of a system, to explain reality from them, however, is difficulty the isolation of the components, due to the process of socialization through every social phenomenon generate a biological and economic dependence, then, some social phenomena are part of economic science.

The application of economics as a science, as part of a whole, can promote a favorable socioeconomic development, when the mixture of these two groups are included in a cooperative process. On the other hand, triggering a disruptive investigation between the science and the distinctive patterns of the economy, coupled with the obligation of reach the satisfaction of needs, would make a difference from the studies that takes into account the practical and the mobile of the human's activities based in an economic that depend of the origin of new social needs and their relation with the social well-being (Ávila, 2004).

When science is reinforced with research, the resulting development generates a proportion of wealth that can origin a dispute between economic agents monitored by the economy (Vienney, 1983). The approaches and research provided when the economy and the science are separated might release many important factors without an appropriate analysis, then science should be a system immersed inside the economy.

Additionally, public policies have resulting from the study of economic factors that have been broadly attributed and immersed in finances and the activities of the civil services. Analysis from an economic point of view is also viable, on issues such as organized crime (Friedman, 2007), the educational system, the legal framework, public choice, religion (Laurence, 1998), and science.

The problems of intentionality in the study of the behavior of economic agents are the emergence of new parameters that show the complexity of identifying frequent consumption patterns and their choice alternatives in the nature of the economy. The rhythm is gradually marked by the spatial configuration of the economy and the blocks between nations, and by the interrelations among the novel communication relations, and economic, environmental, social, and cultural factors (Dabat, 1998).

This rhythm falls on assumptions of compulsive consumption patterns and production systems that neither considers the prevention or long-range proposals, nor approach a wide range of activities which might allow to all species to maintain a dignified life. Associated with the consumption characteristics that now tend about a capitalist system, it is necessary to create remarkable alternatives that consider a perspective natural and friendly with the environment, without negative effects on the factors involved in production and future incomes.

Despite of the current modification of the exchange mechanisms and what is intended to be offered in a market, there have been diverse cultures that mean to be in total dependence with the environment.

2. The origin of the bioeconomy

Despite of the identification of diverse economic orders that have derived from an exhaustive socioeconomic research which could help to increase the social and academic development, there are many Universities and Institutions with the proposal of include the bioeconomy as a research field (Fairlie, 2017).

Bioeconomy was described by the European Commission (2011) as the integration of the production paradigms that depend on biological processes and with natural ecosystems, use of natural inputs, that could have required the minimum energy and wastes. Nowadays, economy considers that the inputs of processes can be reused in the ecosystem towards a sustainable development (Georgescu-Roegen, 2003). The current ideology of sustainability in economy is directed by some economists who have adverse opinions of the neoliberal approaches, since it must be interpreted in a way that is immersed in the capitalist system.

The bioeconomy also analyzes the topics inherent to capitalism, accordingly, there is an assumption of the errors in neoclassical economics, since a rational management of ecosystems sometimes in not considered in classical economy. In this scenario, it is necessary carrying out economic activities concerning that could reduce the negative environmental impacts with the emphasis of offering services to human-beings and promoting the development of the community.

The neoliberal economy is conceived like the actions the carried out to mechanize and rationalize the regulation of the production processes considering the environment, despite of the preeminence of financial power, to reach it, the system becomes in the creator but also participates in its historical conditions to allow its spatio-temporal existence (Aglietta, 1999). The neoliberal approach is born from the interest in sustainability whose methods are validated by public policies. Since 1972, the land has been considered as a natural resource that should be rationalized utilized, and based on contemporary approaches, land is part of the metabolism of cities, and their anabolism and catabolism, before land was considered as a human property (Hodgson, 1995).

Economic ecology represents scientific models of sustainable management and the valuation of the unsustainable, integrated by comprehensive and inclusive production models that consider environmental and social variables. Therefore, environmental economics focus on study of the preservation of the natural resources, including many analytical tools to help finding the economic decisions with minimum negative impact on the environment. Considering that environment is a provider of ecological and natural resources, and services, this kind of economy should work with other sciences, looking forward a transdisciplinary research field (Carpintero, 2005).

The bioeconomic particularity depend on other economy branches, as the ecological economy needs the environmental economy concepts. Therefore, bioeconomy is supported by the governments and citizens, research organizations, academics, and companies whose integral participation might achieve a sustainable development. Optimal management of the bioeconomic indicators would support the solidification of innovation systems (Pavone, 2012).

3. Bioeconomic imperatives and governmental role

To obtain novel markets and boost the economic growth, the bioeconomy considers as priorities: 1) the facilitation of bio inventions developed through multidisciplinary research; 2) the development of rules and laws focused on reducing obstacles; 3) the speeding up in the regulation processes; and 4) the reduction of environmental costs and risks to human health. In addition, bioeconomy identifies and promotes the opportunities for the development of alliances between public and private sectors, where competitors contribute with resources, knowledges, and experience to reach successes and/or failures.

Consequently, the multisectoral sector can be improved, considering agriculture, the health sector, the obtention of energy, the environmental impacts, and the public administration (Maxon and Robinson, 2012). As an example, the inclusion of biological materials can be sustainable substitutes of prime materials, specially of hydrocarbons applied in industries and manufacturing processes. Then, innovation is necessary to obtain an sustainable growing and to generate novel economic opportunities, and public policies should include it to promote the productivity, novel markets, and strategies that might reduce the social and environmental negative impacts (Reinoso, 2017).

The foregoing intervenes in the way of governing societies, in addition, political concerns are attributed to it, meanwhile transitions are reinforced by acts and promulgations provided by government regulations and public policies. This is defined by Heclo and Wildasvsky (1974) as the government action directed to obtain external objectives, then, government systems are legitimately legal in proportion to the opportunities and social benefits that they achieve for the population (Reyes, 2007). However, many public policies generated under empirical and pragmatical concepts to support the governmental actions have been mobilized and instrumentalized to benefit the pluralist ideas, neo Marxists and neo corporativists (Muller, 2004).

Although there is the interest of increase the environmental sustainability, the governmental actions seem to be so far from the bioeconomy principles. The governmental instruments are those promulged by the Stockholm and Millennium Declarations that have been importantly contributed to the design of public policies with incentives to a pro-bio environmental management.

In the United States of America (USA) the public policies are oriented towards a bioeconomy based on agriculture to move away from energy dependence and reinforce the greener economy (Eaglesham, 2006). According to the Service of Economic Research (2000) public policies are the result of some agricultural policies based on the market, focused on the proportion of large payments to farmers as a compensatory measure between low purchase prices and high production costs, the technical mismanagement and the contamination of crops due to the penetration of polluting gases emitted by factories lacking gas emission control.

Before to implement any mitigation or change measure, it is important to consider the changes of the available economic indicators. For example, the "Big Mac" index, which works based on the theory of purchasing potential, and the idea that exchange rates should move towards an equal rate and weight through the different countries (The Economist, 2017), bioeconomy is based in the research of indicators is an starting point to find solutions.

In USA, the first main indicators were low prices and production costs and after their application both improved by 13%, in addition, the policy called "bioeconomic based on agricultural mass" had economic benefits in the formation of social capital and a greater profitability in the production space which derived in an increase of 14% in quality standards. North American government is interested in investment and created the «National Bioeconomy Blueprint», published in 2012 to reinforce its activities related to the bioeconomic and biological-based products (Maxton and Robinson, 2012).

Another latent example was presented in the middle of the year two thousand, entering the topic of conversation in European political spheres (European Commission, Staff Working Document on Innovating for Sustainable Growth, 2012). However, the foundations for the bioeconomic originated strategic objectives in the European Commission that highlighted the non-physical investments but based on knowledge and the role of biotechnology in the innovation and development (European Commission, 1993).

Nowadays, the bioeconomic technology platform (2011) shows that the bioeconomy has a market size of more than 2 trillion euros and offers 22 million jobs in various sectors, including agriculture, forestry, food chemicals, and bioenergy, and it is attributed to a optimal government management and successful proposal of public policies.

A proposal for the retribution of the land that has been transformed to promote the reduction of damage of it, the novel vision is that land can make a friendly contribution to satisfy the need of production of a service and/or a material good. The centralization of bioeconomic objectives with the greatest boom is being presented with the initiative of biorefineries to produce biofuels (Jong, 2013) whose might solve the problem of the increasing of fossil resources prices, the uncertain availability of those, and the environmental damages derived from GHG emissions, considering that the manufacture of biofuels implies the substitution of petroleum by biomasses as a raw material to produce chemicals and fuels (Cherubini, 2010).

China and its model of four bioindustries, and its forecast of a transition towards the bioeconomy through the development of biofuel, biohydrogen, among others, is an example of the interesting option of the technological driving force for the transformation of chemicals (Lee, 2016); similarly, Italy has a total of 12 biorefineries that employ 1,600 people directlyf for the creation of biomolecules and biomaterials (Philp, 2012).

In terms of a development perspective, it is a challenge to join the environmental with the policies issues, and the union of both represents the necessity of the joint work among researchers and members of the public function, and there are some theories that look forward the best environmental performance.

Apart from the bioeconomy variables and foreign countries' advances, bioeconomy actions should affect the socioeconomic development, since to reach an effective change of any economic process it is necessary the supporting dynamics contributed by primarily and secondary actors along the value chains and socio-political contexts. Organisms with a bioeconomic approach must promote the biological-based and circular economy that requires the construction of new value chains involved in the production process, and in consequence novel alliances among participants are required. In addition, the development of novel networks is important. Consumers also play a very important role at the moment of decision, as they try to avoid perceived risks or limitations of products and materials, then it should be honest advertisements about the implications of an circular base economy (Venkata *et al.*, 2016).

Mexico has had approaches for a bioeconomy approach, since in economy the energy pattern is defined by the type of sources of energy mostly used in processes, and in Mexico as in other countries the energy pattern is primarily from fossil energy, although it is looking forward the development of solar, wind, and geothermal sources of energy.

4. Environmental policies

The state government can be a tool to reach bioeconomic objectives since it can contribute to the creation of effective policies. There are environmental policies, that aware or not of environmental responsibility, are promoted by institutions look forward the environmental preservation and care. However, the development of environmental policies falls during their design since the scientific research is not always useful for their development. Then, it is necessary to translocate the scientific reports and the abundant information in a minimum useful parameters and derived conclusions.

An effective environmental policy requires to integrate sectoral policies, by knowing the relationship among the environmental conditions and the pressure of its exploitation promoted by the sectors; the environmental conditions most be evaluated by either the usage of natural resources and the polluting emissions.

Environmental policies in the different countries have tended to gradually increase the supply of renewable energy, for example, in 2008, European Union make a long-term projection to reach in 2020, the substitution of the 20% of its energy supplies with renewables sources, and reduce the GHG emissions (Clean, 2008).

In addition to the policy-action implementation proposal, the bioeconomic approach represents a challenge, intended to be carried out in a sustainable scenario: satisfying the needs of the present without compromising the ability of future generations to satisfy their own needs (Moreno, 2007; Martínez and Roca, 2013). Sustainability is a long-term principle and with a wide range of management strategies to allow the human-being ensure both the present and future survival. In the globalizing context, the sustainable principles are the emerging limits and the reorientation of the civilizational process of humanity, thus as a normative criterion for the reconstruction of economic order as a condition for human survival (Leff, 1998).

Management systems should continuously change to allow them to be productive and self-sufficient, without losing their functionality, they would complement to policies that promote the increasing of yields, innovation, and new markets while include strategies to reduce the negative social and environmental effects (Reinoso, 2017).

The combination of policies and their commitment to current environmental challenges may be attracted to generate educational organizations that could join efforts to perform projects and develop strategies to reduce the global future concerns by the application of precautionary measures to mitigate the impact of ecosystems. The integrated public policies to actions would bring novel production paradigms and the organization of systems that consider the dynamics of the biological cycles to promote an integrated economic dynamics with the primary sector (Medina-Cuéllar and Portillo, 2017).

5. Development of bioeconomy

The application of bioeconomy as a model to overcome the economic paradigms most be useful for the environmental conservation and the fulfillment of global coverage, despite the wide range of primary activities that take place in the environment. In this sense, the primarily objective is the rational usage and exploitation of the biomass and obtention of wealth from the earth resources, as the millions of plants, animals, and microorganisms species, the genetical diversity, and the intricate interactions that constitute the ecosystems that build the environment affected by the resources abundance, rates of production, habitat productivity, climate variability, spatio-temporal adaptations, evolutionary history, etc.

6. Bioeconomy under a scenery of climatic changes

In addition to the high rates of deforestation and the loss of hydrological services of ecosystems, the abatement of the water availability is considered one of the most important environmental challenges intended to be solved with the novel approach of bioeconomy (Manson, 2004). In the hydrological sector itself, proposals aimed at economic optics are already emerging, marine plants that generally live on rocks or other hard substrates in coastal areas called algae, have received much interest and attention in applications related to energy, food, biosensors, and pharmaceutical applications (Venkatesan *et al.*, 2016).

Earth planet has important differences of the concentration of gases in the atmosphere: Oxidizing (oxygen (O_2), carbon dioxide (CO_2)), reducing (methane (CH_4), hydrogen (H)), and inert (nitrogen (N)) that allow the life. These gases are into the atmosphere, primarily composed by nitrogen (78.3%), but balanced with other gases present in smaller quantities. On other planets, these gases concentrations vary and reduce the probability to the support life, additionally not all planets have an atmosphere to regulate the internal temperature to support the life (Newell *et al.,* 1975).

The greenhouse effect is due to an unbalance of those gases, the reduction of some of them allow a greater solar radiation that penetrates the surface of the planet (although part of the infrared radiation is absorbed and remitted to outer space). Resources such as water, CO_2, CH_4, and nitrous oxide (**NO_2**) are natural components of the atmosphere, and the components manifest in gaseous form and have the property of absorbing part of the incoming radiation, hoever when those gases excessively increase, the radiation that escapes is less and the current temperature increases, the phenomenon that has occurred is called greenhouse gases (Rodhe, 1990).

Increasing the concentration of GHG increases the temperature of Earth and affects many biological processes. As an example, the greenhouse effect has altered the proportion of pollinators like the bee (*Apis mellifera*), bees´ flight is linearly related to temperatures in the range of 14-22° C (Reyes and Cano, 2000).

Different comprehensive approaches of the climatological variation have been studied by authorities, but some of them do not consider the climatic changes as priority. For example, USA has withdrawn from the Paris agreement, minimizing the effects of climate changes considering it as Chinese's strategy to destabilize the global economy (El Financiero, 2017). The Intergovernmental Panel on Climate Change (2017) defined this thinking model as a "fantastic" misinterpreting of the statistics of the climate through the long periods. However, the environmental degradation, in part, is attributed to human activities.

Humans pollute and cause environmental changes because of the economic activities, and those are regulated and promoted by Institutions that lead decisions that damage the environment. This means that pollution is the cheapest way to solve a common practical problem: Satisfying a need of any type at any environmental cost. Therefore, individuals decide to produce and consume within a listed range of economic and social institutions (Field, 1997).

7. Modeling the climate changes and the bioeconomy

How climate changes affect the environment is sometimes undetectable and might have a favorable or unfavorable sensation depending on subjective criteria. The excessive CO_2 emissions mainly promoted by the combustion of fossil hydrocarbons and that increased since the beginning of the industrial period contribute to global warming. Although CH_4 emissions are less than CO_2, the CH_4 has more potential to global warm than CO_2.

Global warming not only refers to the temperature increasing but also to changes of other climatic variables that affect the life survival and the productive activities (for example: The precipitation, wind, radiation, and humidity) (Stainforth *et al.*, 2005).

The detection of the global warming is important to quantify the effects on the value chains, the production potential, or even on the obtention of the desired utilities. Global climate changes can negatively affect the production and the consumption patterns, and the monetary capacity to sustain the production. Environmental and economic costs are factors that increase over time and can decrease or increase production. However, the maximum potential warming promoted by anthropic activity is attributed to Industries, and the minimum to the agricultural and livestock sectors, and to the deficient management of wastes and by-products. The intention to seriously mitigate warming must begin with policies focused to reduce the burning of fossil fuels (Barros, 2005).

Agricultural systems encompass both agricultural production and marketing systems. They are rich in complexity and diversity. Generally, all systems include economic considerations. Understanding how such systems are structured and function requires the use of mathematical modelling frameworks that represent their key features. Models have been developed to investigate specific issues to reach different objectives as to relate causes and effects, to obtain novel hypothesis, to simulate or predict future trends, and even to control some systems.

Bioeconomy is supported by the modeling processes and can include both deterministic and stochastic models. Although, modeling is not performed exclusively by economists, explanations and economical applications of models that depending on climatic variables are useful to design both management strategies during the production processes and to obtain public policies.

Many models to associate environmental conditions with the productive potential have been developed and validated since 1980. Deterministic and dynamic models are directly applied to control theory which could be the special difference among traditional econometric models primarily based on statistics and deterministic and theorical models (Van Straten, 2008). Many agricultural and bio-resource sciences work with models have been using to automatize some agricultural or biotechnological processes performed in greenhouses or bioreactors.

As an example of this kind of models applied to theory control and thereby useful for the automatization of processes, is the development of the 0universal crop growth simulator (Simple and Universal Crop Growth Simulator (SUCROS)), generated around 1980 to relate the physiological process of plant's growth with the biomass yield: The model associates the CO_2 caption and respiration with the environmental fluctuations. This model have been evaluated and validated along the time, and although the prediction is not the main objective of SUCROS, it has been useful to understand the effects of the environmental on crop yields and to generate novel hypothesis (Goudrian and Van Laar, 1994).

Bioeconomy is primarily supported by models to predict the potential effects of climate change on crop yields requires models that relate the weather and crop yields. Statistical models belong to stochastic group, with a diverse modeling tools as time of series, linear models (applied to continuous or/and discrete variables), non-linear models (orthogonal polynomial, non-linear regressions), etc., additionally, stochastic models can integrate random and/or fixed effects variables to obtain best unbiased estimators (BLUES) or even best unbiased predictors that consider different spatio-temporal evaluations (BLUPS). Therefore, stochastic models allow to reach some control on production systems since they can have enough accuracy to relate climate changes with production fluctuations, and therefore to simulate and predict future responses under different climatic sceneries. although this kind of models are not necessarily useful to automatize can allow the optimal decisions around investments and incomes and might be useful to design novel public policies around the environmental conservation and exploitation.

CERES-Maize model was generated in 1986 by Jones and Kiniry and have represented a useful to predict maize future yields, predict even in crops evaluated in different times or spaces. The model was performed using different methods: 1) Single model of time-series; 2) Single model using panel data; 3) single model using cross-section site average weather and yield data. CERES-Maize model has been evaluated and validated in different space and temporal environments (Jones and Kiniry, 1986; Hodges *et al*., 1987; Tojo *et al*., 2007), finding that future maize yields are primarily affected by temperature and precipitation changes (R^2= 0.54 to 0.69) (Lobell and Burke, 2010). Lobell and Burke (2010), applied CERES-maize model to simulate crop yields under the future scenery - if temperature increased 2° C and precipitation reduced 20%- produced by global warm. Although statistical models have limits, models are useful to take correct decisions.

Applying this modeling tools and considering the honey production as a possible index of the natural resources availability, Medina-Cuéllar *et al*. (2014; 2018a) also used different modeling tools to relate the honey bee production with the climate changes in a semi-arid region of Central-North Mexico. Honey bee yield data from 2000 to 2014 were included to obtain Cobb-Douglas models, best model showed a relation among environmental factors and honey bee yield of 70% (R^2= 0.70), and showed that the conservation of natural scrubs, traditional systems of agriculture and the minimum temperature primarily affected the yield. On the other hand, two future sceneries considering the increases from 0.6 to 2.5° C of the minimum temperature would considerably negative affect the honey-bee yield, even if precipitation would not change. Additionally, that study shows how honey-bee yield could be a bioeconomic index to assign a monetary value to natural resources conservation.

Although, it is not well known in agro-modeling if linearization followed by evaluation of eigenvalues and eigenvectors of the system matrix is useful to obtain dominant time constants and dominant directions in state space, and offers opportunities for science-based model reduction. The continuous state space description is also useful in deriving truly equivalent discrete time models, and clearly shows that parameters obtained with discrete models must be interpreted with care when transferred to another model code environment (Van Straten, 2008).

Medina-Cuéllar *et al.,* (2018b), also obtained deterministic models to relate environmental variables with honey-bee production. Multifractal Detrended Fluctuation Analysis (MDF) can be an alternative to identify correlations in time series. The derived models showed that it is possible to make long-term predictions for honey-bee production that firstly depend on the climate classification, and secondly of the land usage; derived results could be design novel sustainable management strategies. This information could be useful to generate public policies about the usage of fertilizers and about the wild flora, forests, and scrubs conservation (Wratten *et al.*, 2012; Benelli *et al.*, 2014).

To protect ecosystems it is necessary to quantify the impact of productive activities and planning strategies to maintain or restore the natural covers (Menz *et al.*, 2011; Wratten *et al.*, 2012; Benelli *et al.*, 2014). Deforestation and intensive production contribute to global greenhouse gases emission, to desertification process, soil impoverishment, and negative impact the water quality (Menz *et al.*, 2011; Wratten *et al.*, 2012). Consequently, the modeling of honey production can associate climatic changes, availability of predominant nectar sources, and the phenological development of the bees (Lobell and Burke, 2010; Zoccali *et al.*, 2017), and calculate these environmental services in local incomes.

Control plays an important part in agricultural and bio-systems-engineering, but practical control options are restricted to alleviating growth limiting conditions, rather than true crop control. Then, the most important to reduce the uncertainty (Van Straten, 2008). Even, other statistical tools, as the orthogonal polynomial (trend analysis models) analysis allow to obtain the inflection points to optimize the resources invested in production and reduce the pollution of the fertilizers usage in agricultural practices or grain inclusion in livestock (Portillo-Vázquez *et al.*, 2014; Tirado-Estrada *et al.*, 2020). Tendency models are useful to describe dose–response phenomena; in biological processes, quadratic and cubic models can find the inflection points of optimal values and discriminate between the sub or over-doses (Medina-Cuéllar *et al.*, 2021).

For example, the excessive application of N fertilizer has negative effects on crops, greatly reduces N-use efficiency, and causes significant nitrate leaching losses, contributing to GHG since it is the major source of N_2O (Martins *et al*., 2015). Therefore, N must be applied at rates that satisfy both economic and environmental objectives and is critical for sustainable agriculture (Zhou *et al*., 2014).

8. Activities related to the agricultural sector

Agricultural activities belonging to the primary sector comprise a set of actions that transform the natural environment, to make it more suitable for the growth of crops. Its beginning originates in the Neolithic period, when the economy evolved from harvesting to livestock, thus allowing greater availability of food and a field with the characteristics to be manipulated again to be able to improve the technique and seek care. of his environment; It is one of the pillars when talking conceptually about self-sufficiency (Saez, 2009).

The primary sector includes almost exclusively extractive productive activity, which is why it is also called the extractive sector. It covers the activities that mean extraction from nature, without more transformations than those carried out by it. Activities related to agriculture, livestock, forestry, hunting, fishing, and mining are included in this sector. This sector has been characterized by its average progress. Primarily conditioned by the land factor; It is made up of the natural resources provided by nature in fixed amounts, hence it is also known as the nature factor, which cannot be increased or consumed (Barsky, 2001). Broadening the concept, it is the set of elements that nature makes available to man, soil, air, light, etc. The agricultural sector itself, in its combination of factors of production, is called the primary factor; since its supply is decisively isolated from the economic system itself.

The agricultural sector has remarkable characteristics that generate an inclusion, concerning the other productive sectors, that is, those of transformation and the tertiary sector. Although the agricultural essence, distinguishes the extraction work, there is another correlation, and it is the proportionality of essential foods for the subsistence of the species, and its permission for the development of vegetable crops, among others.

9. Designing sustainable management alternatives for the agricultural sector

The third sector is distinguished by the proportionality of urban, industrial, and recreational services (Ruoco, 2002) that could promote the land preservation culture. David McGrath (2012) mentioned that the energy used for the agriculture should be quantified by including within the incomes the human work, and the impact on primary or secondary ecosystems that are damaged to increase the spaces for crops and livestock.

Agriculture is complicit in a large part of carbon dioxide emissions, through deforestation and biomass burning, and also through the burning of fuels of non-renewable origin in the development of these activities, as mentioned before, human beings can modify and find alternatives to improve production or be more efficient, but nothing makes sense if it is not done under a scheme of joint responsibility between producers and the economic and political systems that govern them, without their intervention in the responsible production, it is impossible to improve the state of the ecosystem.

Modern agriculture systems are very intensive in the usage of fossil fuels, since tilling the land would present complications if there was no option for better performance of the crop with previous land preparation. Bioeconomy integrates the agricultural knowledge (quantifying the effects of the overexploitation of natural resources and their regenerative potential) to develop the technology capable of facing the environmental challenges. Although, most GHG emissions are released by transports, industries, and natural phenomena, the contribution of the GHG emissions by agriculture and livestock activities most be analyzed and reduced. Grains used for human and animal feed is that the agricultural processes to produce large volumes of grain such as deforestation, land preparation, and fertilizer application contribute high volumes of greenhouse gases emissions (Beauchemin *et al.,* 2008; Knapp *et al.,* 2014).

Crops and livestock production can be optimized to reduce their environmental impact by improving their systems' efficiency, but researchers, producers, economists, and political systems responsibility of generating and applying optimal production methods.

Emissions of gases from livestock sector contribute to global environmental greenhouse gases. Livestock contribute 18% of global anthropogenic greenhouse gas emissions (FAO, 2006). When broken down to individual gases, livestock contribute 1.35%, 15%, and 19% of total CO_2, N_2O, and CH_4 anthropogenic emissions, respectively (Knapp *et al.,* 2014). Ruminants reared on tropical pastures contribute the most enteric methane emissions due to the lower quality of feed and the longer time it takes for these animals to reach slaughter weight.

The composition of fermentable fraction in ruminal environment can affect not only the livestock production but also the environmental impact because of the GHG emissions attributed to meat and milk production. The proportion of soluble carbohydrates can improve the milk yield (Miller *et al.,* 1999) since it affects the ruminal ecosystem, the fiber degradability, and the amino acids absorbed in small bowel of ruminants (Lee *et al.,* 2012). Additionally, the proportion of soluble carbohydrates and structural carbohydrates (quantified as Neutral Detergent Fiber (NDF)) affect the fermentation kinetics and the amount of methane produced in ruminal that would contribute to GHG emissions. Them, strategies to mitigate enteric CH_4 production include increasing the quality of ruminant diets through the increasing of grains proportion in ruminant diets (Beauchemin *et al.,* 2008).

Increasing the grain and stover individual yields and quality, and on the other side, the improvement of the starch:cell wall (neutral detergent fiber (NDF)) ratio of whole maize plants would be an alternative to use higher amounts of forage in ruminant diets (Khan *et al.,* 2015; Tirado-Estrada *et al.,* 2018). World food security depends on reaching crop and livestock-feeding efficiency. Improving the forage yield and quality is an alternative to reduce the costs of livestock feedstuffs' environmental and economic costs (Oba and Allen, 1999; 2000a, b).

An alternative is the usage of agricultural by-products to feed ruminants that might reduce economic and environmental costs (Liang *et al.,* 2015; Tirado-Estrada *et al.,* 2018, 2021). Most grains used in animal diets can also be directly used by humans as food thus creating competition between man and animals, raising demand for grains on the world market and driving prices beyond the reach of the common man. Maximizing the forage and fibrous by-products in ruminant's nutrition could reduce the usage of grains for livestock production (Beauchemin *et al.,* 2008; Knapp *et al.,* 2014). In addition, it could reduce the oxidants of milk and meat (Lazalde *et al*., 2021) and improve the animal welfare (Lee *et al*., 2013; Saleem *et al*., 2013).

Many biotechnological products that can be evaluated to improve the production and reduce the potential livestock-derived pollution (Tirado-Estrada *et al.,* 2016; Tirado-González *et al.,* 2018, 2021; Carrillo-Díaz *et al.,* 2022).

Knowing the real effects of climate changes is useful to develop solutions as reforesting, developing “clean” energy, improving energy production systems, investing resources to study and improve the ecosystems efficiency, etc., however, those solutions most be promoted by public policies. Deforestation, desertification, the abatement of available water, the reduction of flora and fauna diversity and therefore the genes diversity reduce the possible adaptation and survival of life in Earth (Márquez, 2015).

In Baja California Sur, Mexico, a study was conducted to relate the yield obtained from fishing and the climate, to find strategies to improve the natural resources sustainability, the results indicated that the fishing season can be reduced from eight to four months, that would contribute to a bioeconomic process for the marine species management (Canedo *et al.*, 1999), in addition to the initiation of the operation of eleven biofertilizer production centers, and so on. support the initiative to reduce greenhouse gases (Martínez and Roca, 2013). Despite the deterioration in natural ecosystems and the negative effects on the quality of life of both human beings and flora and fauna, in Mexico, the application of public policies had not been essential in the country, although there is already a comprehensive vision of restoration and in favor of bioeconomic management (Carabias *et al.*, 2007).

In addition to the importance of algae as food in its original form, its high carbohydrate content has promoted the industrial use of algae species as a source of hydrocolloids, such as alginate, microbiology, and medicine, as well as in the plastics industry (Khalil *et al.*, 2017). As for the fishing work, it has a double intervention on the bioeconomic on the one hand, it contributes to the emission of greenhouse gas produced by the use of fuels; and on the other, it modifies marine ecosystems, the basis of fishery resources, so that fishing could mitigate its carbon footprint by reducing its consumption of fossil fuels, and therefore its contribution to greenhouse gas emissions. Optimum fisheries management coupled with a bioeconomic approach is essential for maintaining lasting fisheries that limit catches of weakened and endangered species. For this reason, it is necessary to integrate appropriate mitigation measures to protect the environment systems and help to ensure the productive ecosystems under a scenery of climate changes (Perez, 2004).

Conclusions

The activities of human populations are immersed in the public function must visualize the range of options for social and economic development in favor of the governed sphere. Once there is prior knowledge about the indicators and the importance of each one of them, it is necessary to take active measures to reduce risk or increase a benefit.

A clear example is that in the bioeconomic situation, the order is inappropriate for a design methodology where the government initiative stands out, in this case, it was first the theoretical part and the superimposed concepts of other currents to generate a combined approach of the previous attributes. and to obtain resources with effective technical management so that similar conditions are maintained or away from the deplorable synthesized by scholars.

When the problem of climatological conditions emerges and it is emphasized that the first affected sector is agriculture, evidently due to its dependence on the environment, the bioeconomic fits perfectly with the presented context and it is the approach and the alternatives that appear as a possible agent. mitigating and that would benefit in the same way, that is, without trying to counteract any productive work (except those that generate environmental damage).

To maintain the praxis from generation to generation, it is for this and other remarkable facts that it must be taken into account for the creation of public policies in favor of this sector, without delimiting the others, but with a fundamental approach, as well Likewise, the measures that are taken into account to reduce environmental fluctuations will be another key and sustainable factor for activities of any kind, belonging to sectors other than agriculture. The tonality of preserving the means with which profits are obtained is the adaptive bioeconomic approach in public policies in the face of climate change in the agricultural sector.

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