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THE SEVEN DEADLY SINS OF THE AGRI-FOOD SECTOR IN MEXICO AND HOW TO NULLIFY THEM

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ABSTRACT

The worldwide agri-food sector is crucial for sustaining life. Similarly, the recent pandemic made it clear that the best way to resist, overcome and adapt to health problems is to maintain a healthy and adequate diet. At the present time, food is derived from an agri-food sector subordinated to a particular economic and technological model. In this analysis, we aim to deepen understanding of the current logic and dynamics of the agri-food sector, in order to propose strategies that will improve food production. Firstly, we assess the importance of the agri-food sector, world demographic trends and their needs, as well as certain problems, for example climate change and its effects. Moreover, we undergo an analysis concerning the way the current use model implies an almost uncontrolled attack against life and resources; for this, we make reference to seven major behavioral defects identified in the agri-food sector. Based on this analogy, we propose some alternatives for the future of the Mexican agri-food sector, in the face of future scenarios of climate change, natural disasters, pandemics, war or conflicts, and economic instability, which we believe will become increasingly constant. In principle, we propose consolidating food self-sufficiency; changes in the technological model, while continuing to employ modern technology; together with a profound reorganization of economic and social systems. Finally, we should emphasize that this transformation will not be easy or peaceful because many economic interests prevail.

Keywords: food and health, food self-sufficiency, technological system, science and technology, agri-food policies.

INTRODUCTION

The agri-food sector consists of all those activities related to the production, harvest, transformation, distribution and commercialization of food for human consumption. These are derived from the value chains related to agricultural, livestock, forestry, and fishing activities, among others. The agri-food sector has great economic and social relevance in Mexico, as it contributes 7.5% to the economy. Besides this, the trade balance has manifesed a surplus since 2015. Among the most exported products in the country are pulses, vegetables, avocados, tomatoes, peppers, fruit and cattle (Food and Agriculture Organization of the United Nations –FAO, 2019).

The importance of the agri-food sector for society goes far beyond its relevance for a nation's economy; this sector is unique in that it ensures the maintenance of life and its

reproduction in a strict sense. Likewise, the recent pandemic clearly indicated that the best way to resist, overcome and adapt to health problems is by maintaining a healthy and adequate diet. An adequate and balanced diet is important for strengthening the immune system and preventing contagions such as COVID-19 (Villapol, 2020). Similarly, modern chronic degenerative diseases such as diabetes mellitus, obesity, cancer, hypertension, cardiovascular diseases, tend to reflect the food we consume (Gallo *et al.*, 2020; Grados *et al.*, 2022). This means that we should prioritize the agri-food sector and reaffirm its value in order to improve life. Currently, society faces very complex problems (pollution, resource depletion, climate change, natural disasters, pandemics, wars and economic instability, among others), which have increasing impact and are more frequent, and which relate to the dominant economic development model (Vargas-Canales, 2022).

Evidently, there is a gradual increase in awareness concerning the constant crises caused by environmental, economic, social and health problems. This means there is consensus in the scientific community, who recognize that the current model may lead to an environmental catastrophe in the long term (Economic Commission for Latin America and the Caribbean - ECLAC, 2016). Similarly, certain global trends such as population growth, population aging, poverty, migration, and urbanization have important implications for economic and social development, and for environmental sustainability (United Nations, 2019). There is also a growing demand for resources to guarantee that present and future generations have access to food (Dal Moro *et al.*, 2022).

Another very relevant aspect in the food context is climate change, which is generating changes in weather patterns. Some groups opine that these changes may be natural, caused by variations in the solar cycles. It is argued that it is not known with certainty to what extent natural conditions contribute to climate change. Likewise, it is unknown to what extent humanity contributes. However, when the speed of the changes is analyzed, it is evident that since the 19th century, human activities have been the main driver of climate change, mostly due to the burning of fossil fuels such as coal, oil and gas

In addition, the 20th century was characterized as a period of unprecedented economic expansion, that was perceived to constitute natural progress and likewise the accelerated population growth after the world wars was not deemed a problem (Bardi, 2014). In 2020, several cities around the world experienced extreme temperatures that had not been previously recorded (McLennan, 2022). The negative effects are unquantifiable. It is important to highlight two with important social implications. The first is related to the increased vulnerability of the agri-food sector to respond to future food demands for the population. The second is related to the ecophysiological effects; in the form of droughts, floods and severe storms that reduce productivity and quality of life.

Elevated levels of pollutants affect outdoor activities; this increases stress, psychological effects and can lead to interpersonal and intergroup conflicts (Evans, 2019). Recently a problem has been identified that affects all aspects of our lives. The presence of microplastics has been detected in water, air and many of the products we consume. These are <20

µm particles that can penetrate cell membranes; this situation puts nutrition, metabolic processes, reproduction and behavior of organisms at risk (Hale *et al*., 2020). Fragments and fibers of multicolored microplastics have been found in water trapped in plant leaf membranes (Fogašová *et al*., 2022).

These findings allow us to infer that global society has reached an unthinkable level of degradation, contamination and alteration of ecosystems. Plant cell membranes have very specific and discriminatory selection, absorption, and transport mechanisms for water and nutrients. Theoretically, it should be impossible to find foreign elements in them; so what was found demonstrates exacerbated risks and vulnerability for agri-food systems, and by extension, for the health of all ecosystems. This leads to the question, what is the production logic of the agri-food sector today? In this sense, the research aimed to provide a conceptualized comparison to understand the current logic and dynamics of the agri-food sector, in order to propose suitable strategies to improve food production.

DEADLY SINS AND THE AGRI-FOOD SECTOR

In this conceptual analysis, an analogy with the deadly sins is used to refer to the principle human errors that have been committed in terms of food production. Modern society is experiencing a deep crisis of values, which is getting worse day by day. The limits that as a society we have failed to comprehend refer to everything being destroyed without thinking twice about these actions or foreseeing consequences. Clearly, it is the market that establishes these limits and indicates what we should do and how we do it. A society dominated by selfishness and intent on conflict, destruction, waste and war has been configured. Apparently, our interactions have been assimilated by an increasingly ignorant society. Today, more than ever we have access to knowledge, education; we know how to read and write, but we don't and we resist learning. In today's knowledgeable society, no one has the capacity to integrate the information that we have, so we have become an ignorant society (Brey *et al*., 2009).

The impact of scientific and technological development in all sectors is very low. In Mexico, there are a number of limitations to progress in science and technology, causing increased concentration and inequality, which positions us at a low level internationally (García *et al*., 2017). This occurs firstly because of ignorance and also due to an increasingly prevalent attitude that attributes them little importance and relevance. Besides this, the communication of science and technology is not perceived as a tool that enables a genuine social appropriation of knowledge, while generating innovation (García-Cruz, 2019). In other words, it is necessary to promote public understanding of science with greater intensity, along with greater participation on the part of other actors, in the processes of knowledge production (Kreimer and Vessuri, 2018).

Contrarily, technology has surpassed us; now we have the world in our hands and we don't know what to do with it. Technology advances at a much faster rate than understanding of its scope and risks. Today's society in its entirety is not up to the task of all the scientific and

technological developments that have been generated. Great scientific and technological developments are not sufficient to achieve progress, without governments creating the institutional framework, in particular through education, welfare and training programs, necessary to understand and assimilate new technologies (Focacci and Perez, 2022). In this sense, educational institutions face the greatest challenges in terms of current and future problems; without a doubt, children represent our greatest hope and to a lesser extent, young people. However, it is evident that sometimes they have no comprehension of what they have inherited and do not value life, time and all the knowledge accumulated from previous generations.

Regarding the comparison with the deadly sins, we should clarify that we are not referring to the identification of human transgressions committed in place of the good conduct established by Christian morality. Because 20th century generations are familiar with this idea, we propose a notion to explain the transgressions that modern society has incurred against the correct functioning of the agri-food sector. These are transgressions that are made on a recurring and even habitual basis, so that human conscience has become confused and what should be the sector's real vocation is distorted. It is about the inadequate functioning of a system that can be depicted in terms of the existence of a generalized evil. An evil, which implies unilateral and asymmetric ties in society and is based on accumulated and monopolized power (Peralta, 2022). In this analysis, the seven deadly sins that were considered most relevant were raised and addressed; these are combined, and depending on the perspective may even overlap, form a group or classify one within the other.

Lust

As lust implies an uncontrollable desire for something; here we argue that for some decades, prominent portions of the agri-food sector have gradually surrendered to the markets, owing to an exacerbated desire for profit. Currently, the system of mass production and food distribution no longer responds to the nutritional needs of society, or to sustainable production based on respect for the environment. The sector is now based on a model of strict capitalist logic. Maximum benefit is sought, and costs are "optimized" through the exploitation of labor (Vivas, 2011). Agri-food systems are totally dominated by the ultimate intention of commodification and profit maximization, food is seen exclusively as just one more commodity.

Food is produced, marketed and consumed with high levels of toxic agrochemical residues and other molecules that are applied in large-scale production (insecticides, herbicides, fungicides, antibiotics, hormones, dyes, flavorings, etc.), where only economic rationality, profitability, competitiveness matter. Companies reproduce ideologically oriented interests, depending on how dominant groups form in each place, and this is also expressed by the agri-food market (Fracarolli, 2021). Because of this, agri-food systems that aim to reproduce life have been marginalized and in some cases dismantled, and likewise the production of healthy, nutritious, innocuous and culturally appropriate food.

Evil manifests itself in two ways that directly threaten life. The first and mos violent is the risk of the annihilation of the other (Jiménez, 2022). Under current conditions, the agri-food system is not devised to reproduce and preserve life. The system is geared towards reproducing capital, regardless of the consequences. However, this implies a profound alienation of the individual. This means that everything is a commodity and has no further significance; even people and human relationships have become merchandise, so that the value of the human condition has been prostituted. This situation is part of a historical social system in which a process of commodification of all things initiated. Through time, historical capitalism has implied a generalized commodification, first of all production processes. Then, in the course of their attempt to accumulate more and more capital, capitalists have attempted to further commercialize social processes, in all spheres of economic life (Wallerstein, 2001).

Gluttony

Gluttony manifests itself in excessive eating and drinking. Globalization has initiated an uncontrollable objective to continue with the expansion of the production frontier. Here, agri-food systems respond to global demands that are characterized by excessive consumerism defined by the global north. Currently, we produce more food than we require as a population, however, hunger and other problems related to food persist. The loss and waste of food along distribution chains is estimated at around 31% (Food and Agriculture Organization of the United Nations - FAO, 2019; United Nations Environment Program - UNEP, 2021). Similarly, for over a decade, the FAO (Food and Agriculture Organization of the United Nations, 2011) have reported that consumers in industrialized countries waste an amount of food equivalent to the total food production of Sub-Saharan Africa.

This allows us to infer that much more food is produced than is required to feed the population and that this refers to a matter of distribution, not production. At the same time, worrying global trends in malnutrition are manifesting, including a rapid increase in those overweight and obese; however, other forms of malnutrition persist. In Mexico, it is estimated that 4.8% of children <5 years old are underweight, 14.2% stunted, and 1.4% emaciated (Cuevas-Nasu *et al.*, 2021). In contrast, the combined prevalence of those overweight (39.1%) and obese (36.1%) affects about 8 out of 10 people, aged 20 years or older (Kánter, 2021).

This has a historical origin. Diet is a concept derived from the concrete historical relations of capitalism. In other words, different diets are directly linked to historical periods of capital accumulation and during this historical expansion of the capitalist market, this opportune moment was employed to influence taste and massively reproduce consumption trends with modification of agrifood systems (Hiramatsu *et al.*, 2023). Rising food consumption per person relates to rising per capita income and is becoming an increasingly important driver of increased food demand (Fukase and Martin, 2020).

But is this so even in countries where populations are increasing their per capita income? Evidently there are populations in the global north that pertain to a population stratum, whose purchasing power is disproportionate. Currently this includes Norway, Ireland, the United States, Canada, the United Kingdom, Germany, Sweden, Finland, among others (World Bank, 2021). Meanwhile the rest of the population, whose income has not increased are condemned to consume cheap, non-nutritious and unhealthy food. Fortunately for them, the capitalist system also provides them with, for example, dehydrated soups, packaged baked goods, ice cream, cereals, and more. These ultra-processed foods are easy to prepare, transport and store, and are cheap. Recently, a clear relationship has been detected between the consumption of ultra-processed products and impact on mortality (Brambila-Paz *et al.*, 2023).

Currently, local agri-food systems respond to the interests and needs of other populations outside the territories where they are produced. For example in Mexico, red fruits (or 'berries') are produced (González-Ramírez *et al.*, 2020), the production of which has promoted the development of global value chains that subordinate traditional agri-food systems. There is an evident constant demand on the part of societies in the global north to consume sumptuous ('gourmet' or 'delicatessen') foods. Consequently, a small part of the population that concentrates more than 60% of net wealth maintains extravagant consumption, revealing a little-known aspect of the civilization crisis: unsustainable luxury; both socially and ecologically (Ramírez, 2016). In this sense, enormous amounts of resources are allocated inequitably to produce and market these luxurious and highly profitable items of merchandise.

Greed

Regarding greed; this consists of increasing acquisition and hoarding of material gains and social validation, such as status or power. A few decades ago, industrialization and markets worldwide initiated a reconfiguration. This reconfiguration resulted in hyper accumulation and concentration of power of the large companies that control the agri-food sector, not only worldwide, but also in Mexico. Over the past century, powerful food and beverage companies have enjoyed unprecedented commercial success. Yet while these businesses prosper, the millions of people who provide them with the land, water and labor needed to produce their products face increasing hardship (Oxfam, 2013).

Currently, 10 companies control the world food market (Associated British Foods, Coca-Cola, Danone, General Mills, Kelloggs, Mars, Mondelez International, Nestlé, PepsiCo and Unilever). Mergers make these companies bigger and bigger along all the value chains. Large companies in the US and Europe became transnational corporations by investing in other countries, rather than just exporting their products. Oligopolies, for which a few players determine the outcome, emerged at various stages along the value chain (Alliot *et al.*, 2017). For several decades now, neither small producers nor consumers have the power to even decide what, how, for what or for whom, to produce. This implies that

large corporations are the ones that decide what foods, with which characteristics, we must consume.

Consumers also play an important role in these international trade dynamics. Many consumers do not want to deny themselves the enjoyment of their favorite products and flavors, regardless of the season of the year. To this end, agri-food systems have incorporated technology that breaks with the seasonality of crops and are willing to move these goods irrational distances. Moreover, in some agri-food regions with very specific characteristics and oriented to satisfy international demands, science and technology have developed impressively and have managed to minimize, and in some cases eliminate, the effect of factors related to environmental conditions and resource endowment. If the food desires of global societies are profitable, capitalist food systems will do what is necessary to satisfy them.

Laziness

Considering laziness, this entails certain attitudes such as negligence, apathy, boredom or carelessness, when carrying out activities. In the Mexican agri-food sector, this deficiency manifests in various forms. One of these relates directly to the policies that have been implemented in the sector, which generated two well-defined issues. Firstly, a welfare policy that never dealt with problems availing small producers or the more traditional sectors. This is mainly due to the fact that Mexico is a country with deep asymmetries, meaning that a generic policy will not have the expected general impact (Sánchez, 2014). This discourages production on the part of the smallholder agricultural sector and decreases its productivity, ultimately causing its downfall. Other effects include the increase in technically regulated productivity due to specific demand, the concentration of land and products, specialization and agri-food competitiveness. However, this occurred among a small group of farmers dedicated to the production of crops of high commercial value, which exacerbated sectorial asymmetries.

Consequently, for a long time evaluation and consideration of the amount of natural resources that are being extracted and depleted has been neglected. Concerning the dynamics of specialization and competitiveness of the agri-food sector in Mexico, it is apparent that this production system is subordinated to the market that generates significant environmental load, and transforms land areas without taking into account their characteristics and evolution (Vargas-Canales *et al*. ., 2022). At the beginning of the year 2000, it was already very evident that the problems of environmental degradation and loss of biodiversity were manifestations of unsustainable agriculture. These two problems, together with the pernicious effects of climate change, limit the opportunities to produce food in the medium and long term, and make the national community more vulnerable. In the short term, what is at risk is the population's access to food, which is also mediated by socioeconomic conditions (González and Macías, 2007).

Anger

Anger is defined as an emotion of intense rage, often accompanied by violent behavior. Several decades ago in Mexico, a kind of "exodus of frustration" initiated from areas participating in the agri-food sector. In other words, these deficiencies have resulted in the abandonment of land and emigration, generally of young people (adolescents and young adults) from the countryside to the cities and abroad. This represents an extremely violent situation attacking those who provide us with food, raw materials and ecosystem services without which we could not live, while driving them into conditions of extreme poverty and lack of job opportunities, abandoning everything and risking their lives, in search of better conditions.

For a long time, it was well known that rural poverty and the more traditional agri-food sector was neglected by public policies, as indicated in reports by the different national and international organizations, involved in this sector (National Council for the Evaluation of Social Development Policy, Economic Commission for Latin America and the Caribbean, United Nations, World Bank, among others). The development of rural areas faces numerous difficulties, where the fight against obstacles indicates that many projects and strategies seem to collide structurally. The most important are related to access to credit and savings for the poorest; the exclusion of indigenous populations or for reasons of gender; as well as access to public services in the most isolated communities, which are essential for their development opportunities (Martínez-Carrasco *et al.*, 2014) and the abandonment of older adults, who die ignored and in misery.

Beyond the exclusion of large portions of society, the violent dispossession of resources seems like another manifestation of anger. The agri-food system is violent in nature given the enormous need for raw materials ('inputs') that are required for production. Huge amounts of land, water, financial resources and labor are consumed annually to sustain productivity that enables international competitiveness. However, a large part of these resources are in the hands of peasant communities and indigenous peoples who have historically resisted and continue to resist dispossession. For the system, these resources are wasted and with reference to discourse "manifested in the rhetoric of development" the population group in power justifies its attempts to appropriate land, genetic resources, cultivated species, water and people's very lives from the rural population. For some decades there has been accumulation by dispossession, going from a process of colonization of new sources of supply for the capitalists: including water, electricity, housing or health services, to the appropriation of the most diverse natural resources and the dispossession of small owners and communities, so that eventually all labaor and resources are destined to the enrichment of capital (Harvey, 2003).

Envy

Envy refers to misery derived from not owning what the other has. In this sense, it is alleged that despite the fact that Mexico has so many natural resources, we are in a

deplorable cultural situation. This is perhaps due to our lost roots, the bad influences of a devastating conquest and colony, a directionless independence, a revolution where only a few benefitted, a contemporary era with corrupt governments and a passive and disinterested society (Guarneros, 2019).

Thus, envy would refer to the feeling of displeasure of not having something and, besides that, the desire to possess something in particular, which has been generated over time. This may even imply the desire to deprive the other of a particular thing, should it happen that what is wanted or desired has been or might be attained by another. In the case of the agri-food sector, it is possible to understand envy as a defect, with reference to a fable in the public domain. In very simple terms, the "fable of the Mexican crabs" told once again by Guarneros (2019), reflects a painful truth that we experience on all fronts; in our offices, public or private, in politics, at school, in the neighborhood… everywhere. Mexican (crabs) cannot climb out and/or grow because they do not help each other. If envy were a contagious and deadly disease, our society would already be dying (Guarneros, 2019).

It is thus appropriate to ask ourselves, what is the origin of this behavior? What led us as a society to this situation? In reality, this behavior is explained by the basic assumption of modern economics, which states that human beings are naturally selfish, and for the economy to function correctly, it is not possible to consider being supportive (Monares, 2016). This economic model of a self-regulated market that is based on freedom, justice and security, in fact and in accordance with its logic encourages selfishness and individualism. Ways of proceeding, contrary to those that existed in Mexico prior to the conquest; the deterioration of a social fabric based on a common or, at least, community culture has deteriorated, to the point of disintegrating in recent years. In this current view of life, it is not possible to promote cooperation, solidarity, reciprocity, the common good, meaning that the community is gradually weakened. This is not a minor problem because it fragments our society and does not permit the construction of successful organizational schemes.

Pride

Finally, pride constitutes excessive valuation of oneself and one's own merits. In this sense, the agri-food sector overestimates its capacity to produce food and its capacity for resilience. The Mexican agricultural, livestock and fishing activity throughout 2020, operated in an adverse environment, conditioned by the effect of social distancing measures within national territory and in relation to nations with which it maintains a close commercial exchange of these goods. However, with varied sectorial nuances, the agri-food sector generally registered, favorable productive behavior Servicio de Información Agroalimentaria y Pesquera (Food and Fisheries Information Service) - SIAP, 2021.

It is paradoxical that Mexico imports basic agri-food products to feed its population. These include maize, beans, wheat, rice, soybeans and sorghum; and of animal origin, milk and

its derivatives, beef and eggs. Notably, import figures have been growing for several years and recently their growth rate has ascended. Besides this, most of the necessary inputs for production such as fertilizers, agrochemicals, seeds, technology and even services are imported. Mexico does not have the basic industry for the production of inputs that the agri-food sector needs. The Mexican agri-food sector, in terms of territory, land area, location, and conditions represents a world power for food production and export. However, it continues to increase its food dependency and produces cheap food and labor. Likewise, the current dynamics of the sector depletes, pollutes, erodes and destroys the natural resources that constitute the production matrix.

ALTERNATIVES FOR THE FUTURE OF THE AGRI-FOOD SECTOR IN MEXICO AND THE WORLD

In order to propose alternatives for the future of the agri-food sector in Mexico and find ways to reverse the crucial errors presented here, it is pertinent to appraise some possible world scenarios. And do this with the intention of developing better production, nutrition, protecting the environment and improving life (FAO, 2021). Everything seems to indicate that the future will be determined by climate change, natural disasters, pandemics, armed conflicts and, without a doubt, greater economic instability.

Given the envisaged scenarios, the first thing a nation should do is consolidate food self-sufficiency, with the idea of gradually suspending dependence on foreign sources. According to the Food and Agriculture Organization of the United Nations (FAO, 2002), food self-sufficiency is a condition that ensures the food needs of a population are satisfied by means of local agri-food production. This condition offers the principal advantage of shielding the food supply and ensuring it against fluctuations in price, availability and conditions of international trade, in agricultural products. Policies that promote a self-sufficiency approach tend to seek to reduce levels of dependency on food imports (Martínez, 2016).

Mexico has unique ecological, climatic, cultural, social and economic characteristics in terms of its position in the world for implementing sustainable, highly productive and diversified agri-food systems; with a production capacity to cover the 365 days of the year and in some areas with the capacity to implement two or three annual production cycles. However, an alternative development model is required for the Mexican agri-food sector, based on a comprehensive outlook, and on other political, technological, economic, environmental and social criteria. For this, it is convenient to begin with agendas and appropriate development models that tend towards scientific and technological sovereignty in the sector.

Regarding the alternatives that Mexico plans to implement in order to fulfill the agenda of sustainable agri-food systems, notably we should make clear that generic strategies cannot be considered. Mexico is a country with very diverse natural ecosystems throughout the territory, which is why a differentiated public policy strategy is required. Likewise, if we

do not take into account the capacity for natural regeneration or ecological succession, we will fall into the error of pushing the environment to extremes that will gradually reduce resilience capacity, until this can no longer be recovered. Therefore, the proposals or alternatives for the future of the agri-food sector in Mexico must be considered from a territorial and ecological perspective.

In simple terms, ecology is the area of biology that studies the interactions of ecosystems in their relationship with the environment and with other ecosystems that pertain to an overall global system. This science studies how the interactions between organisms and their environment, affect properties such as distribution or abundance and their limits and capacities. It is about implementing an ecological outlook that considers the physical limits of natural systems; and moreover moves towards a rationale for life that encompasses a broad perspective; not only human life but life in its entirety

Apart from this, it is essential to understand the field of action and its dynamics. For Lefebvre (1991), the field of action must be understood as a social construct; the result of the dynamic interaction between mode of production, social and political relations and symbolic constructs. The field of action is a theoretical and methodological concept that explains the social relations that human beings establish in cultural, social, political or economic spheres (Llanos-Hernández, 2010). Consequently, when thinking about designing public policy strategies for sustainable agri-food systems, it is important to clearly identify the different fields of action that man and nature have built over time.

Once the framework for action has been identified, in the following we define the procedures to be implemented to reverse the current dynamics of the Mexican agri-food system. In reality, this entails implementing a combination of technological strategies, so that in situations of scarce natural resources and environmental contamination, agrifood systems respond to the requirements of current and future populations. This combination of technological strategies implies modifying methods of food production or reformulating some already existing technologies; which are described below:

1. **Family farming,** is the central component of proposals designed to achieve the production of food that we as a society require. Family farming is oriented towards the production of food of animal and vegetable origin, in small production units employing family labor, so as to enable the reproduction of the activity in the community and thereby safeguard agri-food biodiversity and the sustainable use of natural resources. This type of agriculture, includes more than 90% of agribusinesses around the world and has the capacity to produce more than 80% of the food calculated as the global requirement for society to live well (FAO, 2022). It also contributes to reducing food waste and losses, and ensures easier access to quality products at affordable prices (Dal Moro *et al.*, 2022).
2. **Agro-ecology** can be conceived as a possible epistemological hub for a new food model; because it contemplates not only a technological proposal but also the organization of

production, employing a different configuration of actors, technology and marketing with State and community participation and renewed power relationships. Agro-ecology can be considered multi-epistemological, as it does not rule out scientific knowledge; however it does not prioritize it over other types of knowledge (Ruiz-Rosado, 2006). Currently, eco-technological innovation approaches are already being generated that seek to respond to the specific needs of different social actors, for example peasants, companies, rural communities and social organizations (Gavito *et al*., 2017).

3. **Organic agriculture** and the methods it applies, contemplate harmony with the environment. With the use of few external inputs, it has aroused the interest of consumer groups, farmers, technicians, researchers and government institutions, both in our country and abroad. The term organic agriculture, describes alternative agricultural production systems and is considered synonymous with biological, ecological, or alternative agriculture, although the four terms emphasize different aspects. Organic agriculture applies agronomic, biological and mechanical methods, combined harmoniously, as opposed to the use of synthetic materials, in order to perform any specific function within the system (Céspedes, 2005).
4. In the case of **biotechnology**, this is not in itself considered to constitute a science, but rather a multidisciplinary synergism, where sciences such as biology, biochemistry, genetics, virology, agronomy, engineering, chemistry, medicine, veterinary medicine among others, are integrated. Biotechnology initiated with the objective of providing innovative and sustainable solutions to environmental pollution, production of medicines, alternatives for agriculture, modern techniques for the genetic improvement of cattle, fish and birds, to name some applications (Wilches, 2010).
5. The **bio-economy** emerged several years ago as a response to the search for viable alternatives to deal with environmental problems derived from the production of goods and services. Likewise it responded to the need to generate a model for sustainable economic development that guarantees fulfilling global objectives for food security. Bio-economy implies using biological resources that are renewable to produce food, materials and energy (European Commission, 2021). It is a highly complex concept that encompasses all sectors and systems that use biomass in their production processes (Lakner *et al*., 2021). The bio-economy involves the entire economy and the "cradle-to-cradle" model, which implies systems that produce zero waste (Kopnina, 2018; Velasco-Muñoz *et al*., 2022).
6. **The social solidarity economy** has as its goal the conscious construction of an economic system where everyone is conscious of everyone else's needs. These are organized through social relations of production and exchange based on the non-exploitation of the work of others, on fair exchange, reciprocity, cooperative competition, emulation, association and recognition of the other as an equal, without renouncing legitimate personal interests. This implies a democratic society, although not one devoid of conflict (Coraggio, 2020). In other words, it is about breaking with the continuance of

logistics of the individual that persist in the expansion of capital, and that thus threaten the possibilities of generating well-being and sustainability (Belmont *et al*., 2022).

7. **Agriculture 4.0 and 5.0** consist of including and integrating the latest developments based on digital technologies. These will help to improve the decision-making process and are based on the massive use of data for decision-making. Agriculture 4.0 and 5.0 are generating great expectations for the agri-food sector, particularly, as a result of the benefits and positive impacts that result from its implementation (Rolandi *et al*., 2021). Besides this, one of its most important operational methods requires that it focuses on sustainability and care for the environment (Vargas-Canales, 2022). Digital agriculture is essential to energize and move towards other, more sustainable forms of food production (Bellon-Maurel *et al*., 2022).

Evidently, the proposed technological strategies belong to the same philosophical premise that perceives the urgent need to change tactics in terms of production models and types of economic relationships, as well as rationale. Similarly, the latest technological components and artifacts are complementary and integrated. However, notably some of these contrast with the dominant economic model and that this undoubtedly limits their widespread implementation.

However, the dominant economic model assumes that there are no viable options (Belmont *et al*., 2022), while dismissing and marginalizing the proposals that have been evolving since the 20th century. At the same time, there is a certain consensus in the scientific community that the current economic model no longer responds to the needs and problems of society. For this reason, it is convenient to build new scientific and technological development agendas that aim to maintain and reproduce life in the fullest sense. This while gradually reducing foreign dependence because of the high costs involved in the transfer and import of technological goods and services, Oficina de Información Científica y Tecnológica para el Congreso de la Unión (Office of Scientific and Technological Information for the Congress of the Union) - INCyTU, 2018. In short, the value of these proposals is that they consider ecological, territorial and socioeconomic aspects, in order to design public policies that will ensure sustainable agri-food systems.

CONCLUSIONS

Production logistics of the agri-food sector, are largely determined by demand from the world food market. This demand is based on a few companies and is generally oriented to satisfy the tastes, preferences and needs of the global north, whereas the remainder of the population does not have access to healthy, nutritious, safe and culturally appropriate food.

The current dynamics of the agri-food sector in Mexico has generated major problems. These are notable in terms of their relationship with the environment, the overexploitation of natural resources and the contamination of ecosystems. In the social sphere, there is

exclusion, marginalization, poverty, oblivion and abandonment of people who do not align with the strategies of the agricultural export market. Other even more pressing aspects relate to the indiscriminate use of agrochemicals, which cause more and more health problems among the population.

It is essential to reverse the current dynamics of the agri-food sector and put it on a anew trajajectory from its origins towards the reproduction and maintenance of life. Most of the strategies to rescue the agri-food sector are not new and are complemented by the most up-to -date technologies. The technological proposals that comply with these principles are family farming, agro-ecology, organic agriculture, bio-economy and certain advances in biotechnology as well as what is now known as agriculture 4.0 and 5.0, which is also important. Besides this, a profound economic and social reorganization is required, which the social solidarity economy could implement. This transformation, although appearing mandatory in rational terms, this will not be easy and we surmise it will not be peaceful, as economic interests will be affected.

We consider that these alternative proposals on the future of the agri-food sector, should consider ecological, territorial and socioeconomic approaches to promote transformations. These represent fundamental aspects in terms of the design of public policies for health, food, education and scientific and technological development. To the contrary, should current dynamics continue, hunger, malnutrition, food excesses, and obesity will persist; and consequently, modern health problems related to chronic degenerative diseases are likely to radically increase.

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