

Research Article

PRODUCTIVE ARTICULATION IN MEXICO IN TOMATO CULTIVATION, FUTURE ACHIEVEMENTS, AND CHALLENGES, 2023

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Abstract

The Primary Sector, the support of the world economy, is undergoing serious transformations, such as the breaking of links in productive chains, incorporating transnational actors into the production of natural products and boosting the industrial, commercial and services sector; which has been subject to strengthening, in important countries of the world as well as in emerging economies. For this reason, the case of tomato in Mexico is addressed, in producing areas, to determine the degree of participation of actors of the productive group in the value chain, suggest alternatives and solution improvements in production, and the participation of groups of interest; the cultivation, harvesting and marketing of tomatoes; exposition of the productive chain and integration based on the quintuple helix model, (Carayanis and Campbell, 2012), the objective of this article is to analyze the productive articulation in tomato production in Mexico and the participation of the various actors, companies, government, academia and society to know the scope and challenges for the future. The methodology is a qualitative approach based on content analysis, identification of areas of opportunity to counteract dysfunctions and government support for the sector.

Keywords: Productive coordination, Economic actors, Value chain and Tomato cultivation.

INTRODUCTION

Mexico is characterized by being one of the main tomato producers internationally. The income is significant for the GDP (Gross Domestic Product) of the country, (INEGI, 2022). The productive articulation of tomato in the country is part of a link that exists between sectors that are relevant and influence the value chain, such as; The government, business, academic and social sectors, each one, intervene directly in the future of the agricultural sector, specifically tomatoes. A significant event was the COVID-19 pandemic, which brought a drop in the production figures of this resource. With events like this, challenges can arise at any time, modifying the scope and opportunities planned by agribusinesses and the government. It is relevant to know about the productive articulation, what relationship each sector has with each other, and in turn each one how it intervenes in the value chain; to begin to identify the future challenges that Mexico will have in tomato cultivation. The objective is the analysis of productive articulation focused on tomato production and that its study allows us to know the scope and challenges for the future.

METHODOLOGY

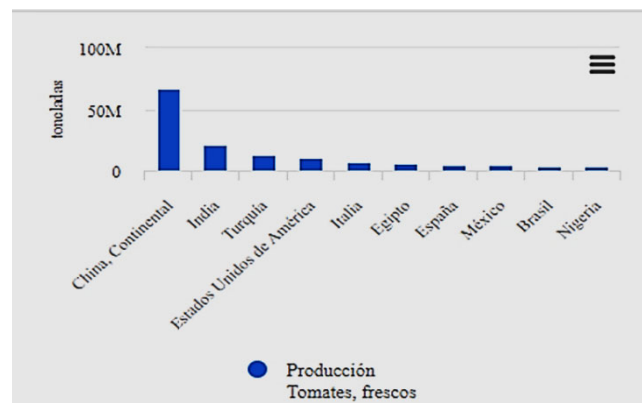
For this study, the qualitative approach is taken, since the research seeks to understand tomato production, based on the analysis of the value chain within the productive articulation in Mexico. One of the techniques used to collect information is "Content Analysis", which is based on reading (textual or visual). The essence of this method is that it is carried out in a systematic, objective, replicable and valid manner, with this, recent articles were compiled in relation to tomato production. Another technique, "Exploratory Research", which is used to study little-talked about problems, this in order to obtain

a general understanding until the investigations that arise in the process, to help answer questions about what, why and as. The information was taken from secondary sources; pages of government agencies, producer associations, main tomato farmers, websites with academic articles related to the topic of productive coordination and the primary sector.

Theoretical framework and research findings

International tomato production in Mexico

Tomato also known as "red tomato" - *Lycopersicon esculentum L.* - is a round or oval red vegetable. Highly valued for human consumption, it also generates considerable income, jobs, and a high nutritional value for the diet (Agriculture and Development R, 2016). According to the FAOSTAT statistical database (Food and Agriculture Organization of the United Nations, 2021), it was noted that the main tomato producers were; China, India, Turkey, the United States of America, and Italy.



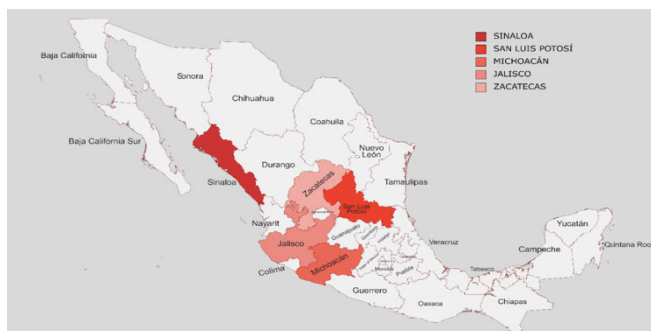
Source: FAOSTAT (2023)

Figure 1. Top 10 countries with the highest production of fresh tomatoes

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The order of each region is from highest to lowest number of tons produced and indicates that China is at the top with 67,538,340 tons, followed by India with 21,181,000, Turkey with 13,095,258, and the United States of America with 10,475,265, Italy with 6,644,790, Egypt with 6,245,787, Spain with 4,775,380, Mexico in 8th. Place with 4,149,241, Brazil with 3,679,160, and Nigeria with 3,575,968. In order to outline the research, it is necessary to know the history of production of the product in Mexico; in recent years the participation of states such as Sinaloa, San Luis Potosí and Michoacán has been notable. Next, a map of the main tomato-producing states in 2018 is shown, where the color red in its different shades shows the position of each state. The brightest red is the highest producer and the lightest red is the lowest.



Source: Own elaboration, based on data from SIAP-SAGARPA (2019)

Figure 2. Map of the main 5 tomato producing states

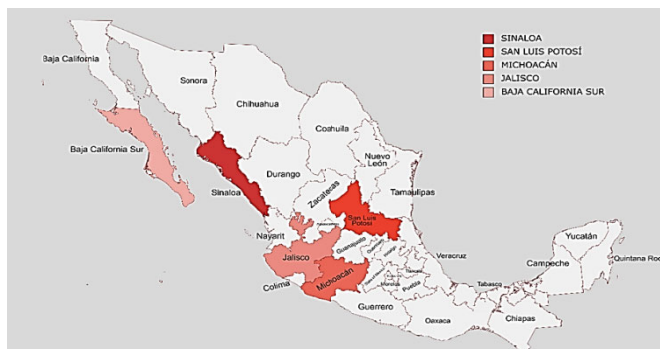
The following table specifies the number of tons produced in 2018 by each federal entity.

Table 1. Main 5 tomato producing states

Position	State	Quantity produced (t)
1	Sinaloa	1'088,252
2	San Luis Potosi	393,582
3	Michoacan	281,848
4	Jalisco	189,848
5	Zacatecas	182,773

Source: Own elaboration, based on data from SIAP- SAGARPA (2019)

In March 2020, the start of the COVID-19 pandemic became official, and from this date things changed significantly; Because the economy was affected throughout the world, companies went bankrupt, causing a massive loss of jobs and other economic sectors were affected, including agriculture. Below is a map of the main tomato-producing states in 2021. The dynamics are the same, the color red in its different shades shows the position of each state. The brightest red is the highest producer and the lightest red is the lowest.



Source: Own elaboration, based on SADER-SIAP data

Figure 3. Map of the main 5 tomato producing states (2021)

The following table specifies the number of tons produced in 2021 by each federal entity.

Table 2. Main 5 tomato producing states

Position	State	Quantity produced (t)
1	Sinaloa	677,612
2	San Luis Potosi	440,876
3	Michoacan	283,259
4	Jalisco	197,679
5	Baja California Sur	173,540

Source: Own elaboration, based on SADER-SIAP data (2021)

One of the changes seen for 2021 was the large decrease in tons produced by Sinaloa compared to 2018, but the rest of the states increased their production. In addition, Baja California Sur displaced Zacatecas, taking fifth place in the table. The pandemic brought changes in agriculture, but over time this sector evolved technologically in response to the situation. For the year 2023, the SIAP (Agri-Food and Fisheries Information Service) reported that "if growing conditions are normal, for the 2022/23 season, Mexican tomato production is expected to remain at 3.70 million tons, based on the increase in yields as the use of greenhouses and other production technologies continues to expand in the sector" (Bernal, 2022).

Productive articulation

Productive articulation (PA) is part of a link between economic actors that relate to each other for the same objective. The voluntary interaction between these agents is representative of a productive community that seeks mutual benefit. It is possible to find different modalities of productive articulation such as clusters, business networks, industrial districts or local productive arrangements, depending on the country or international region where the concept is applied (Huerta, 2013). Every production cycle has a productive articulation and its value chain, for its analysis giving a specific approach to tomatoes in Mexico, we will work with four important sectors; business, government, academic, social and environmental, (Carayanis and Campbell, 2012). Each of these are linked to the value chain, therefore, they directly affect the cultivation, harvest and marketing of tomatoes.

Triple, quadruple and quintuple helix relationship with the productive joint

In the last decade of the 20th century, the concept of the "Triple Helix" emerged (Etzkowitz and Leydesdorff, 2000), in which the interrelationships between the business sector, government and academia were established, pointing out concrete actions suggested for each one. of the actors in productive articulation projects in the industrial sector, but also years later it was incorporated in the tertiary sector, commerce and services, some important aspects of this model is the contribution of each of the interest groups (actors) in the projects For example, companies with the manufacturing, distribution and marketing of products; the government with the definition of legal-legal guidelines and public policies for the operation of cluster initiatives, the academy with the performance of basic and applied research) for the integration of proposals from the organizations that comprise it (Lindqvist *et al.*, 2013). Years later, the "Quadruple Helix" model appeared (Carayanis and Campbell, 2012), which incorporates the participation of civil society in innovation projects, giving rise to the knowledge society and with it "democratic"

participation, which may have a “political” connotation, however, the broader vision of productive articulation is important. Finally, the “Quintuple Helix” (Carayanis and Rakhmatullin, 2014) has been disseminated in recent years, aligning the SDGs (UN, 2015) with the concept of the environment, in addition to the four helices noted above; The aim of this model is to develop projects in which the different sectors are involved in the approach to caring for the ecological environment and achieve a balance between the different participants in the concept. The meaning of productive articulation from the different helix approaches allows the development of projects linked to the primary sector that facilitate the interaction of all its participants (Huerta, 2013).

Value chain and its actors involved

“The value chain according to the Government of Mexico is part of a theoretical concept that describes the way in which the actions and activities of a company are developed” (National Institute of Social Economy, 2019). Pavel (2018) mentions that the value chain is part of a circular economy, it carries the interest of interested parties. Creating a value chain requires having a competitive advantage to be able to satisfy customer demand in an economical and competitive way. Focusing on tomato cultivation, the value chain refers to those “links” that are part of and intervene in an economic process, starting from raw materials (cultivation) to distribution (sale). For each “link”, a value is added that, translated into competitive and economic terms, is the amount that the consumer is willing to pay for a certain amount of tomato. The value chain can be enriched by two means; one is for the primary activities, which refers to the actions that focus on physical processing (cultivation, harvesting, washing, etc.) and the other is for the transfer process to the buyer (sales, distribution, marketing, etc.). According to (David, 2014), the analysis of the value chain implies for business organizations, determining all the primary and secondary activities that are linked to the determination of the cost and value of the product or service to the public, significantly in Compared with competitors, it is important to know what relationship each sector has in the value chain and how it affects tomato cultivation.

Business sector

Demand is constantly changing, but in recent years there has been a decisive and permanent increase. The main reason, the growth of supermarkets. This has caused profound changes in the production, collection, transportation and marketing processes of tomatoes. The modifications have been enormous, the land, as a resource, has been exploited beyond its natural capacity. For “better use” they add different types of chemicals to the crop that modify the tomato, growing in greenhouses. remembering that the function of a greenhouse is to provide artificial conditions (microclimate), to generate greater productivity to the crop in a short time. This causes a reduction in the cycle of open-air plants (Raymond, 2017). Companies easily opt for this method, since it has advantages and comforts, including higher yield, lower production risk, possibility of growing all year round, obtaining product out of season, control of pests, weeds or diseases, greater comfort and safety. Despite climate changes, Mexico continues to be one of the largest tomato producers. Since it still has the appropriate weather conditions and natural resources for its production,

therefore, it would be inconsistent that, being one of the countries with the highest production, the cost of this vegetable is high. So, to meet the demand, what companies do is exploit the land, add chemicals and see greater profitability with the use of greenhouses. Now, the relationship that the business sector has with the tomato value chain is great; It can be said that the increase in demand caused by supermarkets has led companies to exploit all artificial resources to respond to demand. The natural production processes that occurred before, with which we work today, have modified the activities in the value chain. Therefore, the chain is affected by the change in the way in which tomato cultivation and production activities are carried out. The fact that chemicals are used as part of the resources and the use of greenhouses alter and harm the quality, flavor, as well as benefits of the vegetable. Currently, every organic product is equal to quality, since the process and development is respected, having the benefits and natural characteristics of the tomato.

Academic sector

The objective of culture and education is to train people with knowledge capable of transforming or creating something positive for the world; Education at a higher level is even more significant and specialized, with the pedagogical field being part of one of the sectors related to the productive articulation that provides support to all actions that support the growth of the country, and among them is agricultural activity. At the end of each calendar, universities see professionals graduate to collaborate in their field; that in the field of agriculture, people are created who develop, promote and create positive actions within the field. One of the most prominent universities is the University of Guadalajara (UDG), which has the Jalisco University Network (UDG), through one of its centers such as the University Center for Biological and Agricultural Sciences (CUCBA), where they carry out studies on these topics in the field. That adds the contribution of scientific research, which invites us to analyze critical or important situations that are related to progress or advancement in the improvement of the country's agricultural sector. And according to the results of the research or analysis, strategies or feedback are created that support the development of the problem or situation.

Social sector

Tomato production is for the benefit of the entire population, therefore, the help of third parties is necessary; for this, there are associations, which are groups of people who work collectively, with the aim of supporting the same cause, these are non-profit. The Law of Agricultural Associations, article 2, mentions that Agricultural Associations are considered by the State as cooperation organizations and are established with the union of the country's agricultural producers in order to generally promote the development of the Nation's agricultural activities and the protection of the interests of its members, encouraging the development and improvement of the production processes and marketing of agricultural products. The Mexican Foundation for Rural Development, AC is a non-profit institution, which has the mission of promoting increased productivity and human development of farmers, their families and rural communities. These associations add education and entrepreneurship as part of the activities to promote in worker communities. There is also the National Agricultural Council (CNA), an organization for the representation, defense and promotion of agri-food activity that

supports 1.8 million primary producers (small and medium), representing both the agricultural sector and the common interests of its members, helping to promote the Mexican countryside (investment, transformation, added value, productivity, among others). The social sector represents free, non-profit support; which invites producers to feel motivated and protected by third parties; This influences the tomato production value chain in different aspects; the motivation to continue with agricultural activity, improve processes, create new opportunities and the well-being of workers.

Government sector

In Mexico, the Ministry of Agriculture is a Department of the Federal Executive Branch, whose objectives include promoting the exercise of a support policy that allows us to produce, take advantage of and improve the comparative advantages of our agricultural sector and integrate environmental activities. rural sector to the productive chains of the rest of the economy that stimulate the collaboration of producer organizations with their own programs and projects, as well as with the proposed goals and objectives, for the agricultural sector, contained in the National Development Plan, (*Secretariat of Agriculture and Rural Development, 2018-2024*). The institutional objective focuses on coordinating, researching, analyzing and proposing strategies that help provide an innovative, productive and inclusive approach to food self-sufficiency, rural development and well-being of the population. Consolidating the production and supply of quality food.

In recent years, the sustainable aspect has been taken with greater importance, since it has been a factor that has generated relevant changes in the country's production; In the current situation of the agricultural sector, it has become difficult, both for the government and for farmers, since there have been disorders in natural resources for the production and development of agriculture. The fields have become infertile (soil erosion), climate change harms crops, deforestation and even crime (cartels) has taken over the land dedicated to cultivation.

In response to these problems that invade agriculture in Mexico, today, programs have been created by the Ministry of Agriculture and Rural Development (SADER) with the purpose of helping the development and promotion of agriculture. Some to highlight are; "Production for well-being", this provides direct economic support to small and medium-scale producers, preferably producers of corn, beans, wheat and rice; Another program is registered as "Fertilizers for well-being", which consists of delivering fertilizers to producers of priority crops, in order to continue and improve food production. Finally, the "Promotion of Agriculture, Livestock, Fishing and Aquaculture", which deals with calls to promote the activity.

The government is a sector that can greatly influence a situation, whether social, economic and educational, and it is the economic power they have, the same as that of responsibility. So far this sector has tried to make progress with some problems, but no response has been seen in the area of violence. The cartels have invaded territories, carts and even businesses. The National Guard has been one of the most perceived actors, since it can be seen patrolling in strategic areas of the country, but this is not enough to solve the problem that harms the agricultural sector.

Environment Sector

The incorporation since 2015 of the Sustainable Development Goals (SDG, 2015), has directed the other sectors, government, academia, business and social, to pursue purposes aimed at the development of policies, activities and systematization of processes to reduce the impact on environment, in alignment with international provisions in this regard. The challenge for the primary tomato sector is to use cultivation, harvesting and marketing systems that are friendly to the environment and to raise awareness among producers about the use of techniques that favor their empathy with sustainability practices.

RESULTS

According to the analysis of the parties related to the value chain, the following results are obtained: The business sector focuses mainly on satisfying the needs of the market, the philosophy followed is ambitious and unstoppable, first of all there is selling, the modification of cultivation techniques or chemical substances to advance the natural production process matters little. of the tomato. This indicates that the business sector is affecting the value chain, since, instead of supporting and respecting the nature of the crop cycle, it is subtracting the quality of the product, modifying processes and adding the necessary substances for forced development and accelerated. There are few companies that support the organic field, this is because there are several factors that can reduce or affect the profit of the business. The academic sector is responsible for supporting agriculture publicly and privately, providing trained and specialized people destined for the well-being and development of agriculture. Likewise, they are dedicated to field research to search for topics that are considered relevant and important. During the analysis, it was perceived that there is very little financial support from the government towards the area of educational research. On the part of the social sector, the support of different associations is present, their existence helps the value chain have a positive increase in value and thanks to the approach given by the cooperatives, benefits can be obtained, seeking to improve and encourage production, Likewise, safeguard the well-being of farmers.

Finally, in the government sector, there are social and economic programs to support agriculture; But the same importance must be given to the promotion part, since with the passage of time a decrease in the number of producers can be seen in the future. Mention that in some way the environmental sector is related to interest groups; producers are affected by different factors; increase in processed products, insecurity, shortage in promotion for agricultural activity, among others. The average education of farmers is below what is considered "basic." Therefore, there is little knowledge of the rights that correspond to them, and it is also difficult for them to act in the face of insecurity problems. Therefore, they must approach the authorities to know their rights by law as citizens and farmers. Crime is increasingly affecting the population, the agricultural sector is beginning to look vulnerable, since one of the problems that is considerably affecting tomato producers is drug trafficking due to the change in land use.

Conclusion

Given the results obtained from the content analysis, there are sectors that currently provide positive effects to the value chain, they are heading towards a path of development and

well-being for the country. A clear example is the academic and social sector; Well, the first provides all possible support through the people who make up private and especially public institutions, in the same way, the social sector offers non-profit support to small tomato producing companies. However, issues need to be improved for the rest of the parties. For the business sector, world authorities need to force companies to carry out a strict regime for the reduction or prohibition of acceleration processes and the use of chemicals in foods produced in countryside. But this is very difficult, since the interests both parties take precedence, both for the global economy and for the business world. In that case, it is necessary for market, that is, the consumer, to avoid buying processed foods and support organic consumption.

The government sector can influence many issues to collaborate with the different problems encountered. Primary there is the aspect of social programs for farmers; great importance must be given to the promotion and compensation for agricultural activity, since there are fewer and fewer people willing to work in the fields. On the other hand, a problem that is becoming very important are criminal groups related to drug trafficking, who are appropriating crop fields, affecting the production and work of producers. Different solutions can be given to combat this problem, but reality limits possibilities. The level of insecurity affects many aspects. They have better weapons compared to the authority, they harm citizens and threaten to do it again if the government does not cooperate and if that were not enough they force people to join. With this scenario, it is very difficult to face the crime face to face.

Table 3. Proposals for the Quintuple helix

Interest group	Proposal
Business	<ul style="list-style-type: none"> Carry out strategies focused on benefiting the environment; improvement of processes for the reduction of natural resources, etc. Give a natural and organic approach to products, in way that is profitable.
Academic	<ul style="list-style-type: none"> Continue with the contribution towards research and development of agricultural activity. Persisting with the conviction made for better financial support for the research area.
Social	<ul style="list-style-type: none"> Consume organic products. Report acts that threaten agricultural activity. Hold meetings with the different groups so that they can provide solutions to the sector. Programs to raise awareness among citizens to avoid the consumption of processed products.
Government	<ul style="list-style-type: none"> Programs with greater focus on the promotion and compensation for agricultural activity.
Environment	<ul style="list-style-type: none"> Producers must assert their rights more, demand protection and security. Greater influence on the part of World Authorities to promote and raise awareness in society in a more aggressive way.

Source: Own elaboration, 2023

Despite the negative points to work on, Mexico is a country that provides many benefits in terms of diversity, the climate still lends itself to respecting the cultivation process, with the need to modify and add chemicals to accelerate production you can see how one sector can affect the other within value chain, as well as the importance of each of these, to generate positive or negative changes that contribute to benefit or harm the other in an important way.

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