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Competitiveness of Zacatecas (Mexico) Protected Agriculture: The Fresh Tomato Industry

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Abstract

The industry of fresh tomato production under protective structures in Zacatecas has undergone accelerated growth in recent years. Free trade, market globalization, new trends in the agro-food sector, as well as the food and financial crises, are impacting its competitiveness. In this study competitiveness of the industry of fresh tomato production under protective structures in Zacatecas was evaluated to provide elements that contribute to the design of policies aimed toward development of sustainable competitiveness. A systemic competitiveness model was applied, and a SWOT analysis was performed. The information was obtained through interviews with technicians and/or owners of the production units and complemented with interviews with researchers and government authorities. It was shown that a high level of technology is a necessary, but not sufficient, condition for achieving sustainable competitiveness.

Keywords: development, technology, greenhouses, systemic competitiveness

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Introduction

Protected agriculture is a broad category of production methods in which there is some degree of control over one or more environmental factors. The structures under which protected agriculture takes place can vary from the simplest, least expensive shade house to the most costly, high-tech greenhouse with automated climate control. In the state of Zacatecas, as in other regions of Mexico, protected agriculture production systems have seen accelerated growth in recent years. The mean annual growth rate of the cultivated area from 2001 to 2007 was 30.5%. Currently, this area is estimated to be 184.2 hectares, 95% of which was cultivated under tomato (Padilla-Bernal, Rumayor-Rodriguez, and Pérez-Veyna 2008), accounting for around 10% of the total area of Mexican covered horticultural production (Cook 2007; Padilla-Bernal, Rumayor-Rodriguez, and Pérez-Veyna 2007b).

The rapid expansion of protected agriculture in the state of Zacatecas is attributed to several factors. First and probably the most compelling is the potential return on investment; these production systems can be highly profitable because of the favorable climate in production regions. In those such as the Zacatecas high plateau, where climate is temperate, dry and with good conditions of sunlight, it is possible to lengthen the growing period or to produce year-round, meaning extraordinary profits for the growers. A second factor is proximity to the US border; the US is the largest export market for Mexican tomatoes. A third is support from government organisms; government programs provide support for protected agriculture installations. The state government, during its last two development plans (1999-2004 and 2005-2010), has promoted protected agriculture as part of the strategies aimed to reactivate the rural sector. Government authorities at the local and federal level have encouraged protected agriculture projects as a way to offer employment opportunities and improve the welfare to rural producers (Sagarpa 2006; 2008; Sedagro 2008).

As in Mexico, in the US and Canada the greenhouse tomato industry has shown high growth rates. Expansion began in the 90s (Cook and Calvin 2005), but recently growth has become stable[1]. Even though Mexico was the last of the three competitors to enter the industry, it now has a larger area, which continues to expand rapidly (Cook and Calvin 2005; Padilla-Bernal, Rumayor-Rodriguez, and Pérez-Veyna 2007a). In terms of technology and yields, however, Mexico has lagged behind. In 2006, average greenhouse tomato yield in Mexico was estimated at 130 tons per hectare, while in the US and Canada yields are more than 450 tons (Cook 2007). The low average yields in Mexico are attributed largely to the wide range of technologies used by growers, from shade houses and macrotunnels to permanent greenhouse structures with limited or passive environmental control and high-tech greenhouses with both fully active environmental control and hydroponics.

One of the characteristics of the fresh tomato industry under protected agriculture in Mexico is its high concentration. Like that of field production, a few companies control a large part of the production (Wilson and Thompson 2004; Padilla-Bernal, Thilmany and Loureiro 2003). The US is the largest consumer of this type of tomato and imports more than it produces (Cook and Calvin 2005). In recent years, imports have increased faster than production. Canada exports

[1] The mean annual growth rate during the period 1994-2006 was 16.5% in the US and 11.5% in Canada, while from 2003 to 2006 it was 3.5% and 1.2%, respectively.

60% of its production to the US, and almost all of the greenhouse tomatoes produced in Mexico are sold in the US or Canada (Cook and Calvin, 2005; USDA-AMS, 2005; Cook, 2007). At present, the demand for greenhouse tomatoes in Mexico is limited, but will probably grow in the near future. It is estimated that only 15% of Mexican greenhouse tomatoes are sold on the domestic market; this is attributed to the possibility of selling lower quality rather than to strategic marketing decisions.

A consequence of rapid growth of the tomato industry under protected agriculture is lower prices on the US market, especially during the summer when the three countries offer their produce (USDA-AMS 2005) and the retail demand for greenhouse tomatoes in the US market is saturated (Cook 2007). Simultaneous placement on the market has led to legal disputes among groups of growers of the three countries (Cook 2002; Cook and Calvin 2005). Once all of the duties on vegetable imports in North America are eliminated, market protection will take on the form of non-tariff barriers.

Although tomatoes can be produced anywhere in any season, especially in greenhouses, aspects of profits still impose seasonal limits on production, in particular in the US and Canada, where greenhouse production is impacted by climate. Because of the low winter temperatures in the US and Canada, costs soar and production is limited. One of the weaknesses of the Canadian greenhouse tomato industry is the lull in production during the winter, while the principal US greenhouse tomato growers produce year round, though it is difficult to find a region where production is as profitable in the winter as it is in the summer (Cook and Calvin, 2005). The four largest enterprises are located in Arizona, Texas, Colorado, and coastal southern California and account for 67% of domestic production. High prices during the winter help the year-round US producers withstand the very low prices during the summer season. However, expanding winter production in Mexico will likely decrease prices and put competitive pressure on year-round growers in the US. The largest exporter of greenhouse tomatoes in Mexico, Desert Glory, a US firm operating in Jalisco and Colima, ships tomatoes year-round (Cook and Calvin 2005), thanks to the region's mild climate. Sinaloa, the main fresh field tomato exporting region in Mexico and a leader in greenhouse-tomato export, because of the hot, humid summers, produces only during the winter (Padilla-Bernal, Thilmany and Loureiro, 2003). But large field-grower exporters in Sinaloa and the Baja California peninsula are also experimenting with protected agriculture, either shade houses or greenhouses, near their field operations. In sum, in Mexico, increasing attention is being given to the location and structure of the production units in order to minimize the costs of creating the ideal conditions for vegetable production for a specific market niche. The main strength of the protected vegetable growing industry is Mexico's climate, which allows production during winter in some regions, such as the high altitude temperate regions of central and northern Mexico: Zacatecas, Chihuahua and northern Sonora, near the US border. Year-round production is a factor that can encourage growers to invest in advanced technology. On the other hand, the main obstacles for this industry are: the high cost of capital, high energy costs, inexperienced management, lack of infrastructure and input suppliers, as well as the inconsistent quality of the produce, implying lower prices for Mexican growers (Cook and Calvin 2005; Padilla Bernal et al. 2007a). These critical points require special attention since they limit the industry's competitiveness.

Globalizations, aperture of the economy, and market liberalization have totally changed the economic and entrepreneurial context. Also forming part of the new context of agribusiness are the financial and food crises and the changes that directly impact the agro-food sector, such as reduction or elimination of government support, rapid technological advances (informatics, microelectronics, biotechnology, genetic engineering, nanotechnology, and telecommunications), and greater concern for environmental protection. In addition to this is the demand from consumers oriented by criteria of quality, food safety, convenience and nutrition (Brambila 2006; Kinsey 2005; Suárez and Bejarano 2001), which is exerting pressure toward better, more highly differentiated products on both the international and domestic markets. The demand for different foods forms part of the new civilization and the new agriculture considered in the new economy (Brambila 2006). This situation is not foreign to the tomato market; differentiation is demanded for both field grown and greenhouse tomatoes (Kaufman et al. 2000; Calvin and Cook 2001). Today, the economy, as a whole and, in particular, the enterprises of the agricultural sector, is competing not only in international markets but also in the domestic market. They are facing the phenomenon of global hyper-competition on the local market (Altenburg, Hellebrand, and Meyer-Stamer 1998; Villarreal 2007). To survive, the enterprises must have international quality and standards of efficiency as their production goal, as well as the attributes of speed, global perspective, and permanence (Brambila 2006). This is a difficult challenge, and to be able to meet it depends both on an organization's internal decision-making and on decisions made on the outside.

Presently, an enterprise's competitiveness is in function not only of its productivity, level of organizational learning, technological development, market prices and customer satisfaction, but also on regional incentive policies, links with sectorial and entrepreneurial cooperation, macroeconomic and international context, as well as the security and trust of society (Esser et al. 1996; Villarreal 2007). That is, competitiveness is a systemic phenomenon; being competitive is required at the enterprise, sector, national economy, government and institutional levels.
In this context, an isolated enterprise cannot be competitive since competition is not between enterprises; it is present in the enterprise-chain-cluster-regional pole-country scheme, which requires efficient integration of the global value chain and efficient operation at each link (Esser et al. 1996; Meyer-Stamer 2005; Villarreal 2007). In this scheme, enterprises of all of the productive sectors should seek a sustainable competitive advantage based on the capacity to learn and innovate, as well as on technological, productive and organizational changes.
The objective of this study was to evaluate the competitiveness of the industry of fresh tomato production under protective structures in Zacatecas to provide elements that contribute to the design of policies aimed toward development of sustainable competitiveness. The analysis parted from the classification of production units by technological level and destination market for the tomatoes. Two research questions were answered by this study: Are the export-oriented production units more competitive than those that sell their produce only on the domestic market? Do the production units with a higher level of technology have more developed competitive capital?

Methodology

To evaluate the competitiveness of the industry of fresh tomato production under protective structures in the state of Zacatecas, a model of systemic competitiveness was applied following

Esser et al. (1994; 1996) and Villarreal and Villarreal (2002; 2003). Under this approach, the competitive position of this industry is determined in an integral form within a globalized setting. The starting point is the principle that competitiveness is not an isolated effort, but rather it involves changes and interrelationships at different levels within the economic system. The analysis was conducted under an integral approach that includes the microeconomic level as well as the mesoeconomic, macroeconomic, international, institutional and sociopolitical levels. The research presents how each of these levels contributes to the ten class of capital formation of the industry's systemic capital was determined within the industry. These ten sources of capital frame the level of the industry's competitiveness and This is integrated with the ten capitals of competitiveness (Table 1), which are the pillars of sustainable growth in an open economy (Villarreal 2007).

Table 1. Levels of economics and competitive capitals for the formation of systemic capital

Economic level	Competitive capital
Microeconomic	Entrepreneurial
	Labor
Mesoeconomic	Organizational
	Intellectual
	Logistic
Macroeconomic	Macroeconomic
International	Commercial
Governmental and institutional	Governmental Institutional
Political-social	Social

Source: Villarreal 2007.

The information required was obtained using a questionnaire, which was applied during interviews with 45 technicians of the production units from March to May 2008. This information was complemented with ten interviews with owners or managers. In addition, from May to August of the same year, two researchers of INIFAP (National Institute for Research in Forestry, Agriculture and Fishing) and one from the Universidad Autónoma de Zacatecas (UAZ) were interviewed, as well as five functionaries of state government institutions related to programs of protected agriculture. The criteria used in the selection of the production units for the study were the following: a) size, ≥2,500 m^2, b) production of vegetables, excluding production of seedlings and flowers, and c) willingness of the people to answer questions. With the information obtained from the interviews, competitiveness indexes were obtained by capital and at each economic level studied. Furthermore, a SWOT analysis for the development of systemic competitiveness was conducted. The interviewees evaluated themselves by responding to groups of statements referring to the indicators related to the formation of the different competitive capitals. The interviewees responded by expressing their agreement with the statements on a scale of 3 to 0: 3=totally agree, 2=partially agree, 1=disagree, and 0=does not exist. The information was processed for each of the indicators, capitals and economic levels analyzed, calculating the maximum number of points per level. A similar scale was used by Giuliani, Pietrobelli and Rabellotti (2005), who also determined the indexes in a like manner, to explore how small-and medium-sized Latin American enterprises (SMEs) may participate in global markets in a way that provides for sustainable growth. They analyzed the degree of collective efficiency and levels of upgrading the clusters in Latin America. The index by level represents the relationship between the points of the level studied with respect to the highest

possible number of points. To enable us to make comparisons, the maximum number of points was considered to be 10. Thus, an average response of 3 would be equivalent to 10. Finally, the systemic competitiveness index of the protected tomato production industry in Zacatecas was obtained by averaging the indexes of the capitals considered.

Table 2. Destination markets by size of the production units of the industry of fresh tomato production under protective structures in Zacatecas

Type of market	**Size of production unit**			
	Small	*Medium*	*Large*	*Total*
Local	6	4		10
National[1]		8	11	19
Local and national[1]		3	1	4
Local, national[1] and international			1	1
National and international		2	8	10
International			1	1
Total	6	17	22	45

Note: [1]Tomatoes are sold in other states of the Mexican Republic.
Source: Constructed by authors with data obtained during field work.

Table 3. Definition of variables and clusters of protected fresh tomato production units

		Low technology		**Transition technology**		**Intermediate technology**		**Advanced technology**	
Variable	**Description**	*Mean*	*S. D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
Structure	Type of structure covering the largest area of the production unit 1 = Almeria type 2 = Multitunnel	1.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
Climate control	Type of climate control 1 = Automated 2 = Mechanical 3 = Manual	2.9	0.3	2.3	0.8	2.3	1.2	1.2	0.3
Cultivation technique	Type of cultivation 1 = Hydroponics 2 = Soil 3 = Soil and hydroponics	2.0	0.0	2.0	0.0	3.0	0.0	1.0	0.0
Size	Size of the production unit 1 $\leq$ 2,500 m^2 2 2,501-15,000 m^2 3 > 15,000 m^2	2.3	0.8	2.2	0.6	2.7	0.6	2.8	0.4

Note: A unit of production with a macrotunnel structure was not included. For the analysis it was included with the low-tech production units.
S.D. = Standard deviation.
Source: Constructed by authors with data obtained during field work.

Competitiveness indexes were also obtained by grouping the enterprises by the market where they sell their tomatoes, domestic or international (Table 2), and by level of technology, for

which the cluster analysis technique was applied. Clusters were determined by the hierarchical analysis procedure with the group linking method using SPSS v16 software. The following variables were considered for clustering: a) structure, b) climate control, c) cultivation technique, and 4) size[2]. Using the clustering report and tree graph, four groups of production units were defined: low technology, transition technology, intermediate technology, and advanced technology (Table 3).

Results

With the field work, we found that 174.1 ha cultivated under tomatoes in 2007 were distributed among 45 production units. The survey represents about 94.5% of the total cultivated area. It is very likely that to date (2009) the total area has changed since, according to government records, 40.5 ha of protected agriculture were granted support (SEDAGRO, 2008) in 2007. Regarding structure type, 54.4% of the total area has Almeria-type structures, 28.6% multitunnels, and a smaller proportion was found with shade house-type structures (7.5%) and macrotunnels (9.5%).

Some growers, to reduce investment or to identify more suitable technology, have decided to experiment with different types of structures or with cultivation techniques. Within the same production unit, there are areas with Almeria-type structures and others with shade houses, or some other combination[3]. They also experiment with cultivation techniques: hydroponics, soil, soil and hydroponics. Regarding climate control (automated, mechanical, or manual), it was most common to find production systems with limited environmental control; in only eight production units climate control is automated.

Competitiveness at the Enterprise or Microeconomic Level

Competitiveness at the enterprise level is the starting point for an analysis of systemic competitiveness. At this level, we analyzed the elements that contribute to the formation of the entrepreneurial and labor capitals. Competitive enterprises are those that satisfy the criteria of efficiency, quality, flexibility, and speed (Esser et al. 1996; Brambila 2006). For the evaluation of entrepreneurial capital, we took into account the effort the production units are making to enrich their organizational intelligence, their productive flexibility, and their commercial agility. In the case of labor, their performance and training were evaluated considering the requirements of the new economy (Kinsey 2005; Brambila 2006) in which the generation and transmission of knowledge and new technologies in the development of the entire value chain are necessary to achieve sustainable competitiveness. In the evaluation, considering 10 as the maximum score for competitiveness, entrepreneurial and labor capitals had indexes of 5.5 and 5.7, respectively (Tables 4 and 5). Only 20 of the agro-enterprises had an index of 6 or more. An index value of six, considering 6 the index that indicates that production units have the minimum capacity to deal with challenges of globalization (Centro del Capital Intelectual y Competitividad [CECIC], 2002). Of the remainder, eight are within the range of 5.25 a 5.75 and are considered to be in transit to levels of minimum competitive capacity at the microeconomic scale. The remaining 17

[2] Production units were classified by size following the criteria of the Zacatecas SEDAGRO-SAGARPA Technical Commission of the Greenhouse Program: a) small, up to 2,500 m^2; b) medium, 2,500 m^2 to 1.5 ha, and c) large, more than 1.5 ha.

[3] In some production units, we found several types of structures under construction. For the purposes of this study, we considered the structure that covered the largest area.

production units all sell in the domestic market. They have areas of opportunity that need attention to strengthen their entrepreneurial and labor capitals.

Competitiveness at the Mesoeconomic or Sectorial level

Mesoeconomic competitiveness is substantiated in organizational, intellectual, and logistic capitals, on which the competitiveness of entrepreneurial groups and regional poles of development is founded (Esser et al. 1996; Villarreal 2007). The increasing requirements of the enterprises are augmented by the growing external requirements. This has implicated that they compete not in isolation, but by forming entrepreneurial groups in networks of collaboration.

Organizational capital is based on productive articulation among enterprises, productive sectors, and industries, as well as among regions. This articulation is efficient when it generates clustered economies that contribute to the collective efficiency of the group of enterprises (Villarreal 2002; 2007). Externalities do not totally explain the success of industrial districts; rather, it is necessary to consider the joint deliberated action of the agents. This cooperation implies the gradual development of trust, which forms part of an integrated process in which the enterprises develop long-term cooperative relationships and establish principles to guide their response in the face of uncertainty. This translates into organizational learning to generate collective efficiency (Esser et al. 1996; CECIC 2002).

To evaluate organizational capital, we considered indicators that determine the modality and intensity of cooperation between suppliers and customers (vertical), as well as among growers (horizontal), aspects that can reveal the level of productive articulation of the value chain. The index of organizational capital obtained by the 45 enterprises was 5.3 (Table 4). The indicators with the highest values were those that referred to collaboration between growers and clients (8.9) and between growers and suppliers (8.5). The lowest values were those regarding collaboration and communication among growers: organization for export (1.3), communication to solve marketing problems (2.5), communication for collective buying (3.0), and communication on the use of technology (3.3). The notably weak cooperation among growers limits the production units' ability to remain in the market since competition in today's world takes place among groups of enterprises, regions and countries.

Differentiating among enterprises, the highest organizational capital index was obtained by those with more advanced technology and by export-oriented enterprises (Tables 4 and 5). For the latter, the advantages of productive articulation are clearer. Some of them have already made strategic alliances with growers and shippers located in the US, while others have constituted integrative enterprises to lend support in buying inputs and in marketing their produce.

Intellectual capital was analyzed as a factor of generation of productive knowledge, which contributes to developing sustainable competitive enterprises. In the evaluation of this factor, the following indicators were considered: links with institutes, research centers or universities; ability to develop technology; and type of relationship with suppliers of technology. The value of the intellectual capital index for the enterprises studied was 3.8 (Table 4). Within this index, the indicator with the highest value was their relationship to the supplier of technology (7.7), while the lowest was the ability to develop their own technology (1.6).

It was found that although centers of research and technological development in the state are willing to collaborate, there is little communication with the production units. Most of the enterprises receive technological support from their suppliers, and they are highly dependent on foreign technology. The fact that production units maintain communication with suppliers of technology is not sufficient to develop the capacity to generate knowledge and innovate. They require more solid links with research and development centers, which could help them find possibilities for improvement.

Logistics capital refers to the infrastructure necessary for efficient mobilization of produce and inputs. For this aspect we determined the degree of development of physical, transportation, and technological infrastructure for international competitiveness. For the evaluation of this capital the following indicators were considered: type and efficiency of transport used to move tomatoes, electricity, irrigation water supply, regional telecommunications, ease of access to suppliers, road conditions, and relationship with customs. The value of the logistics capital index was 6.3 (Tables 4 and 5).

Even though water is scarce in the state of Zacatecas, the irrigation water service obtained the highest value (9.0), followed by electricity (7.8). Telecommunications (4.9) and the customs service (1.7) received the lowest values. Thus, as a group, the enterprises require greater attention to the use of information technology. Those with a higher level of technology and those oriented toward export are more capable of delivering their produce to international markets concordant with the requirements of the demand.

Competitiveness at the Macroeconomic Level

Macroeconomic stability is a necessary, but not sufficient, condition for achieving macroeconomic competitiveness (Esser et al. 1994; Villarreal 2007). Also required is overall, sustained growth, as well as efficiency in key variables for enterprise competitiveness, and implementation of mesoeconomic policies. According to Villarreal (2007), macroeconomic competitiveness is expressed in two aspects: macroeconomic dynamics and efficiency. The variables of macroeconomic dynamics were growth and volatility of aggregated demand. For macroeconomic efficiency, besides economic stability, the variables were real exchange rate[4] and competitive financing and fiscal systems.

For evaluation of the macroeconomic level relating to the protected tomato production industry in the state of Zacatecas, we considered the following variables: demand behavior, access to credit, interest rates, and system of taxation. The macroeconomic capital index was 4.7 (Table 4). The indicator that most contributed to the formation of macroeconomic capital was demand behavior. Although most of the growers reported a stable demand, they expect it to increase. A growth trend in production was observed; some growers seek to take advantage of the winter-spring demand by making use of the climate conditions of their location.

The indicator that least contributed to the formation of macroeconomic capital was access to credit, which limits investment in new technology. The results suggest that reforms need to be

[4] The effect of real exchange rate on competitiveness will be discussed in the section on commercial capital because of its importance in international trade.

made in fiscal and monetary policies that would encourage productive investment in the agricultural sector.

Competitiveness at the International Level

Competitiveness at the international level refers to the ability of the industry to become integrated into international trade, efficiently maintaining trade relationships. This implies implementation of government policies oriented toward the formation of commercial capital. These policies would include trade agreements and programs for the prevention of disloyal competition and contraband, which affect growth of domestic industry (Villarreal and Villarreal 2002). For the evaluation of commercial capital, the following indicators were considered: real exchange rate, imported produce and agricultural inputs, contraband of agricultural products, governmental support for exporting and export documentation of tomatoes. The commercial capital index was 4.4 (Tables 4 and 5).

Real exchange rate is one of the most important variables in the formation of commercial capital, affecting relative prices of the economy. The real exchange rate must be permanently competitive. In recent years in Mexico, the exchange rate has been used as an inflationary anchor, an instrument to stabilize prices. This inflationary anchor was achieved at the expense of increasing overvaluation of the peso, which was reported to be 15% by August 2008, although Calva (2007) stated that by November 2007 Mexico had accumulated an overvaluation of 31.2%. Indeed, in the last few months, because of the financial crisis, the exchange rate has been highly volatile.

In the case of our evaluation of protected agriculture in Zacatecas, the real exchange rate indicator was 4.9. This suggests that the exchange rate has affected exports, a situation that could change in virtue of the world financial crisis. In terms of the impact of imports of produce and agricultural inputs, growers did not express feeling threatened by tomato imports. However, they recognize that fresh produce imports constitute serious competition on the domestic market. Export growers also expressed concern for non-tariff barriers to marketing tomatoes in the US, especially during periods of excess supply. Acquiring imported inputs is costly despite the subsidized exchange rate. Regarding contraband of agricultural products, the growers believe that it does not affect their permanence on the market. Export-oriented enterprises declared that documenting their produce for export is not problematic. Those that sell only on the domestic market, however, expressed a lack of knowledge on this matter.

Competitiveness at the Governmental or Institutional Level

At this level, the formation of government and institutional capital was evaluated, analyzing the model of governmental administration and rule of law. The role of the government is considered to be provider of public services and fomenter of economic and social growth through public policies that are effective and efficient, non-bureaucratic, and transparent and that operate with administrative simplification. The rule of law is substantiated by the formation and development of the society's institutional capital (Villarreal 2007).

For the evaluation of government capital, the impact on the production units of the most

important government programs aimed to support agriculture and rural entrepreneurial development were analyzed. To this end, a list was made of the principal government programs for which the production units were eligible. Growers were asked whether they knew of the program. If the answer was yes, they were asked if they had received support from it and at what level of satisfaction. The government capital index obtained was 2.4.
Of the production units studied, 96% received some support for their establishment from Alliance for the Countryside (Alianza para el Campo), most within the program of Support for Agriculture (Fomento Agrícola). The small production units were those most supported by the Rural Development Program (Programa de Desarrollo Rural). Some of these production units are managed by women, who see protected agriculture as an option for increasing family incomes. They do, however, recognize their limitations in the spheres of organization and marketing because they are not able to relate with other growers and they do not have sufficient capacity to take their produce to market efficiently. As for other government programs, it was found that only a few enterprises have received their support; many enterprises have no knowledge of the programs for which they are eligible and so do not take advantage of the government capital available. These results reflect the need for more promotion and information about the different government programs, informing growers about what is needed to be eligible for support.
Institutional capital is related to aspects that contribute to creating a favorable environment for business, such as the legal state and public safety. Institutions are a reflection of the rules of the game in a society and encourage desirable behavior (Visser 2006). Their function is to create the spaces in which individuals can trust, learn, innovate, and achieve their objectives.

The indicators used for the evaluation of institutional capital were documentation and requirements for access to government programs, access to other institutional support, and compliance with food safety norms as set out in the official manuals. The institutional capital index was 6.6 (Tables 4 and 5). Of the production units studied, 77.8% (35) believed that they could work satisfactorily with the institutions; that is, they have an institutional capital index of at least six. Of the group of enterprises satisfied with the institutions, eight sell their tomatoes on the international market. The results show that most of the growers are confident in the work of the institutions.

Competitiveness at the Political-social Level

Competitiveness at the political-social level is founded on the formation of social capital. This is based on the trust the productive sector has in its institutions and is exercised through norms of reciprocity or networks of mutual commitment (Nooteboom 2003; CECIC 2002). There is a close relationship between institutionalism and development of creativity and innovation, which is based on trust, especially in the organizational aspects of innovation. In a market context or in cooperation networks, the information the different actors have about the market is incomplete or asymmetric. There is, moreover, much uncertainty about the characteristics of the products and the reliability of partners or allies in the networks where they participate. Within this context, institutions must create spaces in which the actors can trust and be able to achieve their objectives (Visser 2006).

For the evaluation of social capital the following indicators were considered: membership and collaboration in growers' associations, willingness to serve on the part of state growers'

associations, collaboration with other protected agriculture growers, and quality of service of state and of federal agricultural institutions. The social capital index was 5.2 (Tables 4 and 5). The indicator that most contributes to the formation of social capital is the quality of service of federal institutions (7.3), followed by that of state institutions (5.7). The lowest indexes corresponded to indicators related to collaboration among growers and the service vocation of the growers' associations (2.4). The results show the need to clarify and strengthen the role of growers' associations in the state of Zacatecas and to encourage their creation in the understanding of the role that institutions play in the development of the industry's systemic competitiveness.

Table 4. Indexes of systemic competitiveness of the industry of fresh tomato production under protective structures in Zacatecas by level of technology

Economic level and capital	Low technology	Intermediate technology	Transition technology	Advanced technology	Index
Entrepreneurial capital	5.3	5.1	5.0	7.1	5.5
Labor capital	5.2	5.5	6.3	7.5	5.7
Microeconomic level	5.3	5.3	5.6	7.3	5.6
Organizational capital	5.2	5.6	4.3	5.9	5.3
Intellectual capital	3.4	4.4	3.7	4.3	3.8
Logistic capital	6.2	6.0	6.3	7.2	6.3
Mesoeconomic level	4.9	5.3	4.8	5.8	5.1
Macroeconomic capital	4.2	5.1	4.4	5.7	4.7
Macroeconomic level	4.2	5.1	4.4	5.7	4.7
Commercial capital	4.2	3.8	4.0	6.9	4.4
International level	4.2	3.8	4.0	6.9	4.4
Governmental capital	2.5	2.4	2.7	2.0	2.4
Institutional capital	6.5	7.1	5.6	6.3	6.6
Government and Institutional level	4.5	4.8	4.2	4.2	4.5
Social Capital	5.1	5.2	3.6	6.2	5.2
Political-social level	5.1	5.2	3.6	6.2	5.2
Index of systemic competitiveness	4.8	5.0	4.6	5.9	5.0

Source: Constructed by the authors with data obtained in field work.

Systemic Competitiveness of the Industry of Fresh Tomato Production under Protective Structures

The Index of Systemic Competitiveness (ISC) of the protected fresh tomato production industry of Zacatecas was 5.0 points over ten, 50% lower than that of maximum competitiveness. This index is lower than the 5.5 points obtained by CECIC (2002) in a survey of 160 enterprises of different industrial sectors of the state of Coahuila, Mexico. These results denote a wide gap that the fresh tomato industry must bridge in order to achieve sustainable competitiveness. According to CECIC, the enterprises or sectors commanding the minimum capacity to confront globalization have an ISC of at least 6.0 (CECIC 2002).

Intellectual and governmental capitals are two important areas of opportunity. The investment in technological innovation and development is a key factor for production units to be able to sustain their competitive permanence in the market. Furthermore, greater administrative simplification and transparency are required in the allocation of resources from public programs. The high technology production units are those that are apparently in a better position competitively (Table 4). However, using the Kruskal-Wallis non-parametric statistic[5] test at a 5% (α=0.05) level of significance, no differences were found among the ISC of the four technological groups (p-value=0.137). Also, with the Kruskal-Wallis test applied to the capitals that integrate systemic capital, it was shown that the specified technological groups differed only in the formation of the commercial capital index (p-value=0.01). The other nine indexes showed no statistically significant differences. This means that high technology enterprises, contrasting with the other technological groups, have more highly developed competitive capacity for marketing their tomatoes. To complement our results, according to Padilla-Bernal et al. (2007a), considering a basic scheme of competitiveness, cultivating slicing tomatoes in a high-tech greenhouse is the best option for orienting the greenhouse tomato industry toward sustainable competitiveness.

Table 5. Indexes of systemic competitiveness of the industry of fresh tomato production under protective structures in Zacatecas, market orientation

Economic level and capital	Export oriented	Domestic market	Index
Entrepreneurial capital	7.3	4.8	5.5
Labor capital	6.9	5.2	5.7
Microeconomic level	7.2	5.0	5.6
Organizational capital	6.3	5.0	5.3
Intellectual capital	4.5	3.5	3.8
Logistic capital	7.3	5.9	6.3
Mesoeconomic level	6.1	4.8	5.2
Macroeconomic capital	6.0	4.2	4.7
Macroeconomic level	6.0	4.2	4.7
Commercial capital	6.7	3.6	4.4
International level	6.7	3.6	4.4
Governmental capital	2.9	2.2	2.4
Institutional capital	6.0	6.8	6.6
Governmental and institutional level	4.5	4.5	4.5
Social capital	6.3	4.8	5.2
Political-social level	6.3	4.8	5.2
Index of systemic competitiveness	6.0	4.6	5.0

Source: Constructed by the authors with data obtained in field work.

Unlike the ISC by technological group, the ISC of the group of production units that export is significantly different from those that do not, according to the Kolmogorov-Smirnov Z non-parametric statistic test. However, when this same test was applied to each of the distributions of the ten capitals, the distribution of intellectual (p-value=0.884), governmental (p-value=0.789)

[5] Application of non-parametric methods depends on simple size and the absence of normality in the data; this conditions the use of parametric tests.

and institutional (p-value=0.789) capitals was not significantly different. This reflects the need for better communication between the production units and research and development centers that can help to strengthen their technological capacity by achieving competitive advantage through innovation. Moreover, it is important to promote government programs that can contribute to scaling up the productive units and to inform growers about them. Government should also promote administrative simplification and actions aimed to instill trust in government organisms.

In the SWOT matrix of the industry, the principal problems and obstacles to the formation of each of the capitals studied are synthesized, as are its strengths and opportunities (Table 6). The main strength of the industry in Zacatecas is the climate of the high plateau, which allows lengthening the growing season, and when the temperatures are not too low, it is possible to produce during the winter with little or no fuel, which, in the face of the financial crisis, opens up an opportunity to increase the number of production units that export. To do so requires greater consistency in production, better yields and the adoption of good agricultural and management practices. The main weaknesses are insufficient productive articulation, lack of training for workers and administrative personnel, as well as an extreme dependence on foreign technology and inputs and little relationship with research and development centers. The main threat is an increase in prices of imported inputs, implicating higher production costs and lower competitiveness, which could lead to exclusion from the market for some of the production units.

Conclusions

Within the context of market globalization and the financial and food crisis, the enterprises of the agro-food sector are facing strong competition in both the international and domestic markets, where their permanence depends not only on the development of competitive capacity of the enterprise, but also on an environment that is propitious for competitive performance. In other words, it is necessary to work with a systemic competitiveness approach, which implicates being competitive at the levels of the enterprise, sector, national economy, government and institutions. The systemic competitiveness index of the protected fresh tomato production industry of Zacatecas was 50% lower than the highest possible competitiveness index. This situation suggests the need to improve variables at the production unit level, such as productivity, organizational learning, technological development, and degree of customer satisfaction, besides improvements required in those external to the production unit. In a globalized context, the export-oriented production units are more capable of remaining competitive, although they need to be strengthened mainly in the aspect of forming intellectual and governmental capitals. This could by achieved through stronger links with research centers and institutes that contribute to developing technology and innovation and through greater promotion and transparency of government programs that protected agriculture growers can have access to.

The enterprises that sell their tomatoes on the domestic market are seriously lagging in the formation of all of the capitals involved in systemic competitiveness, especially intellectual, commercial, macroeconomic and governmental capitals. Therefore, besides the enterprises' strengthening their innovative capacity and links with the government, it also is necessary to strengthen macroeconomic variables. It should be highlighted that although in recent years inflation has been under control, this situation could change on the short term because of the

impact on the agricultural sector by the food and financial crisis. Competitive interest rates and real exchange rates, as well as better access to credit, are needed.

A high level of technology is a necessary, but not sufficient, condition for sustainable competitiveness in the protected fresh tomato industry in Zacatecas. To increase competitiveness, networks of collaboration among growers, customers and suppliers are also needed, considering that a source of competitive advantage is innovation and learning through intellectual capital, better coordination between government action and the productive sector to seek better conditions in the macroeconomic and international setting, and the society's assurance and trust.

Implications for the Mexican Fresh Tomato Industry

For the newly born protected agriculture industry in Zacatecas to attain sustained competitiveness within the global hyper-competition of the domestic market, greater attention and care must be given to the critical points we detected, on the part of both the growers and government. To achieve this will require modifications in the organizational profile of the agro-enterprises. Especially those that sell on the domestic market must increase yields, lower production costs, and improve the quality of their produce. Likewise, in order to decrease dependence on foreign technology, the productive chain requires tighter integration with strong links to research centers that support innovation and product differentiation and diversification.

It is recommended that government programs aiming to create an atmosphere that favors competitive development should promote innovation and environmental protection in order to simultaneously assist economic development and better living conditions for rural areas.

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Appendix 1.

Table 6. SWOT matrix of systemic capital of the industry of fresh tomato production under protective structures in Zacatecas

Category	Strengths	Weaknesses	Opportunities	Threats
Entrepreneurial	Organizational intelligence. The tomato varieties grown are demanded in the local and international markets.	Administration of production units is not adequate for current needs.	Promotion of training courses in agribusiness management with an entrepreneurial approach, considering the formation of value networks.	Risk of being forced out of the market due to a management system inadequate for marketing needs.
	Productive flexibility. Climate of high plateau allows prolongation of growing season, and sometimes winter production with low fuel consumption. Good crop management in export-oriented enterprises.	Learning curve in greenhouse management takes 3 to 5 years. More than 60% of the production units use imported seed and other inputs. High fuel costs.	Publicity of the importance of timely, accurate information about the produce and input market. Development of information systems for production units.	Entry into the local market of larger variety of tomatoes from other regions or imported at a price lower than production cost of production units. Rise in costs of inputs.
	Marketing agility. There is willingness to produce conforming to market requirements.	High cost of intermediaries; 71% of the growers sell their produce to domestic market intermediaries. Inconsistency of tomato quality. Lack of information on norms and standards for selling tomatoes on the international market. Low level of good agricultural practices and management in non-export-oriented enterprises.	Promotion of training in tomato marketing requirements for both domestic and international markets. Promotion of good agricultural and management practices, especially in units of production for the domestic market.	Non-tariff barriers to trade that impede or make difficult international marketing of tomatoes.
Labor	Willingness to learn on the part of workers.	High turnover of trained workers. Lack of training for workers and inexperience of managers.	Improve qualification of workers and administrative personnel through training programs and courses. Establish performance evaluation programs for workers in which economic incentives are included.	Delay in adoption of practices and programs of hygiene, quality, and food safety.

Intellectual	Good relationship with suppliers of technology.	Strong dependence on foreign technology. More than 50% of the production units have foreign technology suppliers. Little relationship with research institutes and centers and universities.	Development of programs to link institutions of higher education and research with the productive sector to adopt technology that would improve productivity and reduce costs. Creation of a program for development of technology for protected agriculture.	Better positioning on the market of enterprises with more developed technology, management capacity and lower costs.
Logistic	Adequate irrigation and electricity service.	Deficient or scarce telecommunications services. High cost of fuel. Only 51% of the units use refrigerated transport.	Promotion of strategic alliances between growers and shippers to guarantee good handling of tomatoes.	Loss of competitiveness due to bad handling during shipping.
Macro economic	Stable conditions of the principal macroeconomic variables, although this has been modified by the financial crisis that began to show its effects in September 2008. 96% of the production units received government support for their establishment.	Lack of Access to credit. Overvaluation of the peso with respect to the dollar in recent years. High cost of capital. Little information on the tax system.	Development of a program of fiscal support for protected agriculture growers. Facilitate access to credit for growers.	Better positioning of enterprises of other regions with greater possibilities for investment and access to credit.
Commercial	Climate of producer regions that allows prolongation of growing season and winter production. Proximity of producer regions to US border.	Overvaluation of peso relative to dollar during recent years, although since early October 2008 the exchange rate has been highly volatile. Domestic market does not pay price premium for tomatoes grown in protected agriculture systems. Low price on the market because standards established by buyers are not met.	Promotion of vegetables grown in protected agriculture systems for the domestic market. Implementation of a program for training in norms and documentation for exporting. Increase the number of export production units.	Access to local tomato market by protected agriculture from other regions of the country or imports. Devaluation of the peso relative to the dollar implies higher costs of imported inputs and thus higher production costs. Drop in tomato prices due to excess supply.
Governmental	96% of the production units received support from the government for establishment of their production units.	Serious lack of information about government programs, other than *Alianza para el Campo*, for which growers are eligible.	Promote public information about government programs for which protected agriculture growers are eligible.	Lower level of investment and technological development in protected agriculture.

Institutional	Good opinion of growers toward government institutions, especially of those related to the agricultural sector.	42% of the growers believe that it is not easy to meet the requirements for Access to a government program. Delays in allocation of government support.	Simplify administrative process of documentation for access to government programs.	Reduction of budget for support of growers.
Social	Good level of service of federal institutions related to the agricultural sector.	Lack of trust in other growers restricts their association or relationship.	Promote collaboration among enterprises and its importance for competitive permanence in the market.	Lack of definition of public policies in support of protected agriculture.