Specialization on a global scale and agrifood vulnerability: 30 years of export agriculture in Mexico

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Large-scale specialization in monoculture production for export markets infringes upon the agricultural and food systems and security of the populations of exporting countries that adopt export-oriented policies because it: (a) entails adopting production patterns that over-exploit and deteriorate the natural and human resources of agricultural regions; (b) subordinates producers and consumers in agroexporting countries to the interests of transnational intermediary companies and the regulations of foreign government agencies that prioritize the interests of their own citizens; and (c) restricts the right of domestic consumers to access a nourishment that is sufficient, healthy and culturally acceptable. The study of this Mexican case allows us to better understand the agricultural and food situation that is currently emerging in developing countries that choose to broadly apply neoliberal policies. Mexico has one of the most open agricultural sectors and is a leading international exporter of several fruits and vegetables; but at the same time it is a net importer of basic foods for its domestic population. This case study is analyzed from the perspectives of plantation-oriented agricultural practices and global commodity chains; however, neither of these perspectives considers the problems of environmental degradation and food security, both of which are studied in this work.

Keywords: agrifood system; vulnerability; food sovereignty; neoliberalism; fruits and vegetables

Historical and anthropological studies that have examined plantation-oriented agricultural practices directed at meeting the requirements of world trade have often done so using longue durée frameworks of analysis that center their attention on the agrifood systems that are created through the production, distribution and consumption of certain crops such as: sugarcane, coffee, bananas, cocoa and cotton (Mintz 1985; Roseberry 1983; Ross 2014; Walsh 2010). Such studies have shown that regions subjected to monocropping undergo processes of agricultural, economic and sociocultural restructuring due to their coordination with metropolitan consumption areas often located in faraway places around the planet. This restructuring is propelled by large production and/or marketing companies that relate production areas with consumers on a continental or even international scale. Finally, these companies have been supported by colonial or national governments that have promoted and guaranteed their economic transactions at the local, continental or international levels.

The contemporary problem of agriculture has also been approached through the study of the production, distribution and consumption chains of certain crops or group of crops that constitute an area of specialization within the worldwide agrifood system (Friedland 2004; Friedland, Barton, and Thomas 1981; Gereffi and Christian 2010; Gereffi, Korzeniewicz, and Korzeniewicz 1994). These studies find their antecedents in World-systems Theory and offer the conceptual tools required to analyze historically the transnational division of labor, technological development and innovation, and the new role of national states in a global economy. Analyses of local and global articulations have been conducted from the perspective of the networks of coordination and power, together with the patterns of governance that are established among ‘lead firms’ and their subsidiaries. Their primacy in such chains rests, on the one hand, on the multiple strategies they employ – at the level of production and/or distribution – to articulate a large number of companies situated in diverse places around the planet; and, on the other, on their linkages to consumers (Dolan and Humphrey 2004; Gereffi 1994; Gereffi, Humphrey, and Sturgeon 2003).

In contrast to other perspectives, such as that of ‘food regimes’, which focus on capital accumulation on a global scale,1 studies of monocropping plantation systems and global commodity chains allow us to analyze in greater depth and detail three especially salient aspects in specific historical and institutional contexts: (1) the multi-local strategies of the social actors involved in

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Food security or agrifood vulnerability

The term ‘food security’, first defined by the Food and Agriculture Organization (FAO) at the Food Conference held in Rome (FAO 1975), has become a polemical concept in both academic and political circles; nevertheless it is still widely utilized in debates on problems of hunger and the commitments of governments to confront them (González 2010). In a ‘biography’ of the concept of food security, Mechlem (2004) points out that, historically speaking, this term has been resignified by various factors, including: the dialog among scientists in agronomic, social and nutritional disciplines that has made it possible to explore more profoundly the complexity of the agrifood problem; the diversity of circumstances in which the world’s poor confront situations of food insecurity (Maxwell 1996); and, finally, the harsh criticism by social movements and non-governmental organizations of public policies, national governments and such international institutions as the FAO and the World Trade Organization, among others (Mechlem 2004, 239; Pottier 1999, 15).

The present study utilizes the term agrifood vulnerability, taken from González and Macías (2007, 48), because it allows us to characterize

...the situation of countries, social sectors, groups and individuals who are exposed to, or are liable to suffer, hunger, undernourishment or sickness through not having sustained physical and economical access to sufficient nourishing food that is culturally compatible, or due to the consumption of unsafe or contaminated products.

This concept, also used by Pechlaner and Otero (2010), makes it possible, on the one hand, to take into account elements of both the natural (frosts, floods, droughts, etc.) and social orders (inflation of food prices, speculation, etc.) that are present in the production, distribution and consumption of foods and that may threaten food supplies and availability; and, on the other, to consider the permanent and adequate access of the entire population to suitable food stocks. Moreover, it opens the possibility of characterizing degrees and types of vulnerability and identifying – socially and culturally – the most vulnerable individuals or groups, and those that suffer accumulated disadvantages (Blakie et al. 1996). Thus, the concept of agrifood vulnerability, unlike that of food security, leads us to identify and analyze the response capacity and resilience of different individuals, groups or population sectors in terms of coping with events of food crisis and recovering from them when they occur (Moser 1996).

A third key term in debates on nourishment is that of food sovereignty,2 which was first formulated by Via Campesina and later adopted by alternative social movements in several countries. This term recognizes the importance of food insecurity and vulnerability, and its contribution lies, first, in its critique of the neoliberal policies adopted by most countries in the world and, second, in the fact that it posits actions and alternative political programs at the local, national and global levels based on the principle that nourishment is a universal human right that must be respected and guaranteed (FAO 2006), regardless of markets and the interests of commercial corporations. This orientation leads to the proposal that peoples, communities and nations must play a pro-active role in determining the agricultural and food system that best suits their natural and social circumstances so that they can eliminate hunger and malnutrition. Moreover, these programs should achieve the goal that the production, distribution and consumption of foods are all based on the principles of environmental, economic and social sustainability, while ensuring that the alternatives proposed also contemplate the participation of peasant producers (Rivera 2007).

In light of the foregoing, this study of agrifood vulnerability and production specialization in a globalized world seeks to enrich the discussion of the urgency of implementing new agrifood policies and programs, as suggested by those who advocate the concept of food sovereignty. In this work, I propose that contemporary production specialization entails: (a) adopting a specialized mode of farming that degrades regional natural and human resources; (b) subordinating local producers to, and increasing their dependence on, the intervention of transnational companies and foreign government agencies that cooperate with national governments and are supported by them; and (c) repercussions for domestic consumers in terms of access to a form of nourishment that is sufficient, healthy and culturally acceptable. In the following sections of this study,
each one of these implications will be examined for the specific case of Mexico.

This case study based on Mexico is important because it explores the agro-food problem that is currently occurring in the so-called developing countries. The government of Mexico chose to broadly apply the neoliberal policies fostered by global institutions like the International Monetary Fund, the World Bank and the World Trade Organization at an early date. Indeed, in 1994, Mexico signed a free trade agreement with countries whose economies and income levels are much higher than its own and, moreover, subscribed to another 11 commercial treaties with 41 nations in both the northern and southern hemispheres. Today, Mexico is one of the countries that has most opened up its agricultural sector. Another aspect that stands out is that it is, at one and the same time, a high food-exporting and food-importing country. In the fruit and vegetable (F&V) sector, Mexico is a leading exporter of such crops as avocado, tomatoes, mango, and chili peppers, among others, while in the sector of basic foodstuffs it is a net importer, a condition that places the nourishment of an ample sector of its population at risk, since it must dedicate a substantial proportion of its income to food purchases (Otero, Pechlaner, and Gürcan 2013).

The empirical aspect of this study of production specialization in Mexico was based on three principal types of information. The first consisted of sources of statistical data and official reports on Mexico and the USA. The second included books, articles and graduate theses on F&V exporting regions in Mexico, while the third was fieldwork carried out by the author and students over the past 18 years in several of these exporting regions, as well as in Hidalgo County in southern Texas. Our field research allowed the author of this study to examine environmental and social changes in the agricultural landscapes of exporting regions, and to sustain broad-ranged discussions with producers, exporters and public officials concerning the problems analyzed herein.

The pattern of productive specialization degrades areas with the greatest hydric potential in Mexico

From an international perspective, Mexico’s agricultural territories are considered ‘mega-diverse’ for they include the places of origin or domestication of several different types of fruits and vegetables, including chili peppers, avocado, papaya and tomato. Today, the areas with greater hydric resources cultivate a broad range of horticultural products, many of which have the largest productive potential in terms of satisfying the country’s demands for food. This section examines important features of Mexico’s national territory, and current tendencies in domestic specialization in F&V production.

Hydric resources in Mexico’s national territory

Compared to other crops, fruits and vegetables have experienced a marked increase in the cultivated surface area. In 1980, this group occupied some 1,200,000 hectares (ha) (2,965,264 acres, or 6.8% of the national agricultural surface area), but 30 years later, in 2009, this figure had increased by 60% to 1,950,000 ha (4,818,554 acres, or 8.9% of the surface area). This growth was constant and contrasts with that of other groups of crops. Indeed, the annual average growth rate (AAGR) of 1.8% that the F&V sector achieved was significantly higher than the corresponding figures for cereals (−1.1%) and industrial crops (0.1%), though below that of forage products (3.2%). Among cereal crops, corn is the staple product in the population’s basic diet. During this time period, the surface area planted in corn had an AAGR of −0.3%.

This expansion of F&V production took place largely in areas with irrigation systems or high rainfall. But such regions are few and far between in Mexico, and so are of great strategic importance for agriculture and for producing food for Mexicans. Based on data from Mexico’s INEGI, 52.7% of the country’s territory is characterized by hydric deficits. Those zones include deserts and arid or semi-arid lands (INEGI 1994). Also important is the fact that the sources of water in Mexico’s national territory are unequally distributed: in fact, 75% of Mexico’s land receives one-third of annual hydric run-off; but those are precisely the spaces where most of the irrigated agricultural land is concentrated, together with the majority of the population and most industrial activity (INEGI 1994).

In 2007, the irrigated surface area in Mexico was 5,600,000 ha (13,837,901 acres), and was classified under two categories: ‘irrigation systems’ (IS) and ‘irrigation units’ (IU). The former exploit water from rivers, streams and springs, and represent 54% of the irrigated area; while the latter extract water from the subsoil using pumping systems, and make up 46% of the irrigated area (CONAGUA 2008). Meanwhile, nearly half of Mexico’s municipalities (45%) lack irrigated lands or have as little as 100 ha (247 acres) (see Table 1). At the opposite end of the spectrum, we find that just 14 municipalities (0.6% of the total) concentrate 24% of the irrigated surface (INEGI 2012), including the largest IS and IR in the country.

Clearly, in a nation where 82% of the agricultural surface area depends exclusively on rainfall, the irrigated areas represent a strategic resource for nourishment (CONAGUA 2008) because the volume of agricultural production there is higher than in rainfed fields. In fact, those lands account for half of all national agricultural production (CONAGUA 2008). In arid and semi-arid regions, the strategic value of water is greater, but agricultural pursuits must compete with the demand of urban populations and industrial and tourism-related activities. At the national level, agriculture utilizes 77% of all water consumed; the rest is used by industry and the population (CONAGUA
Competition for this vital liquid is made especially critical by cyclical patterns of droughts that affect certain areas of the country, especially its northern reaches, but also in desert-like areas in the states of Guanajuato, Aguascalientes, Querétaro, Hidalgo, Puebla and Oaxaca.

The horticultural surface area
Most of the F&V production over the past 30 years has taken place in the states with the greatest hydric resources, because these crops require irrigation and abundant rainfall (see Figure 1). Perennial fruit crops such as mango, oranges, lemons and avocado, among others, are raised in the areas of Mexico that have the highest rainfall, most of them located in the foothills of the Sierra Madre Oriental (Veracruz, Tabasco, Nuevo León) and the Sierra Madre Occidental (Nayarit, Michoacán, Oaxaca, Guerrero, Chiapas).

Due to this territorial distribution of hydric resources, F&V crops are concentrated primarily in just a few states. In 2009, nine states accounted for 59% of the surface area planted with vegetables and 86% of the area with fruit products (see Table 2). The decrease in the area planted with vegetables in some states – e.g. Sinaloa – is a result of greenhouse agriculture, which has gained particular importance there, as shown below.

It is important to emphasize that a certain degree of specialization in the exploitation of land and water for horticultural production also occurs in agricultural regions in states with relatively low rainfall levels where, on the one hand, it limits the recharging of aquifers and, on the other, makes surface water currents an even more strategic resource. This is the case of horticultural lands in desert and semi-desert regions of Baja California, Baja California Sur, Sonora, Sinaloa, Nuevo León, Tamaulipas, San Luis Potosí, Zacatecas, northeastern Guanajuato, and parts of Aguascalientes, Querétaro and Puebla, areas characterized by an intense competition for, and conflicts over, water among F&V producers, the general population and businessmen involved in a variety of economic activities (industry, tourism, etc.; see Monforte and Cantú-Martínez 2009; Troyo-Díéguez et al. 2010). Competition for water can become especially intense in these areas because fruits and vegetables are highly susceptible to drought and demand greater quantities of irrigation water than other crops; moreover, horticultural production for export must take place in arid and semi-arid areas in the winter and spring, precisely the seasons when rainfall is at its lowest levels in Mexico.

Monocropping and environmental degradation
As mentioned above, the extension of the surface area devoted to F&V production was marked, but the increase in production was even greater. From 1980 to 2009, the AAGR of vegetable production was 3.2%, though the cultivated surface area grew by only 1.6% (SIACOM 1980–2009). With regard to fruits, the AAGR of production was 2.3%, but that of the surface area was 2.2% (SIACOM 1980–2009). Upon examining the increase in the production of these crops in greater detail, we find that only a few products account for most of that increase and the concentration of production: i.e. of the 114 fruit crops registered in the aforementioned System of Agriculture Information, just seven – avocado, lemon, mango, papaya, banana, pineapple and grapes – made up 56% of fruit production in the five-year period 2005–2009 (see Table 3).

In the same period, seven vegetable products (squash, onions, lettuce, melon, cucumber, tomato and watermelon) – of a total of 88 – accounted for 50% of the total production of this group of crops at the national level. These figures speak of a growing production-related specialization in the use of the land and water resources in a small group of monocrops.

Between 1999 and 2005, the extension of greenhouses that produce primarily tomato, green pepper and cucumber, grew from 721 to 3200 ha (1781–7907 acres) in the

| IS and units; irrigated hectares according to range | Number | Percentage | Hectares | Percentage |
|---------------------------------------------------|--------|------------|----------|------------|
| No irrigation, or up to 100 hectares with irrigation | 1096   | 44.8       | 23,456   | 0.4        |
| Sub-total                                         | 1096   | 44.8       | 23,456   | 0.4        |
| 101–1000                                          | 677    | 27.7       | 268,250  | 5.1        |
| 1001–5000                                         | 445    | 18.2       | 1,078,114| 20.3       |
| Sub-total                                         | 1122   | 45.9       | 1,346,364| 25.4       |
| 5001–10,000                                       | 127    | 5.2        | 876,089  | 16.5       |
| 10,001–50,000                                     | 89     | 3.6        | 1,796,432| 33.8       |
| Sub-total                                         | 216    | 8.8        | 2,672,521| 50.3       |
| 50,001–100,000                                    | 10     | 0.4        | 696,585  | 13.1       |
| 100,001–170,000                                   | 4      | 0.2        | 571,698  | 10.8       |
| Sub-total                                         | 14     | 0.6        | 1,268,283| 23.9       |

Source: INEGI, VIII Censo Agrícola, Ganadero y Forestal. 2009.
traditional vegetable-exporting states of Sinaloa, Jalisco, Baja California, Baja California Sur and Sonora (Guantes Ruiz 2006), but it is important to note that per-hectare productivity in greenhouses is 300–600% higher than that of open-air production (Guantes Ruiz 2006).

In both cases — sheltered agriculture and open-air cultivation — the marked increase in the volume of F&V production is due to the adoption of an intensive production pattern that utilizes agricultural machinery for many tasks, hybrid and transgendered seeds, fertilizers, chemical
pesticides, the installation of so-called ‘new’ irrigation methods (drip, aspersion, micro-aspersion), and ferti-irrigation (González 1994; Massieu 2004; Soto Mora 2003). Much of this technology is imported, while that which is produced in Mexico is controlled by transnational companies. Clearly, this technological dependence – which also affects certain inputs from agroindustrial plants – increased as the Mexican State made a series of policy decisions designed to decrease its role in the production of such inputs as fertilizers and hybrid seeds, and intensified with the commercial aperture that began in 1986 with the elimination of tariffs on many imported agroindustrial inputs and technologies.

But this pattern of intensive cultivation used in F&V production has caused increasing degradation of environmental and human resources in Mexico’s agricultural regions. The agroeconomic literature widely recognizes that agroindustrial cultivation based on monocropping infringes upon, and severely harms, agrosystems, because it erodes and compacts soils, thus reducing their productivity. Also, it utilizes external inputs – the vast majority of them petroleum derivatives – that contaminate the air, soils and water in producing regions and affect the health of human populations and all living beings in the ecosystem because they propitiate the uncontrolled spread of plagues and diseases in monocrops and other plants in the same genetic family because insects and other transmitting organisms (e.g. nematodes) soon develop resistance to the chemical pesticides and insecticides applied to control them (Alieri and Nicholls 2004; Altieri and Rosset 1999; Gliessman 2007; Pretty 1995).

Each new day seems to bring additional evidence that horticultural monocropping in Mexico generates environmental problems that increase companies’ production costs and, in some cases, render future cultivation unviable (González 2012b). Plagues and plant diseases constitute the most severe, recurrent complications in horticultural regions, and concerns over plant health have led to the suspension of the cultivation of some horticultural crops, as in the cases of the Autlán and Sayula Valleys in the state of Jalisco (Sandoval 2012), the Arista Valley in San Luis Potosí (Garzón-Tiznado et al. 2002; Maisterrena and Mora 2000), the Apatzingán area in Michoacán (Agustín et al. 1994), Mexicali in Baja California (Acosta Martínez, Lugo Morones, and Avandaño Ruiz 2001), and the Bajío in Guanajuato (Garzón, Garza, and Bujanos 1986).

Another serious environmental problem that occurs in horticultural regions is the over-exploitation of subterranean water sources that can exhaust underground aquifers. In cultivation areas near the ocean those empty aquifers may rapidly fill with saltwater that filters in from the sea.
and salinizes the subterranean deposits from which many growers extract water to irrigate their fields. The effects of this problem have been documented in detail in horticultural zones in Baja California (Cook and Amon 1986), San Luis Potosí (Maisterrena and Mora 2000), Jalisco (González 1994), Coahuila (Chávez Guillén 1989) and Sonora (Moreno 2006).

Added to all of these environmental threats are the health problems that pesticides cause for agricultural field-workers and populations that live near producing regions. There, afflictions may be manifested in the poisoning of laborers who may lose consciousness and/or experience respiratory and digestive complications, skin irritations and eye infections. But workers are not the only ones so affected, for the inhabitants of farming regions, especially those who live closest to the fields, often suffer consequences as well (Arellano et al. 2009; Gaytán 2000; Seefoo 2005), the most serious effects of which may not manifest themselves until many years later in the form of altered morbidity patterns in the regional population due to serious diseases such as cancer, arrhythmias and congenital malformations (Acedo 2011; Albano 1986).

In the context of these scenarios of environmental and human health problems caused by intensive horticultural production, foreign and national agroexport companies have shown a recurring pattern of behavior that has been documented since the 1970s (Feder 1977). Upon realizing that environmental degradation is raising production costs and diminishing return on investment, or that they are being subjected to regulations by local producer organizations on production dates or access to water, for example, that restrict their investment schedules, their response is a very simple one: pull up stakes and transport their operations to ‘virgin’ areas that are free of all such limitations. Once established there, they simply re-initiate production of the crop that interests them on the scale and at the time of year most convenient for them with the same disregard as in the previous area (González 2012b; Macías 2006). This behavior pattern is made possible by the dispersion of IS and IU that are 12,350–123,500 acres in size, and by the fact that the horticultural frontier is an open one that allows companies, both foreign and domestic, to rapidly set up new cultivation projects. For all these reasons, it is relatively easy for corporations to amortize the relocation of their installations to regions with unexploited fields that provide greater productive precisely because they have never been cultivated on a large scale or monocropped. Also attractive are the potential advantages of low rental costs for fields and labor because commercial agriculture is not well developed. Moreover, local manpower is usually unorganized and more willing to accept extenuating work regimens in the fields and agroindustrial operations as well as lower wages than workers in established horticultural exporting regions.

The problem is that the economic and social costs of the degradation of environmental resources and the health problems caused by this pattern of horticultural production are rarely borne by the large US and Mexican export companies that generate them since these transnational companies, which have moved from northern to southern Mexico and into Central America, work mainly through contracts with small- and medium-sized local producers. These producers are oriented to the crops with the highest commercial value and, in most cases, have their own machinery and access to private credit.

Agricultural laborers and the residents of production areas exposed to agrochemicals – some highly toxic – are the ones who pay the price in the form of acute and chronic illnesses. Also affected are those local producers who are unwilling or unable to adapt to the arrival of large horticultural companies and, as a result, find themselves pushed out of the vegetable-raising business or forced to reduce considerably the scale of their operations. Also, they often have to invest their own resources later to implement rehabilitation or restoration programs to reverse the medium- and long-term environmental damage done to their home regions once the agroindustrialists move on to greener pastures (González 2012a).

This leads, unavoidably, to the conclusion that the degradation of natural and human productive resources, which accompanies horticultural monocropping in the most productive regions of Mexico, damages national agricultural resources and compromises future supplies of fruits and vegetables for the domestic market.

In the face of this productive and territorial dynamic it is important to delve more deeply into this orientation of horticultural production, these policies for national and export markets, and the role that the government of Mexico has played.

**Mexico’s transnational integration: dependence and subordination**

The implementation of NAFTA on December 1, 1994, was the result of an economic policy adopted by the Mexican State in the second half of the 1980s when the country signed the General Agreement on Tariffs and Trade (GATT). With respect to agriculture, this government policy sought to foment the competitiveness of Mexican produce. To this end, it freed up domestic markets, took measures to guarantee land tenure for entrepreneurs, actively pursued direct foreign investment, and reduced government intervention in the economy and the administration of IS (Calva et al. 1997). These policy moves have propitiated a growing specialization of production, but also increased the dependence and subordination of Mexico’s agrifood sector on the USA.

**The value of F&V production and commercialization**

The rubric in which fruits and vegetables stand out in relation to other crops is in the proportion of the value of
national agricultural production. From 1980 to 2009, this proportion rose from 28% to 41% of the total value of production, surpassing that of cereals and all other crops (see Figure 2). This result shows that the products with the highest commercial value are those that have most greatly increased their share, while cereals, the high-priority products for food sovereignty, fell to second place.

Without question, supplying fruits and vegetables to the domestic market continued to be the main motor and destination for these agricultural products, but their importance decreased in relative terms (see Table 4). In the five-year period from 1980 to 1984, the internal market absorbed 92% of national production, while between 2005–2008 this index decreased to 81%. At the same time, export markets increased in importance and intensified linkages among the producing regions for these crops in Mexico and international distribution and consumption centers. This situation becomes clearer when we consider the AAGR of exports and the national market: the former rose by a rate of 9.5%, significantly higher than the 2.4% of production destined for the domestic market (FAOSTAT 2009).

In addition to the specialization in certain crops mentioned in the first section, it is important to stress an additional element. According to the information in Table 5, the AAGR of the crops selected because they have a larger cultivated surface area and increased production volumes was higher for exported products than for the proportion that was sent to the national market. Based on these figures, we can affirm that specialization in agricultural production in the F&V sector is a response that reflects primarily the demands of international markets.

Having identified the importance of the export market in the expansion of the cultivated area and production volume of fruits and vegetables, it becomes possible to analyze and explain the environmental and social implications of exploiting a strategic resource such as water to satisfy the food demands of consumers in other nations. It is important to understand that when they export fruits and vegetables, Mexican horticulturalists also export

Figure 2. Value of agricultural production: percentage of fruits and vegetables and other groups of crops: 1980–2009.

Table 4. F&V production in Mexico by five-year period: national market, exports, imports and domestic consumption (in metric tons).

| Variable                                         | Average 1980–1984 | Average 1990–1994 | Average 2000–2004 | Average 2005–2009 | AAGR 1980–2009 |
|--------------------------------------------------|-------------------|-------------------|-------------------|-------------------|----------------|
| Domestic F&V market                              | 49,706,892        | 58,795,528        | 71,475,010        | 76,553,212        | 1.5            |
| Export market for fruits and vegetables           | 1,320,759         | 2,245,735         | 4,312,431         | 5,761,931         | 5.0            |
| Percentage of export market in relation to domestic market | 1.5             | 5.2               | 7                 | 9.4               | 9.4            |
| Imports of fruits and vegetables                 | 373,432           | 554,641           | 1,269,643         | 1,448,156         | 4.6            |
| Internal consumption of fruits and vegetables    | 50,080,324        | 59,350,169        | 72,744,654        | 78,001,368        | 1.5            |

Source: FAOSTAT (2009).
water in the form of ‘virtual water’; i.e. the liquid that was required to produce them (Allen 2003). This metaphorical term was developed to make it possible to calculate the water consumption required to produce a good or service, taking into account the climatic conditions of the country, its level of technology, and its cultivation practices. In the environmental and market contexts, ‘virtual water’ is a useful indicator that quantifies the availability of a basic natural resource and its application to human development in a region or country. In the case that concerns us here we can, on the one hand, contrast the increase in the agricultural and economic variables of Mexico with the sustainable supply of foods for its population; while, on

Table 5. Volume of selected fruits and vegetables, and total production volume in Mexico: 1979–2008 (five-year averages; in metric tons with percentages).

|                | 1980–1984 | 1985–1989 | 1990–1994 | 1995–1999 | 2000–2008 | AAGR 1980–1993 | AAGR 1994–2008 |
|----------------|-----------|-----------|-----------|-----------|-----------|----------------|----------------|
| **Vegetables** |           |           |           |           |           |                |                |
| Zucchini       | Domestic market | 170,883 | 168,097 | 155,027 | 180,243 | 393,456 | 3.7 | 7.1 |
|                | Export market | 44,578 | 103,169 | 169,373 | 263,608 | 143,699 | 2.1 | –7.9 |
| % Exportation  | 21% | 38% | 52% | 27% | 27% |                |                |
| Onion          | Domestic market | 367,461 | 469,833 | 603,892 | 699,263 | 975,831 | 4.4 | 4.5 |
|                | Export market | 64,766 | 130,796 | 188,890 | 251,071 | 303,433 | 7.9 | 2.2 |
| % Exportation  | 15% | 22% | 24% | 26% | 24% |                |                |
| Lettuce        | Domestic market | 70,205 | 105,865 | 133,728 | 142,413 | 196,910 | 2.3 | 2.6 |
|                | Export market | – | 5133 | 13,074 | 26,203 | 47,866 | 18.6 | 14.0 |
| % Exportation  | 0% | 5% | 9% | 16% | 20% |                |                |
| Melon          | Domestic market | 239,508 | 228,297 | 335,423 | 324,002 | 393,049 | 6.9 | 1.5 |
|                | Export market | 27,327 | 169,423 | 165,591 | 212,960 | 153,645 | 1.0 | 2.6 |
| % Exportation  | 10% | 43% | 33% | 40% | 28% |                |                |
| Cucumber       | Domestic market | 233,070 | 238,193 | 253,816 | 251,247 | 251,191 | 2.9 | –215.5 |
|                | Export market | 131,690 | 132,571 | 268,890 | 267,247 | 267,191 | 7.5 | – |
| % Exportation  | 36% | 36% | 31% | 34% | 43% |                |                |
| Bell pepper    | Domestic market | 479,057 | 546,530 | 621,228 | 1,104,200 | 1,308,671 | 3.7 | 6.5 |
|                | Export market | 3120 | 76,982 | 159,807 | 294,483 | 424,316 | 9.6 | 7.6 |
| % Exportation  | 1% | 12% | 20% | 21% | 24% |                |                |
| Watermelon     | Domestic market | 304,179 | 323,950 | 297,094 | 451,787 | 673,579 | 7.4 | 5.1 |
|                | Export market | 25,796 | 129,789 | 125,171 | 216,064 | 362,186 | –1.3 | 10.2 |
| % Exportation  | 8% | 29% | 30% | 32% | 35% |                |                |
| Tomato         | Domestic market | 1,169,153 | 1,498,113 | 1,557,115 | 1,594,611 | 1,289,380 | –1.8 | 2.8 |
|                | Export market | 174,619 | 488,334 | 391,041 | 742,513 | 889,153 | 0.7 | 5.6 |
| % Exportation  | 13% | 25% | 20% | 32% | 41% |                |                |
| **Fruits**     |           |           |           |           |           |                |                |
| Avocado        | Domestic market | 450,372 | 567,375 | 720,901 | 767,265 | 879,856 | 3.3 | 0.3 |
|                | Export market | 576 | 6881 | 19,999 | 61,921 | 56,547 | 39.1 | 20.5 |
| % Exportation  | 0% | 1% | 3% | 7% | 6% |                |                |
| Lemon          | Domestic market | 720,828 | 708,741 | 673,127 | 963,760 | 1,439,758 | 0.8 | 6.0 |
|                | Export market | 12,642 | 45,596 | 99,223 | 195,367 | 345,138 | 17.5 | 9.6 |
| % Exportation  | 36% | 36% | 31% | 34% | 43% |                |                |
| Mango          | Domestic market | 792,105 | 1,036,477 | 1,102,834 | 1,223,292 | 1,442,882 | 3.8 | 3.2 |
|                | Export market | 21,573 | 37,255 | 94,626 | 179,436 | 211,041 | 22.9 | 5.2 |
| % Exportation  | 1% | 3% | 9% | 13% | 19% |                |                |
| Papaya         | Domestic market | 392,646 | 514,305 | 356,367 | 492,181 | 742,466 | 2.2 | 0.8 |
|                | Export market | 334 | 2852 | 9234 | 51,567 | 81,638 | 43.1 | 15.5 |
| % Exportation  | 0% | 1% | 3% | 9% | 10% |                |                |
| Banana         | Domestic market | 1,612,362 | 1,857,508 | 1,879,688 | 1,659,634 | 2,031,465 | 2.6 | 0.4 |
|                | Export market | 16,087 | 81,737 | 214,899 | 184,467 | 59,267 | 18.3 | –12.3 |
| % Exportation  | 1% | 4% | 10% | 10% | 3% |                |                |
| Pineapple      | Domestic market | 450,372 | 555,501 | 720,091 | 767,265 | 835,878 | –7.4 | 7.6 |
|                | Export market | 25,425 | 15,664 | 8602 | 15,282 | 28,619 | –6.0 | 13.3 |
| % Exportation  | 5% | 3% | 1% | 2% | 3% |                |                |
| Grape          | Domestic market | 545,793 | 518,565 | 454,478 | 375,813 | 218,466 | –0.3 | –7.6 |
|                | Export market | 12,889 | 33,533 | 42,330 | 87,851 | 138,490 | 23.2 | 8.9 |
| % Exportation  | 2% | 5% | 9% | 19% | 39% |                |                |

Source: FAOSTAT (1980–2009).
the other, it becomes possible to evaluate an agricultural policy designed to promote growth and competitiveness in the international market with one oriented toward sustainable food production and food sovereignty.

Arregui-Cortés and López-Pérez (2007) quantified the virtual water that Mexico exports through its agricultural sector. They found that it doubled in the 2000–2006 period with the principal rubric being that of F&V exports, which represented 31% of all the virtual water exported by the agricultural sector (1675 hm³). This calculation is just one indicator that helps us appreciate the dimensions of the strategic value of water in both international commerce and national policies. It is necessary to frame it territorially and consider other indicators, such as the hydric deficits that exist in many areas of Mexico’s national territory, while also bearing in mind that export-oriented production involves crops that require larger quantities of water than others, and that are often produced in arid regions during the dry season (winter and spring). Finally, the analysis must take into account the environmental costs – never included in the accounts of export companies – of the over-exploitation and salinization of subterranean aquifers in regions near the Pacific littoral in the states of Sonora, Baja California and Baja California Sur.

In Mexico, F&V imports in the five-year period 2005–2009 covered just 1.9% of national consumption; but since then they have experienced constant growth. From 1980 to 2009, they grew at an AAGR of 4.6% (see Table 4). Since the 1990s, supermarkets have offered domestic consumers year-round supplies of fresh fruits and vegetables because the middle- and high-income sectors in Mexico can pay the price of these imported foods. This tendency in consumption habits is also found in countries with income levels similar to those of Mexico where supermarkets play a key role in the ensuing consumption patterns (Regmi, Takeshima, and Unnevehr 2008).

Commercial concentration in the USA

The USA is the principal destination for Mexican F&V exports (see Table 6). In the 1994–2009 period, the concentration of exports to the USA rose from 88% to 99%. Sales of fruits and vegetables to Canada are conducted primarily through companies registered in the USA, most of them American-owned (Calleja 2007). These firms maintain infrastructure in borderland cities like McAllen, Texas, Nogales, Arizona, and San Diego, California (see Figure 1), and have developed direct relations with agroexporters in Mexico’s fruit- and vegetable-producing regions. Canadian marketers prefer to purchase through intermediaries established on the US–Mexico border to assure the quality and innocuousness of the products they acquire (Calleja 2007).

| Year   | Total exports | To USA | To other countries | % to USA |
|--------|---------------|--------|--------------------|----------|
| 1994   | 1764.93       | 1559.14| 205.79             | 88.34    |
| 2000   | 2811.56       | 2494.96| 316.60             | 88.74    |
| 2004   | 4150.46       | 3753.54| 396.92             | 90.44    |
| 2009   | 5813.35       | 5756.00| 57.35              | 99.01    |
| 1994–2009 | 3560.24   | 3332.99| 227.25            | 93.62    |

Source: Total Exports: INEGI-BIE, USA: Department of Commerce, US Census Bureau, Foreign Trade.

F&V exports from Mexico to the USA increased because consumption of these foods was rising continuously there: by 19% from 1970 to 2005 (Wells and Buzby 2009). Mexico has been the principal provider of fresh fruits and vegetables, especially in winter and spring (November–June), when US production decreases. In 2007, Mexico contributed 60% of the vegetables and 30% of the fresh fruits imported by the USA (Brooks, Regmi, and Jerardo 2009); a result attributable to a series of important factors that include: territorial proximity, NAFTA, and the mechanisms of phytosanitary control that Mexican export companies have implemented on Mexican soil under the strict supervision of US government agencies (Brooks, Regmi, and Jerardo 2009). This supervision has been concentrated in border areas, but in the case of some products has extended into production and packing areas located deep in Mexico’s interior. Inspectors, mostly of Mexican origin, are hired by the US Department of Agriculture to monitor the rigorous application of regulations for food safety and innocuousness in Mexico. Another important element – the laboratories that certify the innocuousness of food exports to the USA – is also certified by US government agencies, so Mexico has no certified laboratories capable of offering expeditious services. As a result, all samples of exported fruit are sent to facilities in the USA, though the costs are borne by the foreign exporters.

It is important to point out that this concentration of fresh F&V exports in one country produces great economic and commercial vulnerability in both the country as a whole and, more specifically, among producers in agroexporting regions who concentrate their agricultural and industrial investments in monocrops that are subject to high price fluctuations in export and national markets and to more stringent commercial regulations than other crops. Thus, any price drop, non-tariff-based regulation imposed by the Departments of Agriculture, Health, or Commerce, or sounding of a sanitary alarm, can have catastrophic effects on agroindustrial producers, the economy, and employment in agroexporting regions where the monocrop contributes the lion’s share of the value of production and agricultural employment.
The political dimension of the territorial concentration of exports of Mexican fruits and vegetables to the USA and of the application of sanitary and commercial regulations is closely related to the actions of an ‘imperial’ State that is capable of exercising its authority and imposing norms and coercive legal instruments far beyond its borders (Alvarez 2006). Such transborder actions can be explained in part by a process of cultural penetration into agroexport producers and functionaries of the Mexican government, who come to accept, defend and justify this intromission as part of a ‘natural process’ of global integration and a supposed endogenous ‘development’ of the regional and national economy (Alvarez 2006).

Agrifood vulnerability in a transnationalized context

Given this agricultural policy that prioritizes the competitiveness of Mexican agriculture and fosters greater integration with the USA, it is important to inquire into its effects on agri-food vulnerability. This problem has been studied mainly with respect to crops that supply a high caloric percentage to the population. This is the case, for example, of corn in Mexico, the staple food product for most of the population (Otero, Pechlaner, and Gürcan 2013, 265). But this criterion of distinction does not consider such aspects as food preferences, the predominant culinary culture of a region or country, or the nutritional value that a product contributes to people’s diets. And it is for these reasons that crops like fruits and vegetables are considered to be of secondary importance. But these products are highly valued and incorporated into the daily diet of most of the population, such that scarcity or high prices have severe repercussions on the proportion of family income spent on food and on inflation rates. Indeed, such horticultural crops as tomatoes, onions, varieties of chili peppers, avocado and cucumber, among others, are included in the ‘basic food basket’; an index employed by the Mexican government to measure inflation and its effect on purchasing power (CONEVAL 2009).

Exports of Mexican fruits and vegetables have come to satisfy a very real demand for foodstuffs in the USA during periods of the year when they become scarce. Thanks to the availability of Mexican export products, the prices of these foods do not skyrocket due to scarcity, and it is in this sense that they benefit consumers in Mexico’s northern neighbor. Due to their magnitude, F&V imports play an important role in achieving the goals of the 5-Meals-a-Day for Better Health program proposed in 1991 by the National Cancer Institute, Produce for Better Health and non-governmental organizations (Ralston et al. 2008). This program is dedicated to assuring that North Americans consume more portions of fruits and vegetables on a daily basis in order to reduce the risk of contracting chronic illnesses such as heart disease, diabetes and cancer, which can be caused by deficient nutrition. Among other activities, specific actions have been implemented to improve diets in school lunchrooms by increasing consumption of fruits and vegetables (National School Lunch Program). In addition, authorities are monitoring the effects of F&V prices on consumers’ diets.7

Horticultural producers and exporters are well aware of the growing demand for fruits and vegetables in the USA. Every day they assiduously check the prices offered by marketers in Mexico and abroad, and on the basis of the information available try to channel their produce to the market that offers them the greatest benefits. Another common practice among exporters is to send their highest quality produce to the export market and reserve the inferior quality product for Mexican markets, which are more sensitive to low prices than to issues of quality or product presentation.

The past 20 years have seen a growing convergence of the prices of fruits and vegetables in the region of North America. The clearest example of this is tomatoes; by volume, the principal horticultural product exported from Mexico. Under normal conditions, production of fresh tomatoes from Sinaloa – the main producing and exporting state – is destined to satisfy winter demand in the USA. A study conducted by Padilla-Bernal et al. from 1991 to 2000 found that the behavior of the prices of this crop at the shipping points in Sinaloa responded more to conditions in the Los Angeles market than to those in wholesale markets in Guadalajara or Monterrey (Padilla-Bernal and Thilmany 2003).

When cyclical meteorological phenomena, such as frosts and cyclones, occur in Florida, tomato production may be lost partially or completely.8 In these circumstances, the price of tomatoes shoots up in both US and Mexican markets because national producers prefer to export northwards where people’s income levels are higher and they can obtain higher prices for their produce (Thompson and Wilson 1997). But this choice creates scarcity in Mexico’s domestic market, and pushes prices up for national consumers.

In the US market, importing tomatoes from Mexico and other countries has made it possible to satisfy the growing demand for this vegetable at real stable prices. According to data from the National Agricultural Statistics Service, in 1980 per capita tomato consumption in the USA was 5.8 kilograms, of which imported products represented 22.3% at the national level with a real average price of $0.43 dollars per pound. Thirty years later, in 2009, tomato consumption had risen to 8.8 kilograms, and imports had reached 44.2%, but the real price was still only $0.44 dollars/pound (USDA 2010).

The increasing convergence of prices for the main fruits and vegetables in the NAFTA region has negative repercussions on Mexican consumers because their income levels are so much lower than those of consumers in the USA and Canada. Information from the World Bank shows that
likely to face scarcity and in nourishment of national consumers, who are far more
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prices with the priority given to US and Canadian consu-
year-round at an accessible cost. Thus, the convergence of
and has not helped to make these basic food items available
‘above, satisfy only 1.9% of national F&V consumption.9
that can readily be channeled to export markets.
According to information from the Banco de México
and Mexico’s Minimum Wage Commission, from 1994
to April 2007 the average price of fruits and vegetables
in Mexico increased by 428%, far exceeding increases in
the minimum wage and the accumulated inflation, which
rose by only 274% and 357%, respectively, in that period
(González and Maclías 2007, 67). This growing chasm
between F&V prices and the purchasing power of
Mexican consumers suggests that the boom in the
nations most dynamic agricultural sector has contributed
little toward easing consumer prices for these products,
and has not helped to make these basic food items available
year-round at an accessible cost. Thus, the convergence of
prices with the priority given to US and Canadian consu-
mers – due to their greater earning and purchasing power – underline the purchasing power and right to adequate
nourishment of national consumers, who are far more
likely to face scarcity and inflated prices for F&V products
that can readily be channeled to export markets.
In contrast, F&V imports from the USA and Canada
into Mexico have risen very little and, as mentioned above, satisfy only 1.9% of national F&V consumption.9
Thus, from the point of view of domestic consumers, the
beneficial effects of the convergence of F&V prices in
North America during periods of scarcity or shortage in
domestic markets are extremely limited, as only a small
sector of high-income families can consume imported
fruits and vegetables because of their high prices.
For Mexico, then, exporting fruits and vegetables to its
northern neighbors entails a cost of opportunity since it
involves exploiting strategic, scarce and non-renewable
natural resources – such as water and arable land – in
ways that are unsustainable. This form of productive
specialization also means abandoning the cultivation of
other foods that national consumers demand and that are
now being imported in unprecedented quantities. More-
ever, despite the increase in exports of fruits, vegetables
and other foods, the agrifood balance of trade still shows
a deficit that, in 1991, amounted to 972 million pesos,
but by 2004 had jumped to three billion pesos, and in
2008 to 6.4 billion (INEGI 2012). Between 1980 and
2007, per capita agricultural GNP suffered a reduction of
−0.7%; while per capita production of beans, wheat,
legumes, rice, milk, beef and pork also declined (see
Table 7). The decrease in the production of these basic
foods represents a present and future risk factor for national
consumers, because it means that Mexicans will become
increasingly dependent on food produced in other countries
and, more serious still, increasingly vulnerable to the agri-
cultural and commercial policies of the governments of
other nations and to the decisions of foreign companies.
Table 7. Gross domestic product and selected crop production per capita in Mexico.

|                  | 1980  | 1993   | 2000   | 2007   | 2007/1980 |
|------------------|-------|--------|--------|--------|-----------|
| Agricultural GDP/per capita (2003 pesos) | 2511.14 | 2264.57 | 2264.68 | 2493.85 | −0.7%     |
| Corn (kg/per capita) | 182.24 | 204.22 | 178.35 | 222.26 | 22.0%     |
| Beans (kg/per capita) | 14.44 | 14.92 | 9.02  | 9.40  | −34.9%    |
| Wheat (kg/per capita) | 41.01 | 40.36 | 35.49 | 33.23 | −19.0%    |
| Rice (kg/per capita) | 6.56  | 3.24  | 3.57  | 3.73  | −43.1%    |
| Fruits (kg/per capita) | 112.19 | 117.24 | 135.25 | 142.18 | 26.7%     |
| Vegetables (kg/per capita) | 63.26 | 74.25 | 98.38 | 110.59 | 74.8%     |

Source: GDP: INEGI, Banco de información económica. Population: CONAPO, Indicadores demográficos básicos de México. Agricultural Production: SIAP/SAGARPA. FAO, Faostat. Table preparation based on González and Maclías (2007, 67).
in 2009 per capita Gross National Income in those nations
(at current international prices) was $47,310 and $38,370,
respectively, while in Mexico it was just $14,400 (World
Bank 2010). Worse still, the price increases that lead to
fresh produce becoming scarce in Mexican markets
affects primarily products that have huge demand there
and that are included in the aforementioned food basket:
namely, onion, squash, avocado and, of course, tomatoes.

For Mexico, then, exporting fruits and vegetables to its
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of horticultural areas that produce for export markets contrasts starkly with the poverty and lack of dynamism that characterize the regions that provide the migrant laborers; a contrast that has been maintained for decades. The wages that these migrant workers earn barely allow them and their families to survive and do nothing to stimulate the endogenous development of their home areas. Finally, their availability and willingness to work in the regions to which they migrate are key factors that help explain the capitalization and competitiveness of national fruit- and vegetable-agroexporting industries in Mexico, parts of an agrifood chain that have done little to reduce the marked social and economic inequalities among different regions in Mexico.

Conclusions
This study has been concerned with highlighting three main features of the productive specialization on a global scale, in countries like Mexico, and its impacts on agrifood vulnerability. First is the ongoing specialization in the exploitation of strategic regional productive resources using crops that have high commercial value in national and international markets. This form of specialization entails adopting a production pattern based on monocropping that degrades the natural resources of production areas and damages the health of both agroindustrial workers and residents of cultivation areas. This pattern also soon begins to affect the productivity and profitability of horticultural production in those regions, leading the companies involved to search for other regions where they can carry on their production programs, while taking zero responsibility for the environmental and social costs and simply leaving local producers to face the consequences.

The second element is that the articulation and interdependence of production areas with international consumption centers emerges from the subordination of local producers and Mexican exporters to systems of intermediation and regulations imposed by transnational companies and agencies of foreign governments. Hence, the centers where the decisions that affect the management of the human and natural resources of Mexico’s most productive agricultural regions are taken exist outside the country and respond to foreign priorities and demands, primarily those of the USA. The Mexican government’s agrifood policies support this subordination and agricultural and commercial dependence and fail to concern themselves with the degradation of agrosystems or the environmental and social costs generated in production areas.

The third characteristic is that Mexico’s integration into the region of North America leads to increasing food vulnerability because it prioritizes external demands for food above internal needs, and thus affects the purchasing power of Mexican consumers, many of whom can no longer afford to acquire foods that are in high demand and are included in the staple food basket discussed above. Finally, this integration reproduces marked social and regional inequalities across Mexico.

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Notes
1. This perspective characterizes historical periods of structuring and transition, in which it is possible to identify orderings and agreements on a global scale regarding how foods are produced, distributed and consumed, and diverse forms of hegemony in the world economy. For each ordering we can also isolate certain key social, ecological and nutritional dimensions, characterize how foods are produced and consumed, and discern how capitalism is reproduced historically (McMichael 2000, 2009).
2. Food sovereignty is understood as
   …RIGHT of peoples, communities, and countries to define their own agricultural, labour, fishing, food and land policies which are ecologically, socially, economically and culturally appropriate to their unique circumstances. It includes the true right to food and to produce food, which means that all people have the right to safe, nutritious and culturally appropriate food-producing resources and the ability to sustain themselves and their societies. (Declaration of Nyéléni, Mali, 2007, at http://www.nyeleni.org/spip.php?article125 (12/12/2012))
3. Sistema de Información Agroalimentaria de Consulta, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Mexico.
4. Hoekstra and Chapagain (2007) calculate that producing a 70-gram tomato in average conditions around the world (unfortunately, they do not estimate this for the average environmental conditions in Mexico) requires 13 liters of water. If we project this proportion to one ton of tomatoes, the requirement is 18,571 liters of water. Moreover, if we consider the amount of water needed to produce the 2.9 million tons of tomatoes that Mexico exported in 2008 (FAOSTAT, 2009) the result is 545 cubic hectometers (hm³); a measure equal to 100 m² of water; magnitudes that require the use of reservoirs and water transfers between regions.
5. Arreguín-Cortés and López Pérez (2007) presented a balance between exports and imports of virtual water in the agrifood sector which found that Mexico has a high surplus (24,463 hm³) because in the past 20 years imports of cereals, seeds and animal products have shot up. However, to speak of a surplus of virtual water can lead to a misunderstanding when we analyze the use of a strategic resource like water for food production, since it is not distributed homogeneously in the territory, nor is it exploited in sustainable ways.
6. Regulatory programs focus on: (a) the traceability of products from their origin throughout the supply chain to prevent the distribution of foods that could cause problems for consumer health; (b) innocuousness, to guarantee food safety; (c) the innocuousness of imported horticultural produce, which must be free of plagues and plant diseases that have been eradicated or controlled in the USA; and (d) food quality, which is determined by laws specific to each product that govern such properties as size, color, form and specific flavor.

7. It is necessary to revise the category of ‘luxury foods’ ‘… which invariably make small contributions to total caloric intake’ (Otero et al. 2013, 265) and incorporate into the analysis of food imports and exports the criteria related to nutrition, health and food preferences that government officials and non-government experts deem important.

8. Exports of Mexican tomatoes to the USA are conducted principally by producers in Sinaloa during the winter months, when climatic conditions are less risky than in Florida.

9. Average for the five-year period 2005–2009 (FAOSTAT 2012).

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