Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

Type of the Paper (Article)

Beyond food security: challenges in food safety policies based on international certifications along a heterogeneous food chain. Its effects in Mexican´s health and poverty

Yesica Mayett-Moreno[1,*], Jennie Sheerin Popp[2], and Philip Crandall[2]

[1] Graduate Business School, Universidad Popular Autónoma del Estado de Puebla; e-mail: yesica.mayett@upaep.mx
[2] Department of Agricultural Economics and Agribusiness, University of Arkansas; jhpopp@uark.edu
[3] Department of Food Science, University of Arkansas, University of Arkansas; crandal@uark.edu
* Correspondence: yesica.mayett@upaep.mx; Tel.: +52222 2299400 x 7527; Mobile phone: +52 (045) 222 449 22 02.

Abstract: Taking four of the United Nations Development Goals as reference, this overview describes the need to see from a systemic perspective, the food certifications programs along the food chain in Mexico as today food certifications are voluntary. Using secondary data, the main objectives were: a) there is a fall short in food safety policies and those federal agencies responsible for food safety, to guarantee safe food along the whole domestic food chain, especially in that for low income players; b) the amount of the Mexican Federal Budget Expenses devoted to safety food issues is really low, considering the health, well- being, and food security consequences; and c) due the structural heterogeneity of the Mexican food market, there is a lack of coordination in food regulations along all agents of the food supply chain, bringing to alternate informal markets that put at risk peoples´ health, increasing poverty and inequalities. According to this exercise, only 0.7-8.7% of producers, 12.5% of supermarkets as well as 42.8% of restaurants would have some type of certifications. Public policies must attend this issue in order to improve food safety and security for the whole population, reducing inequalities, poverty and ensuring them a healthy live.

Keywords: domestic markets; small producers; retailers; informal restaurants; low-income population; minister of health; well-being.

1. Introduction

1.1. Food security definition. In accordance with the United Nations Food Agriculture Organization (FAO) [1] "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". This definition highlights safety food as an important component to reach food security, along with economic, physical and social accessibility to all people, always. In medium income countries like Mexico with 53.4 million people in poverty and 24.6 million in food insecurity, is becoming hard to achieve to the whole population [2].

1.2 Food safety and food quality along the agri-food chain (Motivation). Food safety is nearly as important as food security for without safe food the poorest population will continue to suffer negative impacts on their health, loss of personal income, absences from school and inability to work due to illness. Unsafe food creates a vicious cycle of disease and malnutrition; impede socioeconomic development by straining healthcare systems, harming national economies, tourism and trade. Many communicable and non- communicable diseases are caused by contaminated food and water; food security can be jeopardized by pests, plant, animal health diseases or contamination

© 2018 by the author(s). Distributed under a Creative Commons CC BY license.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

in any part of the food chain [3, 4]. The WHO and the Pan American Health Organization (PAHO) have estimated that unsafe food causes one tenth of worldwide illnesses, leading to death of about 420,000 adults and 125,000 children annually [3, 5, 6]. WHO has found that foodborne illnesses and deaths particularly affect low and medium income countries; the access to safe food and water by their poorest citizens remains a great challenge. In Mexico a country with 112.3 million people [7], there were reported 10.9 million cases of diarrhea in Mexican children under five, and the death of 944 children under the age of 14 caused by intestinal infections, which is considered to be the fifth leading cause of death in that age group [8, 9]. Amoebas, salmonellosis and intestinal infectious diseases caused 3,536 deaths in 2013, and are considered the 20th main cause of morbidity in the Mexican population. From 1998 to 2013 deaths by digestive diseases increased 63.1% while the population increased only 15.2% in the same period [10]. For example, the State of Chiapas, with 5.2 million people (considered one of the poorest and with more indigenous population), the same authors calculated that people experienced 25.9 years of life lost due digestive diseases, higher than 24.4 years of life lost due cancer and 21.8 years lost due diabetes. In contrast, in Mexico City, the capital of the country and the biggest urban area with 8.9 million people, equivalent information was of 21, 18.3, and 18 years of life lost, for each illness, respectively [7]. It should be a government priority to ensure consumer´s health through proper legislation and enforcement of rules, especially in the poorest, rural and indigenous areas, that prevent food from chemical, physical and biological contamination, considering their impact in the economic, environmental and social consequences, so food safety is a prerequisite for food security, and are inextricable linked [4, 11, 12].

1.3 Food certifications as a mean to guarantee food safety. Food certifications provide the basis for food control, supervision and control along the food chain. The exposure to risk is becoming higher due fast transport, national and global trade, which increases the risk to transfer contaminants. Public concerns and efforts regards food safety have always been a public health issue, derived of food intake and food outbreaks. Perhaps the international food commerce had leaded us to increase our awareness, as food is the second most traded group of products globally [4]. One of the basic principles to reach for safety food is the adoption of good agricultural practices which are “the basic environmental and operational conditions necessary for the production of safe, wholesome fruits and vegetables” [13]. In Mexico food safety standards are not new to some producers; indeed, there has been gradual progress in embracing certification since the 1960s, mainly in response to demands from foreign food export activities; these efforts were enhanced derived from the North American Free Trade Agreement (NAFTA) signed in 1992. To date Mexican certification programs have been updated and comply with most international standards; nevertheless, food safety standards are not required across all domestic food chain markets, especially are scarce or inexistent in those attending low income consumers. Some authors emphasize the need of re- focus certification in health, and the adoption of food safety standards for domestic consumers, no matter their income or social level [14, 15].

The main problem is that the national /regional and local food supply chain is fragmented and scarce of food regulations, inspectors, so it takes to unsafety food to be sold at the domestic market and for most vulnerable population. Due this, there is a lack of accurate information, and transparency of the most common food illness, that hinder calculate the food illness costs (direct and indirect) associated with food illness, productivity. This situation set back the design and adoption of a public policy to solve and prevent this issue.

The purpose of this research was to demonstrate that: a) there is a fall short in food safety policies (such as food certifications), and those federal agencies engaged in and responsible for food safety and quality, to guarantee safe food along the whole domestic food chain, especially in that for low income consumers; b) the amount of the Mexican Federal Budget Expenses devoted to safety food issues is really low, considering the health, well- being, and food security consequences; c) due the structural heterogeneity of the Mexican food market, there exist a lack of coordination in food regulations (transparency, laws, rules, and bureaucracy) along all agents of the food supply chain,

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

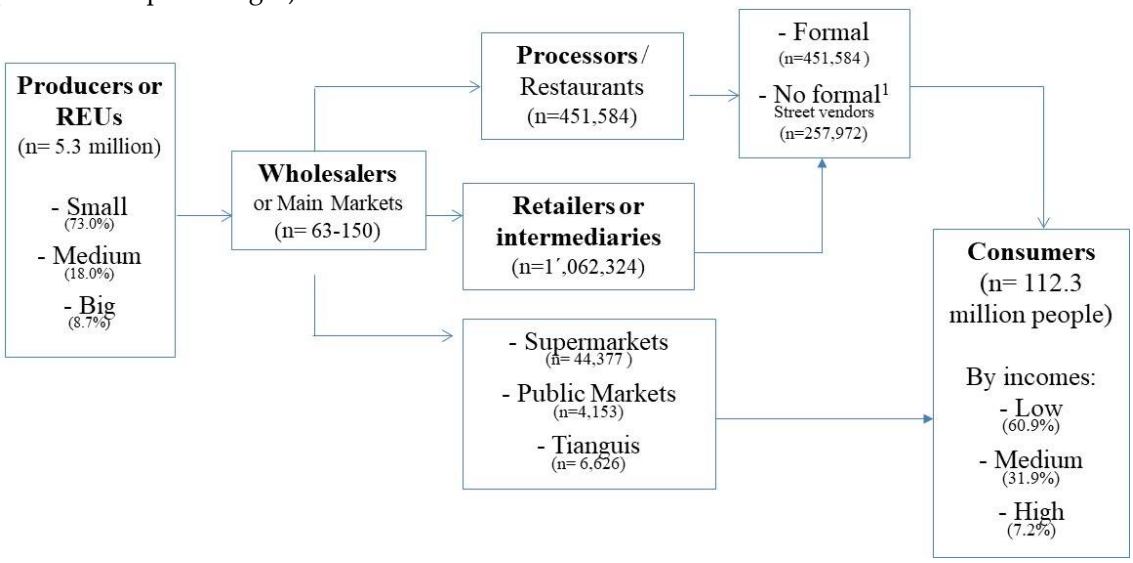
bringing to alternate informal markets that put at risk peoples´ health, increasing poverty and inequalities.

Limitations. As an exploratory research, we present a broader perspective of the fresh food chain in harvested vegetables; we do not include: Genetic Modified controls, biosafety, exported, imported food; pest controls, nor fisheries sanitation data. The lack of official data bases and/or contradictions between them, lead us to estimate most of the information. Inspections or certification for water, imported food, government, nor institutional restaurants (hospital, military, universities, governmental and enterprises´ food vendors) are not subject of this study.

2. Materials and Methods

This research is an exploratory study [16], based in secondary information gathered from national and international official databases. To analyze the food chain dynamic, its importance for synchronization as well as its implications in food policy, we designed a basic supply chain network including some of its different players [17] (Figure 1). For each one of the players, we took information regard the total number of establishments when available, and then we subtract those reported having any certification.

Figure 1. Different players in the basic supply chain network in Mexico, used in this research (frequencies and percentages).



[1] Estimated.

Producers or Rural Economic Units (REUs). In Mexico there are 5.3 million REUs classified into six categories; for this research we merged them into three: Low= E1 Subsistence family farms and E2 Subsistence family farms with some access to the market (73.0%); Medium= E3 Transition and E4 Weak profits (18.0%); Big= E5 Young entrepreneurs and E6 Dynamic entrepreneurs (8.7%) [18, 19].

Wholesalers. According to official databases in the main wholesale center webpage [20, 21, 22], there exists nearly 63-150 registered in the country.

Intermediaries. Before been bought by restaurants, supermarkets, public markets and Tianguis, the produce moves through roughly 1´062,324 of food retailers and brokers officially registered, [20, 21, 22].

Processors or restaurants. Approximately 451,584 food restaurants are officially reported. As there are no official data bases regard informal food vendors or street vendors, we estimated that could

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

exist around 257,972 no formal or street vendors, considering an informality rate of 57.2% in the food sector [23, 24].

Retailers

- Supermarkets. Recent reports mentioned the existence of about 44,377 supermarkets and chain stores in the whole country [23].

- Public markets. Regards the public markets´, we found information available that showed 329 only for the capital of the country, Mexico City [25]; considering that number, we calculated that if one market attends 27,052 people, there would be approximately 4, 153 in the whole country.

- Tianguis. The same situation happened trying to reach out data regard the number of Tianguis or mobile markets, their number was available only for Mexico City (1,343); so we calculated that if one market attends 6,626 people, there would be nearly 16,954 in all the country [23, 25].

- Consumers. For practical purposes, we merged the ten groups ("deciles" in Spanish), reported in the official site of INEGI [26] into three categories according their socioeconomic level: I-V= low (60.9%); VI- VII= medium (31.9%); and IX- X= high (7.2%).

3. Results

3.1 Food security and food safety efforts and achievements in Mexico

Hunger and poverty have been a main concern as Mexico have 47.5% (53.4 million) of the whole population in poverty (36.6% of them are in moderate poverty and 9.5% in extreme poverty); it has been calculated that 40.9% of people from the lowest social level has scarceness on food access [19, 27, 28]. The majority of food vulnerability is now concentrated in rural areas (36.5%) compared to 22.9% in urban zones [27, 28]. The Mexican Government implemented different aid programs since the 1940s to increase food security- such as COMPLAMAR, SAM, PIF, CONASUPO, PRONASOL, PROGRESA, PESA- FAO, OPORTUNIDADES, National Program Mexico Against Hunger- and most recently (2013-2018) the "National Crusade Against Hunger" (CNH) [19, 28, 29, 30]. There were involved various institutions (Minister of Agriculture - SAGARPA, Minister of Rural Affairs, SDR, Rural & Sustainable Development Law- LDRS) trough programs for supporting the income lost "by means of cash transfers, aid in kind, supply networks and social pensions" [31]. Nevertheless, they experienced administrative horizontal and vertical coordination challenges (scarce communication, data bases, duplicity of target population), between interinstitutional authorities (Ministers and Governmental hierarchies), losing not only financial resources, but time, reducing its effectiveness [2, 19, 30, 32].

3.2. Food safety and food certifications at the production level.

To attend food safety from the farm, there have been designed several certification administered by the Federal Government through the Minister of Agriculture, Cattle, Fisheries, Rural Development and Feeding Affairs (SAGARPA), as well as the Minister of Economy (SE). Derived from them, the Subsectors in charge of safety issues at national and in state level are: National Service for Sanitation, Innocuous and Agri-food Quality (SENASICA). In each State there exist local sanitation services [(for example in Puebla, one of the 32 States, there exist the Commission for Vegetable Health (CESAVEP)]. The Minister of Health (SS) evaluates and gives permission in agro-chemicals and food products.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

To date, SENASICA has been in charge of all pests' studies, control and damages, international agreements, among others. It also issues the following official certifications: a) Certification of Food Safety Systems (SRRC) to reach the Food Safety Modernization Act FSMA [33]; b) Good Husbandry Practices (GPP); c) Best Use and Handling of Agrochemicals (BUMA); d) Federal Inspection Type (TIF) to those meat producers and processors; and Mexico Supreme Quality (MCS) certification. The Official Mexican Norms (NOM) of Ag sector depends also on SAGARPA, the Minister of Economy, and the Federal and Competitiveness Sub-Secretary, which also helps in MCS certification process [34, 35].

In order to further discuss how they help to the domestic food safety in all the different players along the supply chain network, we briefly describe some selected federal certifications.

Mexico Calidad Suprema (MCS). In a Federal Effort, coordinated by SAGARPA, MCS was registered as a brand in 1999, mainly to increase agricultural exports [36]. MCS gives support in the accreditation process (based on International Accreditation Forum (IAF) [37] to help: a) training and supervision of Certification Organisms (third party audits) through EMA (Mexican Accreditation Entity; b) technical assistance; c) certification support and consulting for diagnosis of their stages in Good Agricultural Practices (GAP), Risk and Contaminant Reduced System (SRRC) and infrastructure or finance requirements, action plan, implement, pre-test, and certification issues; and d) national and international promotion/advertising. MCS financed 50% of the costs of the certification for those food producers/growers and processors registered in the program.

Mexico's G.A.P. program. Mexico's GAP program was developed from MCS in 2004 to strengthen exports, mainly to Europe. This national GAP program has been harmonized with Global G.A.P and it is devoted to food safety in vegetables and fruits, environmental concerns and safety in workers during the production and processing of food [36].

Organic Production. In 2010 SAGARPA published the Organic Product Law, and by 2013 established the National Council for Organic Production [38].

3.3 Food certifications at the retailer´s level. To get access at groceries stores mainly supermarkets, there are some private certifications that middlemen and retailers must attend, such as PRIMUS GFS, BRC, IFC, SQF-1, FSC 22000, IFS [39].

3.4. Food certifications in processors (restaurants).

"Distintivo H". This certification officially started in 2004 under Mexican Standard

NMX-F-605-NORMEX-2004 Foods, in order to support the tourism sector including restaurants and hotels [40].

Official Mexican Norm NOM-251-SSA1- 2009. All small restaurants that have been

officially registered (for taxes and legal purposes), must attend the and the permission is given only once during their whole commercial operations; for example, a restaurant can operate during 20 years with the same permission, even if they change their size, or sale additional or different products [41].

4. Discussion

4.1. Food security and safety contrasts. In terms of food security, there exist a paradox: on one hand Mexico was the 12th food producer worldwide and third in Latin America. Its agricultural sector (food, cattle and fisheries) experienced a surplus of 3,175 million USD and agri-food exports summarized 105,604 million USD [42, 43]. Mexico has made great strides in building an

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

internationally competitive agricultural industry: it had been in the top 15 global producers of lemon juice; avocado; agave; lemons and limes; frozen, preserved and vinegar vegetables. In the other hand, Mexico has been the largest agri-food importer in this region [27]; it still depends heavily on food imports as nearly 40% of all basic foods are challenging its food security [44].

4.2. Regard food safety, similar situation happens: Mexico is one of the fifth countries worldwide to meet all export food certifications (along with New Zealand, Switzerland, United States and Portugal), such achievement has made it possible to export 18 products (nine vegetables and nine animal), to 160 countries [42]. Nevertheless, food standards are not mandatory across all domestic markets, so not all the players along the food chain attend them; these achievements are done mainly by most big producers, who are certified, as it is a requirement to continue in the export activities. Part of these contrasts could be explained due to the heterogeneity of the production sector.

4.3. The Mexican Agriculture Productive Sector, its structural heterogeneity to achieve food safety. The heterogeneity at the farm level (REUs) can be understood at the light of Mexican history and economic model, which lead to the actual structure in the 5.3 Rural Economic Units (REUs) due differences in the access to markets, hectares (ha) they owned, their value of assets, access to credit, and annual cash income (Table 1) [18, 19].

Table 1. Classifying farms (Rural Economic Units REUs) by access to market, size, access to credit and cash income in Mexico (2013- 2014).

Farm type	Contact with market[a]/ Destiny of their production	Number of REUs (million)	% REUs	Hectares owned	Value assets (thousand USD)	Access to credit per REUs (%)	Estimated cash income (annual) USD
E1 Subsistence family farms	None/ self-consumption	1.19	22.4	3.5	0.23	No access	< 869.1
E2 Subsistence family farms with access to markets	Limited/ self-consumption and national market	2.69	50.6	8.8	2.35	2.7	869.1
E3 Transition	Occasional/ national market	0.44	8.3	32.3	8.23	7.8	3,989.9
E4 Weak profit	95% [a] / national market	0.52	9.9	37.5	14.11	13.1	7,771.4
E5 Young	100% [a]	0.44	8.4	141.4	44.11	44.5	28,773.7

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

entrepreneurs	/national market						
E6 Dynamic entrepreneurs	100% [a] / national & international market	0.017	0.3	297.6	285.11	50.5	> 28,773.7
Total		5.32	100	521.1	364.95		

Source: calculated from the Official Journal of the Federal Government of Mexico[18, 19]. These are official data and do not sumarize100%. Exchange rate: $1 USD= $19.0 Mexican pesos.

For Category E1 (subsistence producers/ family farmers) and Category E2 (subsistence with minimal local market interaction), despite they comprise the largest sector (73.0% of all REUs); their productivity inputs are among the lowest, access to credit is scarce, ha owned are small (3.5- 8.8 ha, respectively), and their assets values are low. This condition affects their food availability and safety.

Categories E3-E4 account for 18.2% of REUs. They sell in domestic markets, but productivity of their inputs is low and access to credit is still minimal. Even though they have more ha under cultivation, their asset values are still low, thus making investment in infrastructure (refrigeration, warehouses, transport, and processing technology) unaffordable. These producers typically have to sell immediately upon harvest and usually at lowest prices. As domestic and local markets are long and not well connected, their crop losses range 15- 35%, hitting their incomes.

Category E5 account for 8.4% of the total REUs. They have access to more sophisticated domestic markets, usually in urban areas, 44.5% of them have access to credit and thus infrastructure investment opportunities. They utilize the most productive land in the country. They are located in the West, Northwest, and central region, one of the most productive areas in the country.

In the same region, are Category E6 export producers, which accounts (0.3%) of all REUs. They have extensive know-how, technology and infrastructure, can produce foods demanded by international markets and can add value to the raw foods produced. Half of these producers have access to credit, have high value assets and thus can afford to comply with food safety standards.

4.4 Certifications in producers

Reliable information regarding the progress in certification by size of producer, number of retailers, and small restaurants is limited. Nonetheless, we can make some assumptions with the information available (Table 2). We found in 2018 there were 36,988 REUs who have achieved any certification in fresh veggies harvested; if there are 5.32 million REU´s, seems like approximately 0.7% of all producers had any type of certification. Another way of seen this is assuming that most certifications would be in E5- E6 producers (0.457 million REU´s) –as they can afford them-; if so nearly 8.9% REUs would be certified. Therefore, it is likely that over 91.1% of REUs would not have any certification, affecting the fresh food sold domestically as well as the respective wholesales, processors, intermediaries and retailers practices [42, 45, 46].

Table 2. Main food safety programs in Mexico and Puebla State (2014- 2018), as part of the Sanity and Innocuous Agrifood, Cattle and Fisheries Program.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

		Nationwide			Puebla [1, 2]		
	Certification obtained	Number REUs/ producers[a]	ha (by type REUs)	Number of States benefited (n=31)	Number REUs	Number of Products	ha (by type of REUs)
Veggies	SRRC	10,350[3]	0.1-972.0	8	296		
	BUMA	1,325[3]	0.1-972.0	16	6	1	1-8
	Packaging (enterprises)	573[3]	-	31	41	30	0.7-250
	Field	1,750[3]	0.1-2,445.0	31	90		
	Harvest (Avocado)	57[3]		3			
	Organic National Distinctive[4]	22,933		23			
Cattle & Fisheries	TIF [4]	443 slaughter houses					
Services (Hotels & Restaurants)	"H" Distinctive[5]	4,000 restaurants					

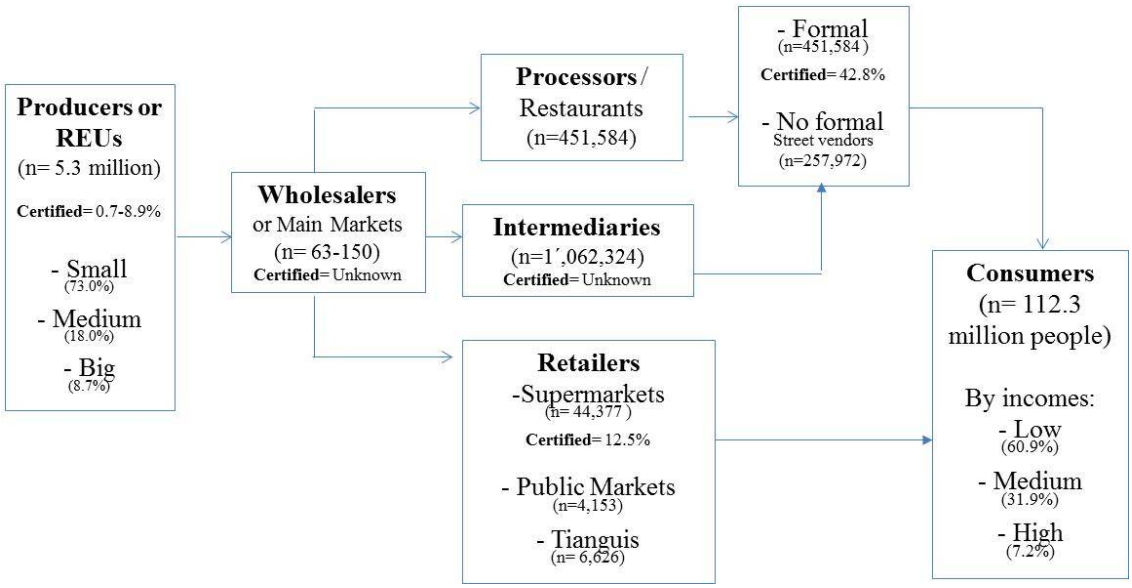
1 SENASICA [45].
2 CESAVEP [62].
3 SENASICA [46].
4 SAGARPA [42].
5 SAGARPA- SEDESOL-INSP- FAO [81].

a Official data sometimes reported producers as synonymous of REUs. Numbers are taken the way they appear in such reports. Unfortunately is not possible to homologate such information. A REUs could have more than one producer, or products.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

In accordance with that, this situation creates a co- existence of two types of food chain networks considering only the fresh harvest vegetables: one certified for export purposes or high income consumers, and other one uncertified for domestic markets and low-medium income consumers (Figure 2). According to this exercise, we would have only from 0.7- 8.7% of producers, 12.5% of supermarkets as well as 42.8% of restaurants with some type of certifications. Unfortunately, the rest of the players along the chain would not have any food safety protocols.

Figure 2. The supply chain network considering those players with and without food certifications calculated in this research.



Regard organic food, the National Council for Organic Production reported 13 certified national organizations (third party audits) and increased their coverage from 600 producers in 2013- 2014, to 5,000 producers in 2014- 2015, and 22,933 in 2017.The number of certified hectares (ha) increased by 512 in 2013-2014, to 142,931 ha, as well as 107 fresh veggies, and 157 processed products certified as organic ones [42, 45]. Nevertheless, organic food is mainly exported or for high income consumers; its impact in the food players are reduced to those wholesalers, retailers and processor who can afford the certification costs.

Complimentary activities came from MCS, who financed around 530 REUs, which is approximately 0.1% of all those [36]. Meanwhile, efforts have been increasing regards SENASICA who in 2018 attended 36,988 REUs, as well as 443 slaughter houses [42, 46], and in Puebla CESAVEP gave equivalent efforts to 433 REUs [45].

Despite those efforts, CONEVAL, the National Evaluation Council of the Social Development Policy, who is in charge to evaluate the performance of federal programs), reported that even when health and food safety information is published, it was often inaccurate and lacking of quantitative measurements. The food safety concerns are mainly in pest eradication and controlling plant pathogens [47], and do not consider supervision along the food domestic chain, the retailers (public

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

markets, low- profile supermarkets, street markets); nor the places of purchase (street tacos, fresh food vendors, small restaurants).

4.4.1. Economic barriers for certification. As we saw, most food cultivated by small and medium producers (Categories E1- E4) sold in the domestic market, lacks Good Agricultural Practices, because these practices often require new capabilities (managerial, technical, infrastructure), and are costly. Then only a small part of the food chain players (Maybe Categories E5- E6, 8.7%), could afford these certifications.

Costs to become certificate can be prohibitive to a small entrepreneur, producer, or middleman [48, 49]. Avendaño and Varela [14]; Avendaño et al. [50] found that the certification process increased the total costs by 2 to 10% for big fresh vegetable exporters in Northwestern Mexico. These authors estimated that producers faced a total of $15,000 USD in production costs during the six to twelve months needed to undergo the full certification process. Recent information from third party audit consultants said that the cost to get Primus GFS (the one needed to have access to supermarkets) rounded $3,306 USD (they need two previous audits, $900 USD each one, plus $450 USD another one or two harvest supervisions, another for packaging, $1,500 USD, plus $456 of taxes and additional expenses for auditors´ travel expenses [51, 52]. Under these constraints, convincing small producers to spend their meager resources on food safety certification is highly challenging. If their estimated cash income is of (869.1- 3,989.9 USD), for E4 it would be the half of their actual cash income. Additionally, in the early stages, certification requires investment in infrastructure and technology. Profits decreased and some producers became disappointed which may have led them to drop certification process and are experiencing barriers of entrance to medium and high-income domestic markets [14, 53].

For example, to access to MCS´s support, producers and packagers previously have to be organized, have adopted a food safety program as well as GAP and SRRC; additionally, producers had to pay the other 50% of the cost [36]. Even if MCS pays 50% of costs upfront, producers cannot cover the remaining 50%.

- Educational and cultural barriers. As Mexican standards and the certification process are mainly used by E5/E6 growers, the process is still complex and worded in a technical vocabulary. These standards have been designed by the private sector following international markets rules, and some of the information is in English. Their content is difficult to read for Categories E1- E3 and some E4 producers, who have a limited or no education and thus have a limited grasp of the English language, unless the certification agencies adapt the documents to their educational level by eliminating technical language as some Latin American countries have done [54, 55, 56, 57]. The way certifications are now administered at national and international level, are exclusive for some REUs, creating a discriminatory and excluding food policy, for all those agents in the supply chain with fewer resources [58]. The average of small producers does not understand what food certifications´ are nor its benefits: a recent exploratory research applied to 265 participants in the broccoli value chain in Puebla (nine small producers, 14 public markets and supermarkets, 15 small restaurants, and 227 medium income consumers), found out that 88.9%, 91.1%, 68.3%, and 73.1% respectively, were not aware of any of these certifications [59].

4.4.3. Organizational structure skills needed to attend certifications. Organizational skills are not easy to build in the short run, so the lack of these capabilities delays producers' access to many of these certifications. For instance, to be certified in MCS, producers and packagers had to be already organized and have already adopted a food safety program, production and good manufacture practices [36]. Another problem is related to sharing official information about other enterprises or REUs that have public or private certifications, its benefits (such as the impact on their productivity, income and employment derived of adopting them) which makes it more difficult to engage more of them to get certificated [48, 49].

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

4.4.4. Food abundance and food scarcity live together in the case of Puebla´s State. The whole country is full of contrasts between abundance and scarceness. To illustrate this, we have the State of Puebla where approximately 40% of the nation's vegetables are produced there. Within this State, the aggregate agriculture sector's share of the State economy was the second largest (3.6%) just behind real estate (3.7%), and larger than the aggregate agriculture sector at the national level (3.1%) [60]. The value of Puebla's food production ranks sixth of Mexico's 32 States [18, 61]. Yet at the same time in 2014, Puebla State´s total poverty was of 3.9 million (64.5%) and is considered the 4th State with the poorest people, and the 5th with people in extreme poverty. Almost a million of them, experience extreme poverty (16.2%), more than half of its population is food insecure, poorly educated, has limited resources and limited income [18, 61]. In the case of Puebla´s State the CESAVEP's budget (a supporting department of SAGARPA and the Rural Development Minister (SDR) for Sanitation activities], was only of 0.057 million USD in 2017 [62, 63, 64, 65]. Data showed that CESAVEP had only provided services to 35 of the 217 municipalities (16.1%) in 2017 [62]. In general, the total number of REUs certified is really low challenging food safety efforts in the State, considering that many vegetables from Puebla are distributed all over the country.

4.5 Wholesalers, intermediaries, and retailers (public and street markets): its importance in food safety distribution. From the farm to the table there is a long and complex road [31, 66]. In general, not all food safety issues rely on the production level. In countries like Mexico, there are typically middleman-intermediaries and monopolistic structures in commodity markets that small and medium sized (E2-E4) fresh food producers must contend with [15, 54, 67]. In the supply chain, E2-E4 producers are the most vulnerable because they have pressure to sell their perishable commodities immediately after harvest, as most of these products have not been certified as well. They are often sold to wholesalers and middleman at low prices that do not require food certifications. Middlemen then sell pooled stocks to public markets, Tianguis, low income supermarkets and informal restaurants, which hardly follow safety neither protocols nor supervised.

4.6 Regards the number of retailers certified, we considered the total of 44,377 reported and took those who belong to the Mexican Chamber of Supermarkets, and convenience stores due to the fact that is mandatory to have the Primus GFS to access to those supermarkets registered [68, 39]; considering that, we will have only 5,567 (12.5%) certified supermarkets. Typically, certified supermarkets attend mostly high income, sometimes medium income people, which are 39% of the Mexican population in urban areas; not to low income ones (61% of the population), neither rural areas (20.7 million people), where there is the highest poverty and food insecurity.

The retailers´ importance in safety food. A large proportion of foodborne diseases are caused by food improperly prepared in food establishments including markets, supermarkets, street markets and restaurants [3, 31, 66]. Therefore, as food can be contaminated at any point along the supply chain, food safety issues must be addressed throughout the entire chain. The Mexican Consumers Federal Attendance (PROFECO) [69] reported that 77.6% of vegetables are still bought in public markets in Mexico City (whose population reaches 20 million people), mainly by medium (81.3%) and low- income people (77.8%), compared with high income ones (69.2%). This puts more vulnerable consumer´s health at risk. Some examples of fresh foods that are purchased by consumers in the lower economic strata [70], have shown that the poorest quality and least desirable varieties of fresh food are most prevalent in places where low income people typically buy food (public markets, street vendors or "tianguis" and cheaper supermarkets).

4.7. Food processors, the lack of supervision in formal and informal restaurants. Official databases reported 451,854 formal restaurants and, due informality rates, approximately would be 257,972 restaurants lacking of any sanitary nor legal permission. [23, 24]. It is very common that 86.7% of Mexican restaurants were not food certified even when some of them showed the permission for working (for legal or taxes purposes), without not physical proof of the food safety, or food hygiene

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

certifications, nor governmental inspections [70]. This possibly indicates a basic disconnect between food safety, the Minister of Health and Governmental regulations, increasing the food risks.

The Minister of Health declared in its web page that street restaurants or street food vendors are not supervised by that institution. For this purpose, there is the Federal Commission to Protect against Sanitary Risks (COFEPRIS), and it attend inspections only under three situations: a) if someone is going to get permission to open or sell food; b) they supervise food vendors, but only when a person makes a complain; c) or they supervise randomly [71]. COFEPRIS did 137,356 supervision visits to slaughterhouses, food factories, as well as food additives, food services, non- alcoholic and alcoholic beverages, purified water, ice, milk and dairy products, fisheries, meat and so on [72]. If we considered only the amount of formal and informal restaurants, food retailers, public markets, tianguis, supermarkets (1´032,397), the supervision´s scope would be minimal. But that report does not indicate in which places, municipalities, or States they did the supervision, reminding that there are more places that need a direct supervision than others according their geographical, socioeconomic condition. Additionally, less than 10% of the people who get sick in these places make a complain [59].

4.8. The consumer´s incomes, needs, lifestyles, and awareness on food safety.

4.8.1 Income inequalities and its relation with food safety and food security. Some studies recognize that most of the problem of food insecurity is income concentration, and the lost in the purchasing power, not only food supply [29, 30, 73]. In Mexico, most of the country's income is concentrated among the few. In 2010, 70.0% of Mexicans shared only 38.0% of the total wealth, meanwhile the upper 10% owned 33.8% of that wealth [26]. Derived of these, each type of consumer spends their budget for food in a different way. Mexico as a medium income country, possess an income elasticity coefficient for food of 0.646 and marginal spent in vegetables 0.084 (while in USA it was 0.346 and 0.061, respectively) [74]. Its food expenses can be understood when there is less purchasing power and food becomes a necessity item, and people with less income increases their expenditure in that item, according to the Economic Theory [75]. This exactly is happening in the country: food remains the largest expense category (35.2%) in the budget for most Mexicans [26]. But the lowest income population (about 14.4 million households, equivalent to approximately 57.6 million people), devotes 34.1% in food, compared with 32.4% and 33.5% in medium and high-income levels, respectively [26]. These issues challenge lower income people who are most price sensitive, pushing them to buy cheaper and uncertified food (fresh or processed), with little concern for its safety or nutritional value.

4.8.2 Lifestyles, less time: the increase in out of home food/ food to go intake and its risks. In 1984 Mexicans did spend 10.4% of their incomes in food out of home; they almost doubled this amount to 21.9% in 2016. Differences arise by income level: despite the lowest income level spend only 18.3% of their income in out of home food; they are 4.4 million houses (approximately 17.7 million persons) which eat out, compared with 3.9 of the highest income levels that eat out of their houses. Those consumers with the lowest income prefer small and cheap restaurants (44.5 %), cheap tacos (52.0%), and mobile/street food small sellers (60.8%), [59]. Unfortunately, many of these types of vendors process food without following any safety protocols, neither a supervision nor control from authorities. Moreover, many consumers do not discriminate among pathogens and the associated risk, and public health officials hardly communicate nor make recalls, publicity about specific hazards, so consumers routinely underestimate small and big risks [76].

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

4.8.3 The risk of eating fresh food and the over- weight and obesity challenge. In the Organisation for Economic Co-operation and Development (OCDE) report, Mexico was the first country with diabetes prevalence (type I or II), as well as obesity and overweight in adults from 20- 79 years old [77]. Particularly this problem affects low income people due they have immediate physical access to "cheaper" uncertified processed food and/ or junk food, intense advertising in mass media, higher prices of safety, nutritious fruits and veggies, and at the same time their purchasing power have been affected. In this prevalence, healthy food lifestyles as the fruit and vegetables intake, are strategic; in the same report, Mexico´s daily fruit and vegetables eating in its population aged 15 years and over was of 43.1% and 57.5%, respectively, while in Australia for example was of 95.0% and 99.0%, for each item. Annual expenditures for vegetables in low income Mexicans range is higher (from $400 to $550 USD) compared with only about half that amount, $285 for high income individuals [26]. This increases the risk to get sick, and the urgency to take actions in fresh food certification efforts at affordable prices.

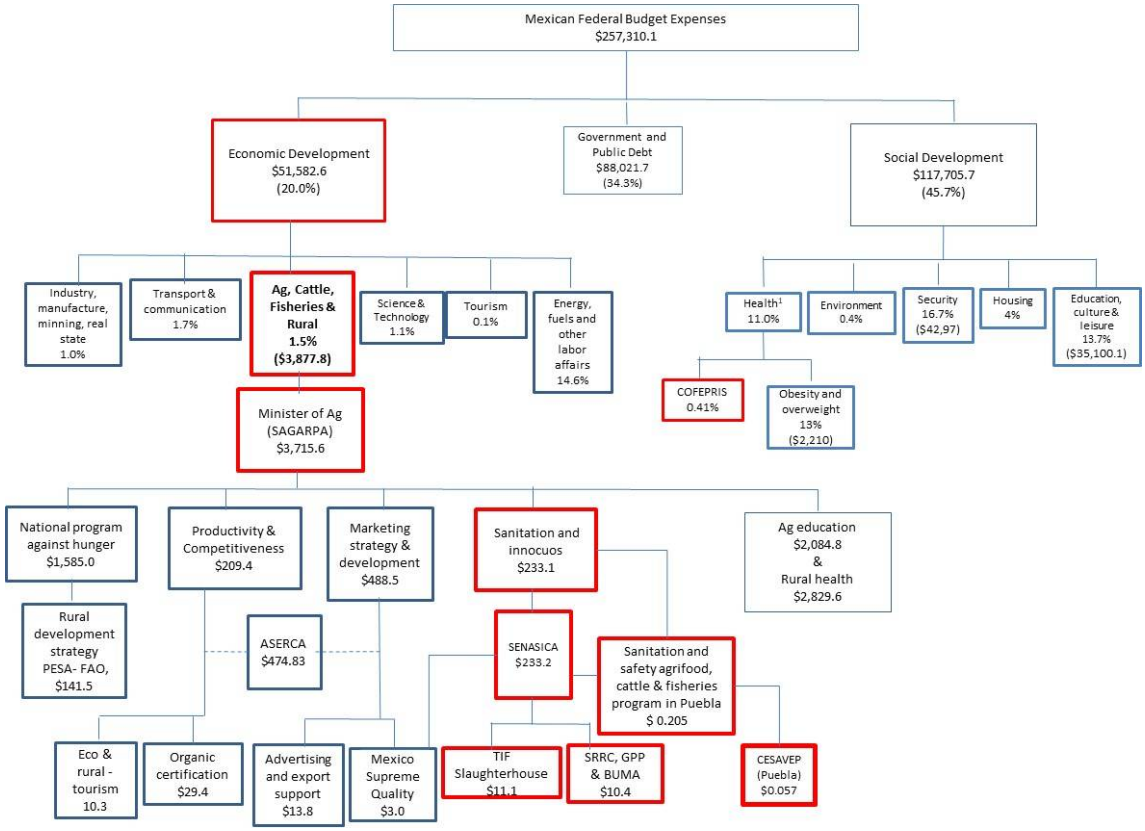
The overweight and diabetes problem as well as other digestive illness (such as cancer), had generated 2,210 million USD of direct costs (amount close to 13.0% of the budget for health in 2008), and 1,315.8 million USD of indirect costs [78]. Some studies calculated the costs of foodborne illness in the US, between $14.1- $77.7 billion USD yearly [79]. Future researches should estimate the respective Mexican cost, as well as the social, economic and health implications.

4.8.4 The International tourism and food intake. Mexico is ranked 6th in tourism visitors worldwide [80]. Since 2007, SAGARPA and the Federal Government established a policy to promote Mexican traditional cuisine at the international level. This is a big challenge having less than 1% of all restaurants in the country certified in Distintivo "H" [81]. The top countries for international visitors are France (86.9 million); Spain (81.8 million), United States (75.9 million), China (60.7 million), and Italy (58.3 million). Improving certifications affairs are important because people from these countries are generally fairly concerned about the safety of their food.

4.9 Federal expenses in food safety issues and public policies regard health. In order to understand if the food safety backwardness experienced in Mexico could be explained at the light of insufficient federal resources, we consulted the Mexican budget deserved to those affairs [64, 65, 82]. We found that in 2017, SAGARPA received $3,715.6 million USD which was distributed in several related programs (Figure 3).

Figure 3. Public expenditures attending food safety programs in Mexico 2014- 2017 (million dollars).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1



Acronyms: SAGARPA= Minister/ Secretary of Agriculture, Cattle, Fisheries, Rural Development, and Feeding affairs; ASERCA= Marketing and Agricultural Markets Development Services Agency; SENASICA= National Service for Sanity, Innocuous and Agri-food quality; CESAVEP= State of Puebla Commission for Vegetal Sanity; SRRC= Reduced Risks and Contaminants System. Exchange rate: $1USD= $19.0 Mexican pesos. Highlighted in red are those attending food certifications, or food safety issues, analyzed in this research.
Sources: Federal Budget for 2015, 2017 [65, 82]; SAGARPA, annual reports (2013- 2017) [35, 38, 42, 54]; CESAVEP, 2015; 2018 [62, 63]; OGF, 2014 [64].

According with those amounts devoted to each institution in the Ag sector, we observed that there is more than the double invested in Marketing Strategy & Development ($488.5 million USD), than for Sanitation and Innocuous Affairs ($233.1). Moreover, the amount deserved in Advertising, Export Support as well as MCS is higher (16.8 million USD) than that for Puebla´s Sanitation and Safety Agrifood Cattle & Fisheries ($0.205 Million USD), CESAVEP for Puebla´s State (0.057 million USD) and SRRC, GPP & BUMA (10.4 million USD) together (considering Puebla State´s importance as a supplier of 40% of the nation´s veggies). The budget allocated for Organic Certification alone (29.4 million USD), was higher than the former three programs mentioned, plus the TIF slaughterhouse, which totalize only 21.7 million USD (given that organic food is not economically feasible to consume for low income consumers, nor all the domestic markets). We think "Productivity & Competitiveness", as well as "Marketing Strategy and Development" activities are important for the Nation´s profits as a whole, but this imbalances in the food policy underestimates an inclusive development and equity; this budget ponder that our priorities are not attend all players who are involved in the domestic food supply chain, who operates with scarcity and giving place to informal nets. Moreover, governmental efforts have considered food safety issues to specific players in that supply chain and leading them to be attended by private (sometimes international) third party auditors, which do not meet those food chain players´ budgets and needs.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

4.10. Certification and training small and medium producers, some experiences in some Latin America countries.

The mere claim that standards exist does not translate immediately into adoption, and not all producers, retailers, processors reach success in the same way and during the same time frame. So, it becomes critical to understand other factors that impact standards, mostly educational, cultural, and organizational [83].

Pérez-Alemán [57, 83] worked on Nicaragua, El Salvador and Guatemala "building collective capabilities, learning and standards diffusion", the knowledge behind the standards (what and why), and the organizational components to meet them (know–how). She found out that the process is not an easy issue as it includes tacit to explicit knowledge, sharing communication and confidence, combining and creating new local knowledge, or mixing local knowledge with national or international knowledge. Shared and spread, this becomes a collective learning process that has to be planned, supervised, adjusted and coordinated on a daily basis and must be recorded so that the valuable traditional knowledge can be passed on. Looking at certification from a different perspective [57, 83, 84], researchers suggest to avoid "taking norms for granted" and "one size fits all", or worrying about why they had not spread the way "they should" in marginalized regions. The authors highlight the importance of using traditional rural and small producers' knowledge, and put it in practice, beyond the mere acquisition of technology, transfer of data in a simplistic way. It has to do with developing new competencies to merge old and new processes, products, organizational activities, and building social capital. Systems of training through associations and groups or regional, national and international network for small countries also did work.

In the Brazilian case, it took five years for sugarcane producers to adopt certification processes successfully. Training auditors and authorities on these issues are more valuable than having seminars for producers and passing out folders that contain the rules. Auditors must adopt a counselor role rather than acting as a supervisor or policeman. Big exporters require a different language and support than domestic small and medium producers, intermediaries, processors; they expect different language because they have different interests along the chain than retailers. Third party auditors, who in rural areas must be close to the producers, must act not as authorities but should help producers translate what the standards and technical language mean. The third-party auditors can thus become strategic partners to help them move to change, to make them feel included and that they are participating in a fair game (no winner or losers). The auditors can also try to build a constructive environment and emphasize the role of the cooperative as a community with shared values.

The increasing demand (internal and external) in Peru for quality asparagus, lead them to a strong cooperation between private and government sectors, in both standards, and cooperation with investments and infrastructure. This increased income and employment across the supply chain including in cultivation of fresh asparagus, as well as in secondary industries (frozen and canned). In addition, they used second grade produce that did not meet standards for exports thus reducing waste and leading to more employment for some of Peru's poorest people [82].

Small producers in low and medium- income countries can develop and discover their strengths and overcome their weaknesses by adopting a proactive strategic response to food safety standards [83]. They can take advantage of their traditional knowledge by discovering new markets or can participate in the creation of new markets or negotiate standards (voice and proactivity) [32, 67, 84]. In Argentina and the Dominican Republic found the Codex Standard to have little influence in these countries, so they designed their own local, regional and Merco Sur rules, trying to avoid entrance barriers to international markets, and re-structured them as a response [14, 60].

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

4.10.2. Retailers challenges. Along the agricultural food chain, certification processes need different strategies, depending on the industry characteristics [56, 87]. At the retailing level, public markets and Tianguis require different information and legislation than supermarkets as do those devoted to low, medium and high incomes consumer.

4.10.3. Processors and restaurants inspections. COFEPRIS and the Minister of Health (SS) must assume this responsibility and integrate efforts with other institutions as SAGARPA, as well as the Minister of Economy to remodel food and health policies. It is important to put a ban and penalize those vendors who sell food in the street´s floor, out of the subway, offices, hospitals, schools, without any sanitary practice. This, in the medium and long run, would eradicate the culture of working out of the law, and at the same time could become a media to get additional taxes, to be invested in federal domestic certifications (infrastructure, technologies, training, inspectors´ wages, among others).

4.10.4. Educating the consumer to inform about food safety at home. The change in the actual food policies takes a while. In the short run, more resources should be invested in order to increase advertising and communication in TV, radio, and websites, to give information regard basic rules people can adopt to improve food safety practices at home to vulnerable people.
Besides, authorities must improve their administrative procedures to persuade the people to complain when they get sick, as well as when those some retailers and processors are selling contaminated food. Such institutional mechanisms should be efficient and give a fast response, in order to reduce the spread of illness.

5. Conclusions

Policy Implications on food safety and food security on the United Nations Sustainable Development Goals (UNSDG). The certification process is a multidimensional and complex issue, particularly in its implementation. Though this report is not exhaustive on the topic, its reflections are centered on the challenges to achieve the UNSDG [88] regard food safety and food security, keeping in mind that all the population, mainly that in poverty, deserves well- being, access to safety, economic, nutritious, sufficient food all times.

In Mexico the federal, regional, and in State food safety regulations are fragmented and complicated. In order to inform rapidly and accurate to all food chain agents the status of inspections, control and findings, federal, regional and local inspectors must adopt basic technologies, high levels of transparency and make public those findings in order to give them attention. Hence, it would be necessary to adopt a more integrated inspection system with authorities closely collaborating, sharing updated information and reform the legislation and inspections of the entire food supply chain, merging the activities and responsibilities of the supervision, between the Minister of Health and the Minister of Agriculture [4]. These fragmentation and unbalances in the federal budgets had led to all institutions involved, to react and solve the food safety problems after they occur, especially in those unattended vulnerable segments of the chain, instead of preventing.

Ironically primary responsibility on food safety issues is not only in food producers. Food retailers, and processors have more responsibility in medium where the level of informal restaurants is of 57.2% and there is a lack of inspections and compliance, not only due restrictions in Federal Budget, but sometimes due to organization crime presence.

The Mexican Minister of Health as a public procurement and all government agencies are significant actors in the well- being of any society, they must show leadership and play a more engaged and strategic role to promote food safety throughout supply chains [31, 66, 76].

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

The claim that "food safety begins on the farm" or "from farm to fork" [13] should become a reduced perspective if we do not consider the heterogeneity that prevails in the supply chain in lower and medium income countries. There is a need to analyze from a systemic perspective, each player in the food supply chain, its needs, resources, infrastructure, access to credit, educational and cultural profiles. Progress regard food safety policies continues centered in export issues in many countries like Mexico, which have the pressure of a public debt, insecurity, poverty, and where the federal budgets are distributed observing inequities, ignoring their population basic food needs and well-being. In order to achieve the UNSDG, we should shift the focus to improve the food safety and food security policies, which at the same time would help reduce poverty.

Author Contributions: Yesica Mayett-Moreno, Jennie Popp and conceived the idea; Jennie Sheerin Popp and Philip Crandall contributed writing and editing the paper in English.

Acknowledgments: We thank the Fulbright- García Robles Commission.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Food and Agriculture Organization of the United Nations. Food security. 2006. Available online: http://www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf (accessed on 30 January 2018).

2. Consejo Nacional de Evaluación de la Política de Desarrollo Social. Informe de Evaluación de la Política de Desarrollo Social 2016. 2017. Available online: https://www.coneval.org.mx/Evaluacion/IEPSM/Documents/IEPDS_2016.pdf (accessed on 2 May 2018).

3. World Health Organization. WHO estimates of the global burden of foodborne diseases. Foodborne Disease Burden Epidemiology Reference Group 2007-2015. 2015a. Available online: http://apps.who.int/iris/bitstream/10665/199350/1/9789241565165_eng.pdf (accessed on 17 February 2016).

4. Gordana, R. Study of food safety inspections. World Bank. 2009. Available online: http://documents.worldbank.org/curated/en/614141468325282214/Study-of-food-safety-inspections (accessed on 23 September 2018).

5. Pan American Health Organization. Health in the Americas: 2012 Edition. Regional Outlook and Country Profiles. World Health Organization Regional Office for the Americas. Scientific and Technical Publication No. 636 2012. Available online: http://www1.paho.org/saludenlasamericas/docs/hia-2012-summary.pdf (accessed on 17 February 2016).

6. Batz, M.B., Henke, E. and Kowalcyk, B. Long-term consequences of foodborne infections. Infect Dis Clin North Am 2013. Available online: https://www.ncbi.nlm.nih.gov/pubmed/24011832 (accessed on 21August 2015).

7. Instituto Nacional de Estadística y Geografía. Anuario Estadístico y Geográfico de los Estados Unidos Mexicanos. 2014. Disponible en: http://www.beta.inegi.org.mx/app/biblioteca/ficha.html?upc=702825097912 (accessed on 14 agosto 2018).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

8. Instituto Nacional de Estadística y Geografía. Estadísticas de mortalidad. 2013. Available online: http://www3.inegi.org.mx/sistemas/sisept/Default.aspx?t=mdemo107&s=est&c=23587 (accessed on 4 Septiembre 2015).

9. Instituto Nacional de Salud Pública. Encuesta Nacional de Salud y Nutrición. Resultados Nacionales 2012. Instituto Nacional de Salud Pública. 2012. Available at: https://ensanut.insp.mx/informes/ENSANUT2012ResultadosNacionales.pdf (accessed on 8 October 2018).

10. Diaz- Cayeros, A.; Egan, A.; Floca, M.; Furszyfer, J.; Gell-Redman, M.; Gomez Morin, L.; Razu, Z. Atlas of Epidemiological Transition in Mexico. Center for U.S.-Mexican Studies. 2017. Available at: http://usmex-health.ucsd.edu/ (accessed on 13 February 2018).

11. World Health Organization. World Health Day 2015 Food Safety. How Safe is Your Food? From farm to plate, make food safe. Campaign tool kit. 2015. Available online: http://www.who.int/campaigns/world-health-day/2015/campaign-toolkit.pdf?ua=1 (accessed on 2 October 2018).

12. World Health Organization. Food Safety Key facts. Fact sheet No. 399. 2015. Available online: http://www.who.int/campaigns/world-health-day/2015/fact-sheet.pdf?ua=1 (accessed on 26 September 2018).

13. Anusuya, E.; Bihn, A.; Gravani, R.B.; Scott, D.L. and Pritts, M.P. Food Safety begins on the Farm. A grower´s guide. Good Agricultural Practices for fruits and vegetables. Cornell Good Agricultural Practices Program. 2000. Available online: https://ecommons.cornell.edu/handle/1813/2209 (accessed on 8 October 2018).

14. Avendaño, B.; Varela, R. La adopción de estándares en el sector hortícola de Baja California. Estudios Fronterizos 2010. Available online: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-69612010000100006 (accessed on 3 November 2015).

15. Salles de Almeida, J. "Normas privadas": el nuevo desafío para las exportaciones de los países en desarrollo. Comisión Económica para América Latina- Naciones Unidas. 2008. Available online: http://repositorio.cepal.org/bitstream/handle/11362/4430/S0800046_es.pdf?sequence=1 (accessed on 23 November 2015).

16. Hernández, R.; Fernández- Collado, C.; Baptista, P. Metodología de la investigación, 6th ed.; Mc Graw Hill: México, 2014; pp. 632; ISBN 978-1456223960.

17. Chandrasekaran, N.; Raghuram, G. Agribusiness Supply Chain Management, ed.; CRC Press. Taylor & Francis Group: Boca Raton, U.S.A., 2014; pp. 670; ISBN 978-1-4665-1674-8.

18. Official Journal of the Federal Government of Mexico. Decreto por el que se aprueba el Programa Sectorial de Desarrollo Agropecuario, Pesquero y Alimentario 2013-2018. Cuarta Sección. 13 de diciembre. Enrique Peña Nieto. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 2013. Available online: http://dof.gob.mx/nota_detalle.php?codigo=5326583&fecha=13/12/2013 (accessed on 12 November 2015).

19. Official Journal of the Federal Government of Mexico. Programa Nacional México sin Hambre. Gobierno Federal. 2014. Available online: http://dof.gob.mx/nota_detalle.php?codigo=5343098&fecha=30/04/2014 (accessed on 12 November 2015).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

674 20. Central de Abasto de la Ciudad de México. Available online:
675 https://uneabasto.com/informacion-de-central-de-abastos.htm (Accessed on 8 September 2018).

676 21. Sistema Nacional de Información e Integración de Mercados. Secretaría de Economía. Available
677 online: http://www.economia-sniim.gob.mx/nuevo/ (Accessed on 26 September 2018).

678 22. Instituto Nacional de Estadística y Geografía. 2018. Directorio Estadístico Nacional de Unidades
679 Económicas. Available online: http://www.beta.inegi.org.mx/app/mapa/denue/ (Accessed on 26
680 September 2018).

681 23. Instituto Nacional de Estadística y Geografía. Censos Económicos 2014. La industria
682 restaurantera en México. 2016. Available online:
683 http://www.beta.inegi.org.mx/app/biblioteca/ficha.html?upc=702825080334 (accessed on 28
684 September 2018).

685 24. Instituto Nacional de Estadística y Geografía. INEGI. Encuesta Nacional de Ocupación y
686 Empleo. Tasa de Informalidad laboral. Indicadores estratégicos. Primer trimestre. 2018. Available
687 online:
688 http://www.beta.inegi.org.mx/app/buscador/default.html?q=tasa+de+informalidad#tabMCcollapse-
689 Indicadores (accessed on 9 August 2018).

690 25. Secretaría de Desarrollo Económico. Ciudad de México. Listado de Mercados Públicos. 2015.
691 Available online:
692 http://www.sedecodf.gob.mx/archivos/Menu_Horizontal/2015/InformacionRelevante/Listado_de_
693 Mercados_Publicos.pdf (accessed on 28 September 2018).

694 26. Instituto Nacional de Estadística y Geografía. Encuesta Nacional de Ingresos y Gastos de los
695 Hogares. 2010. Available online: http://www3.inegi.org.mx/rnm/index.php/catalog/36 (accessed on 4
696 September 2015).

697 27. Consejo Nacional de Evaluación de la Política de Desarrollo Social. Informe de evaluación de
698 la Política de Desarrollo Social en México 2014. 2015. Available online:
699 https://www.coneval.org.mx/InformesPublicaciones/Paginas/Mosaicos/Informe-de-evaluacion-de-l
700 a-politica-de-desarrollo-social-2014.aspx (accessed on 29 September 2017).

701 28. Food and Agriculture Organization of the United Nations. Regional Overview of Food
702 Insecurity Latin America and the Caribbean. 2015. Available online:
703 http://www.fao.org/3/a-i4636e.pdf (accessed on 29 April 2016).

704 29. Torres, F. México: expectativas de su seguridad alimentaria en la fase de economía abierta; In:
705 Ciencia, Tecnología e Innovación en el Sistema Agroalimentario de México; D. Martínez-Carrera,
706 Ramírez- Juárez, J., Eds.; Biblioteca Básica de Agricultura. México, 2016, pp. 856; ISBN
707 978-607-715-314-6.

708 30. Cuéllar, J.A. Programa de seguridad alimentaria: experiencias en México y otros países.
709 Comisión Económica para América Latina. 2011. Available online:
710 http://repositorio.cepal.org/bitstream/handle/11362/26070/LCmexL1035_es.pdf?sequence=1
711 (accessed on 8April 2015).

712 31. Food and Agriculture Organization of the United Nations. Food Safety Risk Management.
713 Evidence- informed policies and Decisions considering multiple factors. FAO Guidance Materials.
714 2017. Available online: http://www.fao.org/3/i8240en/I8240EN.pdf (accessed on 2 October 2018).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

32. Parra- Inzunza, F.; Ocampo- Fletes, I; Gutiérrez A. La experiencia PESA- FAO en la región Mixteca Baja Poblana. In: Seguridad Alimentaria en Puebla: importancia, estrategias y experiencias. Jiménez, F.A. Eds.; Colegio de Postgraduados- Secretaría de Desarrollo Rural del Gobierno del Estado de Puebla- Altres Costa- AMIC, Mexico, 2008; pp. 283; ISBN 978-968-839-539-4.

33. Food Safety Modernization Act. 2017. Available online: https://www.gob.mx/sagarpa/prensa/capacitacion-en-ley-de-inocuidad-de-estados-unidos-beneficiara-a-productores-mexicanos (accessed on 23 January 2017).

34. Secretaría de Economía. Catálogo Mexicano de Normas. 2018. Available online: https://www.sinec.gob.mx/SINEC/ (accessed on 8 October 2018).

35. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 2nd SAGARPA activities report (2013- 2014). 2014. Available online: http://www.sagarpa.gob.mx/Transparencia/Informes/SEGUNDO_INFORME_DE_LABORES_2013_%202014_SAGARPA.pdf (accessed on 16 November 2015).

36. México Calidad Suprema. México Calidad Suprema, el sello de los mexicanos 2018. Available online: http://www.mexicocalidadsuprema.org/proyectos/ (accessed on 15 October 2018).

37. International Accreditation Forum– IAF. Available online: https://www.iaf.nu/articles/IAF_MEM_Mexico/91 (accessed on 8 October 2018).

38. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 1st SAGARPA activities report (2012- 2013). 2013. Available online: http://www.sagarpa.gob.mx/Transparencia/Pot%202013/Informes%202013/INFORME_SAGARPA.pdf (accessed on 16 November 2015).

39. Walmart. Requerimientos de seguridad alimentaria para proveedores de alimentos procesados y productos agrícolas. 2018. Available online: https://cdn.corporate.walmart.com/b3/f4/3b20e09f44868655259e8bb570fe/manual-seguridad-alimentos-procesados-agricolas.pdf (accessed on 14 February 2018).

40. Distintivo H. Available online: http://www.sectur.gob.mx/gobmx/tramites-y-servicios/certificacion-turistica/distintivo-h/ (accessed 12 October 2018).

41. Norma Oficial Mexicana NOM-251-SSA1- 2009. Gobierno Federal. 2018. Available at: http://dof.gob.mx/nota_detalle.php?codigo=5133449&fecha=01/03/2010 (accesed on 12 October 2018).

42. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 5th SAGARPA activities report (2016- 2017). 2017. Available online: https://www.gob.mx/cms/uploads/attachment/file/255710/5TO_INFORME_2017_web.pdf (accessed on 20 January 2017).

43. Secretaría de Economía. Estadísticas de Comercio Exterior de México. Subsecretaría de Comercio Exterior. Total Exportaciones e Importaciones. 2016. Available online: http://www.gob.mx/cms/uploads/attachment/file/81863/Acum-Exporta.pdf (accessed on 11 March 2016).

44. Villa, M. ¿Qué hacemos con el campo? 2da ed.; Mundi-Prensa: México, 2011; pp. 433; ISBN 9786077533696.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

45. Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria. Directorio de empresas y áreas reconocidas 08/10/2018. Available online: http://www.cesavep.org/campanias/Pia/pia_obj.html (accessed on 15 October 2018).

46. Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria. Personas físicas o morales reconocidas por la aplicación de Sistema de Reducción de Riesgos de Contaminación en la Producción Primaria de Vegetales. 2018. Available online: https://www.gob.mx/cms/uploads/attachment/file/397772/DIRECTORIO_EMPRESAS_Y_AREAS_al_30_de_septiembre_2018.pdf (accessed on 8 October 2018).

47. Consejo Nacional de Evaluación de la Política de Desarrollo Social. Instrumentación de Acciones para mejorar las Sanidades a través de Inspecciones Fitozoosanitarias. Informe de la Evaluación Específica de Desempeño 2012- 2013. 2014. Available online: http://www.coneval.org.mx/Informes/Evaluacion/Especificas_Desempeno2012/SAGARPA/8_U002/8_U002_Completo.pdf (accessed on 10 November 2015).

48. Crandall, P.; Van Loo, E.; O´Bryan, C.A.; Mauromoustakos, A.; Viannas, F.; Dyenson, N.; Berdnik, I. Companies´ Opinions and Acceptance of Global Food Safety Initiative Benchmarks after Implementation. J. Food Prot 2012, DOI: 10.4315/0362-028X.JFP-11-550.

49. Lee, J.; Gereffi, G.; Beauvais, J. Global value chains and agrifood standards: Challenges and possibilities for smallholders in developing countries. In Proceedings of the National Academy of Sciences of the United States of America, 31 July, 2012. Available online: http://www.pnas.org/content/109/31/12326.full.pdf (accessed on 13 November 2015).

50. Avendaño, B., Schwentesius, R.; Lugo, S. El impacto de la Iniciativa de Inocuidad Alimentaria de Estados Unidos en las Exportaciones de Hortalizas Frescas del Noroeste de México. Región y Sociedad. 2006. Available online: http://www.redalyc.org/articulo.oa?id=10203601 (accessed on 3 November 2015).

51. IPAAGRO-LUUM Private third party audits. Personal communication, 2018.

52. Globalstd.com. Private third party audits. Personal communication, 2018.

53. Herbert, M.; Mora, J.S.; Martínez, M.A.; García- Mata, R. Impacto económico de la Ley Federal de Sanidad Vegetal en el mercado mexicano de limón persa. Rev Mexicana de Ciencias Agrícolas 2010. Available online: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-09342010000300004 (accesssed on 7 October 2018).

54. Arvizu, E.; Mayett-Moreno, Y.; Martínez-Flores J.L.; Olivares-Benítez, E.; Flores-Miranda, L. Análisis de producción y comercialización hortícola del Estado de Puebla: un enfoque de cadena de valor. Rev Mexicana de Ciencias Agrícolas 2015. Available online: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-09342015000400009 (accessed on 2 November 2015).

55. Neal, J. A.; O´Bryan, C.A.; Crandall, P.G. Preventing Post - Processing Contamination in a Food Nugget Processing Line When Language Barriers Exist. Agriculture, Food and Analytical Bacteriology 2014. Available online: file:///C:/Users/UPAEP/Downloads/Case2-Neal.pdf (accessed on 8 October 2018).

56. Coslovsky, S. Enforcing Food Quality and Safety Standards in Brazil: The Case of COBRACANA. Annals of the American Academy of Political and Social Science 2013. Available online: http://journals.sagepub.com/doi/abs/10.1177/0002716213486468 (accessed on 5 October 2015).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

799 57. Pérez- Alemán, P. Global standards and local knowledge building: Upgrading small producers
800 in developing countries. In Proceedings of the National Academy of Sciences of the United States of
801 America, 31 July; U.S.A., 2012; 12344-9. Available online:
802 http://www.pnas.org/content/109/31/12344.full.pdf (accessed on 18 November 2015).

803 58. Post, D.L. Standards and Regulatory Capitalism: The diffusion of Food Safety Standards in
804 Developing Countries. Annals of the American Academy of Political and Social Science 2005.
805 Available online: https://doi.org/10.1177/0002716204271565 (accessed on 18 November 2015).

806 59. Mayett- Moreno, Y.; Sabogal-Salamanca, M.; Popp, J.S.; Crandall, P.; Arvizu-Barrón, E. Is Food
807 Safety a Real Concern in Mexico and Colombia? A Preliminary Report among Small Producers,
808 Retailers and Consumers. Sustainability 2017. https://doi.org/10.1111/dpr.12295.

809 60. Instituto Nacional de Estadística y Geografía. Sistema de Cuentas Nacionales de México.
810 Cuentas de Bienes y Servicios 2014. 2015. Available online:
811 http://www.inegi.org.mx/saladeprensa/boletines/2015/especiales/especiales2015_09_3.pdf (accessed
812 on 8 October 2018).

813 61. Jiménez, F.A. Seguridad alimentaria en Puebla: importancia, estrategias y experiencias; Colegio
814 de Postgraduados- Secretaría de Desarrollo Rural del Gobierno del Estado de Puebla- Altres Costa-
815 AMIC: Mexico, 2008; pp. 283; ISBN 978-968-839-539-4.

816 62. Comisión para la Sanidad Vegetal del Estado de Puebla. Situación actual del Programa. 2017.
817 Available online: http://www.cesavep.org/campanias/Pia/pia_obj.html (Accessed on 23 April 2017).

818 63. Comisión para la Sanidad Vegetal del Estado de Puebla. 2015. Available online:
819 https://www.gob.mx/senasica/acciones-y-programas/acciones-estrategicas-de-sanidad-vegetal
820 (accessed on 23 April 2017).

821 64. Official Journal of the Federal Government of Mexico. Federal Expenses Budget Approved for
822 2015. 2014. Available online:
823 http://www.dof.gob.mx/nota_detalle.php?codigo=5374053&fecha=03/12/2014 (accessed on 12
824 November 2015).

825 65. SHCP Secretaría de Hacienda y Crédito Público. Presupuesto de Egresos de la Federación 2017.
826 Versión Ciudadana. Secretaría de Hacienda y Crédito Público. 2017. Available online:
827 http://transparenciapresupuestaria.gob.mx/es/PTP/infografia_ppef2017 (accessed on 15 January
828 2018).

829 66. Food and Agriculture Organization of the United Nations. Food Chain Crisis Early Warning
830 Bulletin. 2018. Available online: http://faostat.fao.org/site/339/default.aspx (accessed on 29 August
831 2018).

832 67. Lugo- Morín, D.R.; Ramírez- Juárez, J.; Méndez – Espinoza, J.A.; Peña- Olvera, B. Asymmetric
833 social networks in the horticultural system in the Tepeaca Valley, Mexico. Economía, Sociedad y
834 Territorio 2010. Available online: http://www.cmq.edu.mx/.../est_32_7.pdf (accessed on 8 October
835 2018).

836 68. Asociación Nacional de Tiendas de Autoservicio y Departamentales. 2018. Available online:
837 https://antad.net/ (accessed on 12 October 2018).

838 69. Procuraduría Federal del Consumidor. Survey regards places where households buy their
839 groceries. 2014. Available online:

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

http://www.profeco.gob.mx/encuesta/mirador/2014/Encuesta_sobre_lugares_de_compra.pdf (accessed on 5 December 2014).

70. Mayett, Y.; Martínez-Carrera, M. Estrategias para promover el consumo de hongos comestibles en México, con base en sus propiedades funcionales y medicinales. In: Ciencia, Tecnología e Innovación en el Sistema Agroalimentario de México; D. Martínez-Carrera, Ramírez- Juárez, J., Eds.; Biblioteca Básica de Agricultura. México, 2016, pp. 856; ISBN 978-607-715-314-6.

71. Comisión Federal para la Protección contra Riesgos Sanitarios. Proceso de vigilancia sanitaria. Comisión de operación sanitaria. 2018. Available at: https://www.gob.mx/cofepris/acciones-y-programas/proceso-de-de-vigilancia-sanitaria-75408 (accessed on 8 October 2018).

72. Secretaria de Salud. 5to. Informe de Labores 2016- 2017. Gobierno Federal. 2017. Available online: https://www.gob.mx/cms/uploads/attachment/file/254434/5to_IL_SS.pdf (accessed on 20 January 2018).

73. Consejo Nacional de Evaluación de la Política de Desarrollo Social en México 2012. 2012. Available online: https://www.coneval.org.mx/informes/evaluacion/iepds2012/pages-iepdsmex2012-12nov-vfinal_lowres6.pdf (accessed on 14 October 2018).

74. United States Department of Agriculture. Economic Research Service. Budget shares for broad aggregates and conditional budget shares for food categories 2005. Available online: http://ers.usda.gov/data-products/international-food-consumption-patterns.aspx#26207 (accessed on 3 October 2015).

75. Case. K.E.; Fair, R.C. Principios de Microeconomía, 4ta ed.; Prentice Hall: México, 1995; pp. 620; ISBN 0-13-440918-3.

76. Kuchler, F. How Much Does It Matter How Sick You Get? Consumers´ Responses to Foodborne Disease Outbreaks of Different Severities. 2015. Available online: https://www.ers.usda.gov/webdocs/publications/45419/53640_err193.pdf?v=42243 (accessed on 2 October 2018).

77. Organisation for Economic Co-operation and Development. Health at a Glance 2017: OECD Indicators, OECD Publishing, Paris. 2017. Available online: https://www.health.gov.il/publicationsfiles/healthataglance2017.pdf (accessed on 26 September 2018).

78. Secretaría de Salud. Estrategia Nacional para la Prevención y el Control del Sobrepeso, la Obesidad y la Diabetes. 2013. Available online: https://www.gob.mx/cms/uploads/attachment/file/348803/Estrategia_con_portada.pdf (accessed on 20 January 2018).

79. Hoffmann, S. and T.D. Anekwe. Making Sense of Recent Cost-of-Foodborne-Illness Estimates. United States Department of Agriculture. 2013. Available online: https://www.ers.usda.gov/webdocs/publications/43796/40344_eib118.pdf?v=0 (accessed on 2 October 2018).

80. Secretaría de Turismo. México, Sexto Lugar del Ranking Mundial en Arribo de Turistas Internacionales, confirma OMT. 2018. Available online: https://www.gob.mx/sectur/prensa/mexico-sexto-lugar-del-ranking-mundial-en-arribo-de-turistas-internacionales-confirma-omt (accessed on 30 August, 2018).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 16 October 2018 doi:10.20944/preprints201810.0336.v1

883 81. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación- Secretaría de
884 Desarrollo Social- Instituto Nacional de Salud Pública- Food and Agriculture Organization of the
885 United Nations. Panorama de la Seguridad Alimentaria y Nutricional en México. 2012. Available
886 online: http://www.colpos.mx/wb_pdf/Panorama_Seguridad_Alimentaria.pdf (accessed on 12 April
887 2015).

888 82. Secretaría de Hacienda y Crédito Público. Presupuesto de Egresos de la Federación 2015.
889 Versión Ciudadana. Secretaría de Hacienda y Crédito Público. 2015. Available online:
890 http://www.transparenciapresupuestaria.gob.mx/work/models/PTP/Home/Ultimas_Publicaciones/
891 PEF_ciudadano_2015.pdf (accessed on 12 November 2015).

892 83. Pérez- Alemán, P. Collective Learning in global diffusion: spreading quality standards in a
893 developing country cluster. Organization Science 2011. Available online:
894 https://www.mcgill.ca/desautels/files/desautels/perez-aleman_orgsci_2011_v22_pp173-

895 189.pdf (accessed on 18 November 2015).

896 84. Henson, S. and Jaffee, S. Standards and Agro-Food Exports from Developing Countries:
897 Rebalancing the Debate. World Bank Policy. Research Working Paper 3348 2004. Available online:
898 http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-3348 (accessed on 13November 2015).

899 85. Henson, S. and Jaffee, S. Understanding Developing Country Strategic Responses to the
900 Enhancement of Food Safety Standards. The World Economy 2008. Available online:
901 http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9701.2007.01034.x/abstract (accessed on 13 October
902 2015).

903 86. Ramírez-Juárez, J. 2016. La agricultura familiar y su contribución a la seguridad alimentaria:
904 límites y posibilidades. In: Ciencia, Tecnología e Innovación en el Sistema Agroalimentario de
905 México; D. Martínez-Carrera, Ramírez- Juárez, J., Eds.; Biblioteca Básica de Agricultura. México,
906 2016, pp. 856; ISBN 978-607-715-314-6.

907 87. Donovan, J.A.; Caswell, J.; Salay, E. The Effect of Stricter Foreign Regulations on Food Safety
908 Levels in Developing Countries: A Study of Brazil. Review of Agricultural Economics 2001.
909 Available online: https://www.jstor.org/stable/1349913?seq=1#page_scan_tab_contents (accessed
910 on 13 October 2015).

911 88. United Nations. Sustainable development goals. 17 goals to transform our world. 2016.
912 Available online: https://www.un.org/sustainabledevelopment/sustainable-development-goals/
913 (accesed on Diciembre 2017).