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O fracasso histórico da política de autossuficiência agroalimentar no México e sua perspectiva para a próxima década (2030)

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Resumen

Históricamente, la producción de granos en México ha sido insuficiente para atender su demanda interna. Esta investigación, secuencial mixta, tiene como objetivo analizar el déficit de la producción nacional de granos, la dependencia a su importación (desde los últimos 40 años) y pronosticar su alcance en la próxima década. Se demuestra que de 1980 al 2021 la superficie dedicada a la producción de arroz, avena, cebada, frijol, maíz, soya, sorgo y trigo se redujo 7 %, su producción incrementó 72 % y la productividad (toneladas/hectárea) acumulada de los 8 productos aumentó 47 %; en contraste, las importaciones aumentaron 210 % (en 1980 representaron el 36 % respecto a la producción nacional, y para el 2020 fue del 66 %). Con el *software* Minitab se aplicaron modelos predictivos de series de tiempo de las variables en estudio para pronosticar su desempeño para el año 2030. Los resultados demuestran (respecto a 1980) la reducción del 12 % de la superficie total para esta actividad en el territorio nacional, el incremento de la producción del 96 % y la escalada total de sus importaciones hasta del 253 %.

Palabras clave: México, autosuficiencia alimentaria, producción de granos, importación de granos, política agroalimentaria.

Abstract

Historically, grain production in Mexico has been insufficient to meet its domestic demand. This research, mixed sequential, aims to analyze the deficit of national grain production, dependence on its import (of the last 40 years) and forecast its scope in the next decade. It is shown that from 1980 to 2021 the area dedicated to the production of Rice, Oats, Barley, Beans, Corn, Soybeans, Sorghum and Wheat was reduced 7%, its production increased 72% and the accumulated productivity (tons / hectare) of the 8 products increased 47%; In contrast, imports increased 210% (in 1980 they represented 36% of national production, by 2020 it was 66%). With Minitab software, predictive models of time series of the variables under study were applied to forecast their performance for the year 2030, resulting (compared to 1980) in the reduction of 12% of the total area for this activity in the national territory, in the increase of production of 96% and the total escalation of its imports will be up to 253%.

Keywords: México, food self-sufficiency, grain production, grain imports, agri-food policy.

Resumo

Historicamente, a produção de cereais no México tem sido insuficiente para satisfazer a sua procura interna. Por isso, esta pesquisa sequencial mista tem como objetivo analisar o déficit da produção nacional de grãos, a dependência de suas importações (desde os últimos 40 anos) e prever sua abrangência na próxima década. Para isso, mostra-se que de 1980 a 2021 a área dedicada à produção de arroz, aveia, cevada, feijão, milho, soja, sorgo e trigo diminuiu 7%, sua produção aumentou 72% e a produtividade (toneladas/hectare) dos 8 produtos aumentou 47%; Em contrapartida, as importações aumentaram 210% (em 1980 representavam 36% da produção nacional e em 2020 eram 66%). Com o software Minitab foram aplicados modelos preditivos de séries temporais das variáveis em estudo para prever o seu desempenho para o ano de 2030. Os resultados mostram (com relação a 1980) a redução de 12% da área total destinada a esta atividade no país. território, o aumento da produção de 96% e a escalada total das suas importações até 253%.

Palavras-chave: México, autossuficiência alimentar, produção de grãos, importação de grãos, política agroalimentar.

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Introduction

For the Mexican State, the discourse of food self-sufficiency has been the political pillar that has justified the implementation of populist strategies focused on agricultural production. In this regard, Azpeitia (1987) describes how the ideological approach to agrarian policy in Mexico was always legitimized by the need for "food self-sufficiency" when in the Cardenista period (1934-1940) the "social and peasant issue" was linked for the first time. " to food production, with which said "responsibility" was officially entrusted to the ejidal sector (peasant discourse with a nationalist focus).

Arturo Warman, anthropologist and former Minister of Agrarian Reform in Mexico during the six-year term of President Ernesto Zedillo (1994-2000) in his publication Agrarian Reform: A Long Term Vision" (s. f.) states that the following:

> From 1911 to 1992, just over 100 million hectares of land were given to peasants, equivalent to half of Mexico's territory and nearly two-thirds of the country's total rural property. Some 30,000 ejidos and communities were established, and in 1991, 3.5 million individuals were considered ejidatarios and commoners. At the end of the 20th century, social property comprised 70% of the almost 5 million rural owners and the majority of agricultural producers in Mexico. (párr. 2).

By January 1992, the effects on small agricultural property came to an end with the presidential decree published on the 6th of the same month in the Official Gazette of the Federation. In this, article 27 of the Constitution was modified to terminate the actions of agrarian distribution, thereby establishing clear surface limits for private property, while commercial companies were allowed to acquire rural surface areas of up to 25 times the small property limit; In addition, the legal personality of the agrarian nuclei was recognized to guarantee their ownership and the use by third parties of ejidal and communal lands, the transfer of parcel rights, the acquisition of full ownership and the alienation of the parcels were authorized (Gómez de Silva Cano, s. f.).

Subsequently, the market situation in 1994 (signing of the North American Free Trade Agreement) drastically reduced the value of agricultural products, which gave rise to a new stage of production in Mexico through entrepreneurs and/or small businesses. owners who increased investment in infrastructure and technology to produce more profitable vegetables, fruits and oilseeds. The policy that the government in Mexico adopted to justify the alliance with the ejidal peasantry (since the Cardenista period) had completely failed, which caused "a new concept of food self-sufficiency supported, this time, by the business sectors of the Mexican countryside. (Azpeitia, 1987, p. 149).

The FAO (Statistics Directorate of the Food and Agriculture Organization of the United Nations, 2002) in the publication "Water and Crops, achieving optimal use of water in agriculture" defines food self-sufficiency "when nutritional needs are met through local production" (p. 2). Based on this concept, the research and analysis of statistical information presented allows us to determine the degree of autonomy that Mexico has with respect to the production of basic grains and at what level this objective has been met (beyond the official discourse and to the margin of the demagoguery of Mexican politics).

The study and analysis of the production and import of the main grains consumed in Mexico (rice, oats, barley, beans, corn, sorghum, soybeans and wheat) for the period between 1980 and 2021 is carried out with information provided by official agencies. of the Mexican State (Agri-Food and Fisheries Information System [SIAP]) and international organizations (Statistics Directorate of the Food and Agriculture Organization of the United Nations [FAO], World Bank, etc.). In this regard, it should be noted that the information that the FAO publishes in this regard limits its availability to the year 2020.

Finally, through time series predictive methods in the Minitab software, medium and long-term projections (5 and 10 years) of the area dedicated to grain cultivation in Mexico (hectares), production and yield (tons) are presented as well as its accumulated imports in order to forecast the evolution of this sector over the next decade.

Method

The IMRyD model (introduction, methods, results and discussion) that is followed in the report of this research determines the structure and sections of the academic-scientific articles due to its simplicity and practicality to present the information and results (Codina, L. and Lopezosa, C., 2022); In this regard, Sollaci and Pereira 2004 demonstrate the

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leadership of this method in the academic-scientific literature and explain its benefit by facilitating users' access to specific information.

The central approach of this research focused on the historical production of basic grains in Mexico and how its deficit has affected, continues to affect and will affect its food security. According to the National Council for the Evaluation of Social Development Policy (Coneval) (2010), there are different “dimensions” that allow measuring the status of each country in the matter:

1. Food availability: Describes its availability throughout the year, in good quality and safety conditions; includes primary and value-added products, their imports and exports.
2. Access or ability to acquire food: Physical and economic availability of food for the entire population.
3. Food consumption: Purchase and preparation of food, as well as consumption habits and selection capacity.
4. Biological use: Refers to the quality and safety conditions of food and its use from the nutritional perspective of the population.

Through a mixed sequential process—which delves into the discoveries of one method to give value and continuity to the next (Crewell, 2009)—the food balance indicator is analyzed and studied, which consists of the study of grain production. basics, their consumption and deficit in Mexico, which pays particular attention to the dimension of food availability (Coneval, 2010). This is limited exclusively to the macroeconomic approach to try to forecast its evolution in the next 10 years.

The qualitative stage analyzes the historical dynamics of the case study from an exploratory and descriptive perspective. The first documents the problems of the countryside in Mexico, as well as the historical deficiency in grain production to try to find a broader vision of its context, which serves to present a clear approach to the research problem. The second identifies the causal elements of the problem and its evolution to show a description of the antecedent and its scale to the present.

The quantitative stage includes more than 41 years of the dynamics of the problem of the case (1980-2021). This seeks to investigate, organize, analyze and present numerical information to understand its evolution through an explanatory process. With predictive statistical tools of time series (historical projection) the medium and long-term forecast of

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the variables observed in the context of the Mexican production sector is offered. In this regard, Contreras Juárez et al. (2016) point out the following:

> Methods based on historical data, considered the time series method, consist of the use of analytical methods to determine trends and seasonal variations. In this way, when working with time series, one of the most important questions that the researcher should ask about it is: what is the data generating process from which the studied sample comes?" (p. 389).

The time series have four components: trend, cyclicality, seasonality and a random element (Alonso and Arcila, 2013); Each data series, according to the chronological extension, will present a maximum of three components, without cyclicality and seasonality appearing simultaneously in the same case.

Predictive time series methods are the statistical tool that will allow analyzing and projecting in the medium and long term, according to a historical trend of more than 40 years, the dynamics of the indicators and variables that are studied in this research. In this sense, "time series models predict future values for the variable of interest based exclusively on the historical pattern of that variable, assuming that this historical pattern continues" (Contreras Juárez et al. 2016, p. 389).

The statistical information of the variables of interest was captured in the Minitab software with the objective of applying its analysis and processing in the time series predictive models. This allowed us to identify the forecasts with the best fit and usefulness for this research.

The official page of the Minitab software (s. f.) in "the interpretation of statistics and graphs" briefly describes the indicators that determine the criteria for selecting the result of the time series predictive model with the best forecast of the variables under study (para. 4, 6 and 8):

MAPE. "Mean absolute percentage error (MAPE) expresses accuracy as a percentage of error. Because MAPE is a percentage, it may be easier to understand than other accuracy measurement statistics. For example, if the MAPE is 5, on average, the forecast is off by 5% (para. 4)."

MAD. "Mean absolute deviation (MAD) expresses accuracy in the same units as the data, which helps conceptualize the amount of error. Outliers have less effect on MAD than on MSD. Use to compare the fits of different time series models. Smaller values indicate a better fit (para. 6)."

MSD. "The mean square deviation (MSD) measures the accuracy of the fitted values of the time series. Outliers have a greater effect on MSD than on MAD. Use to compare the fits of different time series models. Smaller values indicate a better fit (para. 8)."

Results

Area dedicated to the cultivation of grains in Mexico

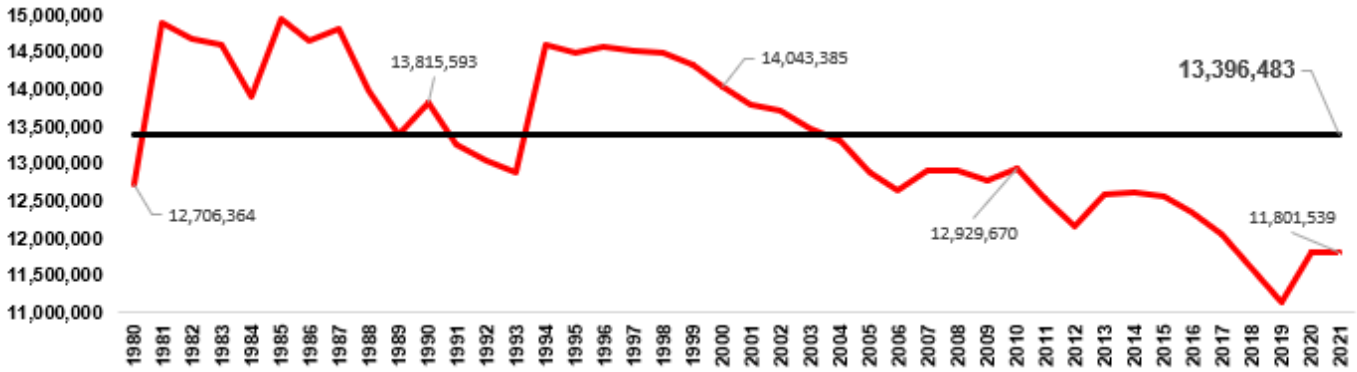
The agricultural area (hectares [ha]) in Mexico dedicated to the production of rice, oats, barley, beans, corn, soybeans, sorghum and wheat (eight grains) decreased 7% in 42 years (1980-2021) equivalent to 904 825 hectares (Agri-Food and Fisheries Information Service [SIAP], 2022). See table 1 and figure 1.

Table 1. Area under grain cultivation in Mexico 1980-2021 (hectares)

Year	SIAP Total Sup. 8 Grains Mx	Change % Base Year 1980	Change Has. Base Year 1980
1980	12,706,364	n/a	n/a
1990	13,815,593	8.73%	1,109,229
2000	14,043,385	10.52%	1,337,021
2010	12,929,670	1.76%	223,306
2021	11,801,539	-7.06%	-904,825
Prom 42 years	**13,358,508**		

Source: Own elaboration with information from SIAP (2022)

Figure 1. Area under grain cultivation in Mexico 1980-2021 (hectares)



Source: Own elaboration with information from SIAP (2022)

Grain production in Mexico

The 7% reduction (more than 900,000 hectares in 42 years) of the area dedicated to grain production did not represent a loss in its volume or productivity. The total accumulated production of the grains under study increased 72%, that is, from 22 million tons to more than 38 million tons (see table 2), according to the following detail:

a) Oats, barley, beans, corn and wheat increased production (65%, 95%, 36%, 122% and 18%, respectively).

b) Rice, sorghum and soybeans reduced their production (-42 %, -7 % y -10 %).

Table 2. Grain production in Mexico (1980-2021)

SIAP Pdn - Tons	1980	2021	Change Pdn (Tons)	Change %
Rice	445,083	257,041	-188,042	-42%
Oat	61,260	101,069	39,809	65%
Barley	528,626	1,032,812	504,186	95%
Bean	945,358	1,288,806	343,448	36%
Corn	12,373,978	27,503,478	15,129,500	122%
Sorghum	4,689,178	4,370,064	-319,114	-7%
Soy	320,848	288,203	-32,645	-10%
Wheat	2,780,055	3,283,614	503,559	18%
	22,144,386	**38,125,087**	**15,980,701**	**72%**

Source: Own elaboration with information from SIAP (2022)

Productivity in grain cultivation in Mexico vs. the global context

The historical productivity of the grain harvest in Mexico (tons per hectare) from 1980 to 2021 reveals that soybeans are the only crop that had negative growth, going from 2.09 to 1.56 t/ha (-25%), the increase in sorghum was only 11% (from 3.04 to 3.37 t/ha) and corn had the best productivity performance with an improvement of 110 % (from 1.83 to 3.85 t/ha). See table 3.

Table 3. Comparative productivity (t/ha) of grain cultivation in Mexico (1980-2021)

	1980	1990	2000	2010	2021	Inc Acum (1980 / 2021)	Productivity % Inc Acum
Rice	3.49	3.85	4.18	5.19	6.38	2.89	83%
Oat	1.55	1.57	1.41	1.66	2.05	0.5	32%
Barley	1.66	1.87	2.45	2.51	3.01	1.35	81%
Bean	0.61	0.61	0.59	0.71	0.77	0.16	26%
Corn	1.83	1.99	2.46	3.26	3.85	2.02	110%
Sorghun	3.04	3.29	3.08	3.92	3.37	0.33	11%
Soy	2.09	2.02	1.46	1.09	1.56	-0.53	-25%
Wheat	3.85	4.21	4.94	5.42	5.99	2.14	56%
							47%

Source: Own elaboration with information from SIAP (2022)

Productivity in grain cultivation during this period (1980-2021) describes the technical and technological evolution that this activity has achieved (despite the negative result for soybeans: -25%); On average, the eight crops jointly increased 47% in 42 years.

Comparing the productivity of grain cultivation in Mexico versus the global context allowed us to understand the level of competitiveness on the international stage. Below, in summary, is presented the statistical information that the FAO (2022) reports worldwide on the production and productivity of the eight grains that are evaluated in parallel in Mexico. The analysis is applied from the criterion:

a) Global context for the accumulated production of the eight grains: total producing countries, total cultivated area (hectares), production (tons) and total productivity (t/ha). Comparative 1980 vs. 2020. See table 4.

Table 4. Area and production dedicated to the cultivation of grains in the world.

Productivity indicator (t/ha)

1980-2020

	Countries Producers 1980	Pdn (Tons) 1980	Sup (Has) 1980	Productivity Tons / Ha	Countries Producers 2020	Pdn (Tons) 2020	Sup (Has) 2020	Productivity Tons / Ha	Inc % Acum Productivity
Rice	110	539,747,742	178,894,779	3.02	115	970,354,451	194,533,948	4.99	**65%**
Oat	56	42,310,288	25,264,330	1.67	74	25,692,482	9,928,188	2.59	**55%**
Barley	77	159,401,433	79,678,084	2.00	102	157,930,764	51,861,372	3.05	**52%**
Bean	96	15,464,214	27,240,057	0.57	104	28,840,312	35,543,700	0.81	**43%**
Corn	140	459,338,440	146,148,299	3.14	166	1,423,229,473	243,275,645	5.85	**86%**
Sorghun	93	64,022,228	46,725,188	1.37	110	62,257,932	40,983,596	1.52	**11%**
Soy	65	89,006,302	57,881,275	1.54	100	373,068,182	136,820,945	2.73	**77%**
Wheat	100	495,400,740	266,443,119	1.86	124	895,180,541	242,389,108	3.69	**99%**
Total	**737**	**1,864,691,387**	**828,275,131**		**895**	**3,936,554,137**	**955,336,502**		**61%**

Source: Own elaboration with information from the FAO Statistics Division (2022)

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b) Leading country by product, total cultivated area (ha), production and total productivity. Comparative 1980 vs. 2020. See table 5.

Table 5. Leading countries in grain production 1980-2020 Productivity (t/ha)

	Leading C. 1980	Pdn (Tons) 1980	Sup (Has) 1980	Productivity Tons / Ha	Part % vs Worldwide Pdn 1980	Leading C. 2020	Pdn (Tons) 2020	Sup (Has) 2020	Productivity Tons / Ha	Part % vs Worldwide Pdn 2020	Inc % Acum Productivity
Rice	China	282,786,522	68,327,486	4.14	52%	China	425,470,729	60,421,784	7.04	44%	**70%**
Oat	URSS	13,907,000	11,757,000	1.18	33%	Canadá	4,575,800	1,314,300	3.48	18%	**194%**
Barley	URSS	40,104,000	31,552,000	1.27	25%	Rusia	20,938,993	8,267,448	2.53	13%	**99%**
Bean	India	2,751,600	9,298,600	0.30	18%	India	5,460,000	13,006,503	0.42	19%	**42%**
Corn	EEUU	168,647,008	29,525,904	5.71	37%	EEUU	360,251,560	33,373,570	10.79	25%	**89%**
Sorghun	EEUU	14,715,900	5,063,800	2.91	23%	EEUU	9,473,620	2,061,900	4.59	15%	**58%**
Soy	EEUU	48,921,904	27,442,608	1.78	55%	Brasil	121,797,712	37,188,168	3.28	33%	**84%**
Wheat	URSS	92,500,000	61,450,000	1.51	19%	China	268,504,710	46,762,215	5.74	30%	**281%**
											115% Inc Prom

Source: Own elaboration with information from the FAO Statistics Division (2022)

In the context of world grain production, all the indicators that were studied show positive growth (see table 6):

The world's surface area increased by 15% (127 million hectares), production by 111% (more than 2,000 million tons) and accumulated productivity was 61%.

• Under the same criteria, when evaluating the corresponding information from the leading countries in the world production of each crop, the increase in accumulated productivity was 115 %, much higher than the average report of the world community (61 %).

Comparative of the productivity of grain cultivation in Mexico vs. the global context:

Table 6. Comparative (t/ha) in grain cultivation (1980-2020) Mexico vs. world average vs. leading country

	Productivity 1980					Productivity 2020 - 2021					
	México SIAP	W Pdn FAO	L. Country FAO	Mx vs W Pdn SIAP - FAO	Mx vs L Country SIAP - FAO		México SIAP	W Pdn FAO	L. Country FAO	Mx vs W Pdn SIAP - FAO	Mx vs L Country SIAP - FAO
Rice	3.49	3.02	4.14	16%	-16%	**Rice**	6.38	4.99	7.04	28%	-9%
Oat	1.55	1.67	1.18	-7%	31%	**Oat**	2.05	2.59	3.48	-21%	-41%
Barley	1.66	2.00	1.27	-17%	31%	**Barley**	3.01	3.05	2.53	-1%	19%
Bean	0.61	0.57	0.30	7%	106%	**Bean**	0.77	0.81	0.42	-5%	83%
Corn	1.83	3.14	5.71	-42%	-68%	**Corn**	3.85	5.85	10.79	-34%	-64%
Sorghun	3.04	1.37	2.91	122%	5%	**Sorghun**	3.37	1.52	4.59	122%	-27%
Soy	2.09	1.54	1.78	36%	17%	**Soy**	1.56	2.73	3.28	-43%	-52%
Wheat	3.85	1.86	1.51	107%	156%	**Wheat**	5.99	3.69	5.74	62%	4%

Source: Own elaboration with information from SIAP (2022) and FAO Statistics Division (2022)

Based on the information collected, the following can be indicated:

1980: Mexico surpassed the world average in productivity (t/ha) in five crops (rice, beans, sorghum, soybeans and wheat). Regarding the world leader (for each product), Mexican indicators were higher in six products (oats, barley, beans, sorghum, soybeans and wheat). In general terms, productivity levels were very good vs. the results of the world stage for this year.

2020 FAO vs. 2021 SIAP: Mexico, with respect to the world average of productivity of each grain, only exceeds this indicator in the cultivation of rice, sorghum and wheat (in 1980 there were 5), that is, it considerably lost competitiveness in five crops (oats, barley , beans, corn and soybeans); and compared to the leading country in productivity, Mexico has negative results in 5 crops: rice, oats, corn, sorghum and soybeans (in 1980 it only had negative results in 2 products).

The increase in accumulated productivity (SIAP, 1980-2021) in the cultivation of the 8 grains under study in Mexico was 47% vs. the world average of 61%, and vs. leading countries of 115% (FAO, 1980-2020), Mexico's lag was 14% and 68% lower, respectively, in the aforementioned global context comparisons.

Historical comparison of the productivity of fruit and vegetable cultivation vs. grains in Mexico

The agri-food policy that the Mexican State applied to the national production sector through the agrarian reform (described in greater detail in the introduction of this research) significantly affected rural production.

The modification of article 27 of the Constitution granted, after several decades, legal certainty and unaffectability of property to small owners and legal entities (both private in nature). This encouraged agricultural production that “would allow us to meet” the internal demand for food in Mexico (after the failure of the ejido system, which basically ended in self-sufficiency and barely subsistence agriculture for the peasantry politically incorporated into this scheme).

The new approach to producing more profitable fruits and vegetables met the demand of domestic and foreign markets with greater purchasing power (Azpeitia, 1987). This statement is verified by analyzing the evolution of agricultural activity in Mexico from 1980 to 2021, by comparing productivity levels vs. the traditional production of grains, on which a large part of society, livestock and industry depends, but which offer limited financial utility

to the producer and which consequently (as will be verified later) has almost exponentially increased its dependence on imports (see table 7).

Table 7. Productivity 12 fruits and vegetables in Mexico (1980-2021). Comparative area, production and annual yield

	Surface (Has)				Production (Tons)				Yield (Tons / Ha)		
	1980	2021	Change (+ / -)	Change %	1980	2021	Change (+ / -)	Change %	1980	2021	Change %
Cucumber	11,259	18,104	6,845	61%	209,782	1,038,999	829,217	395%	18.63	57.39	208%
Tomato	72,469	48,042	-24,427	-34%	1,323,148	3,324,263	2,001,115	151%	18.26	69.20	279%
Broccoli	542	34,253	33,711	6220%	4,208	596,389	592,181	14073%	7.76	17.41	124%
Tomato	20,641	42,673	22,032	107%	156,915	824,978	668,063	426%	7.60	19.33	154%
Carrot	3,227	11,768	8,541	265%	69,804	344,890	275,086	394%	21.63	29.31	35%
Potato	81,459	61,293	-20,166	-25%	1,064,494	1,947,761	883,267	83%	13.07	31.78	143%
Eggplant	781	1,782	1,001	128%	19,413	125,531	106,118	547%	24.86	70.43	183%
Onion	26,949	48,044	21,095	78%	377,772	1,451,250	1,073,478	284%	14.02	30.21	115%
Melon	27,544	17,792	-9,752	-35%	319,933	550,282	230,349	72%	11.62	30.93	166%
Watermelon	31,421	37,426	6,005	19%	446,432	1,194,033	747,601	167%	14.21	31.90	125%
Asparagus	5,094	37,489	32,395	636%	19,447	328,990	309,543	1592%	3.82	8.78	130%
Avocado	65,361	248,456	183,095	280%	434,259	2,442,945	2,008,686	463%	6.64	9.83	48%
Total	**346,747**	**607,121**	**260,374**	**75%**	**4,445,607**	**14,170,311**	**9,724,704**	**219%**	**Prom. Acum. Inc. Productivity**		**143%**

Source: Own elaboration with information from SIAP (2022)

The results of the production/productivity of 12 fruits and vegetables (cucumber, tomato, broccoli, tomato, carrot, potato, eggplant, onion, melon, watermelon, asparagus and avocado) are compared against that of the eight grains previously analyzed in Mexico.

The comparison in the evolution of the productivity of the cultivation of 12 fruits and vegetables far exceeds (in percentage terms) those presented in grain production in Mexico in the same period (1980-2021):

1) The total area increased 75% (260,374 hectares) vs. the reduction of 7% (904,825 hectares).
2) Accumulated production increased 219% (9,724,724 tons) vs. the increase of 70% (37,645,655 tons).
3) Joint productivity (t/ha) increased 143% vs. the increase of 47%.

Comparison of production vs. import of grains in Mexico

The comparison of the accumulated total of grain production versus imports covers the period from 1980 to 2020 (this last year due to the limited availability of information by the FAO).

From 1980 to 2020, the accumulated production of grains in Mexico increased just over 70% (15.5 million dollars). In contrast, imports increased 210% (16.9 million dollars).

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This demonstrates the systematic loss of food self-sufficiency in the domestic market and the increasing dependence on imports (in 1980, imports represented 36%, while national production for 2020 was 66%). See table 8.

Table 8. Comparative production (tons) of grains in Mexico vs. import. 1980-2020

Year	SIAP Pdn Mx 8 Grains	Change % vs Year 1	FAO Imp Mx 8 Grains	Change % vs Year 1	% Imp vs Pdn Mx
1980	22,144,386	n/a	8,074,569	n/a	36.46%
1990	27,378,734	24%	8,665,602	7%	31.65%
2000	28,979,154	31%	18,173,849	125%	62.71%
2010	36,242,904	64%	18,386,037	128%	50.73%
2020	37,645,655	70%	25,004,388	210%	66.42%
Dif Tons 1980 - 2020	**15,501,269**		**16,929,819**		

Source: Own elaboration with information from SIAP (2022) and FAO Statistics Division (2022)

In the percentage analysis of the participation of each of the eight grains with respect to the total annualized joint production and its change in 40 years, the negative evolution is observed in seven of them; only corn has positive growth of almost 17%; In fact, by 2020 it represented almost 73% of the total production of the eight grains (in 1980 it was 55%).

In the comparison of 1980 production vs. 2020, corn increased 122% (more than 15 million tons), in contrast, rice reduced -34% (almost 150 thousand tons), soybeans -23% (almost 75 thousand tons), sorghum (which in 1980 represented 21 % of the total accumulated volume, its share fell to 12.49% in 2020) in 40 years it barely increased its volume by .31% (14,500 tons). See table 9.

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Table 9. Share by crop in the cumulative total of grain production in Mexico (1980-2020)

	Total Production 8 Grains Mx	Rice	Oat	Barley	Bean	Corn	Sorghum	Soy	Wheat	
1980	22,144,386	2.01%	0.28%	2.39%	4.27%	55.88%	21.18%	1.45%	12.55%	**100%**
1990	27,378,734	1.31%	0.44%	1.80%	4.70%	53.46%	21.84%	2.10%	14.36%	**100%**
2000	28,979,154	1.21%	0.11%	2.46%	3.06%	60.58%	20.16%	0.35%	12.05%	**100%**
2010	36,242,904	0.60%	0.31%	1.86%	3.19%	64.29%	19.15%	0.46%	10.14%	**100%**
2020	37,645,655	0.78%	0.18%	2.30%	2.81%	72.85%	12.49%	0.65%	7.93%	**100%**
	Change % (1980 vs 2020)	**-1.23%**	**-0.09%**	**-0.09%**	**-1.46%**	**16.97%**	**-8.68%**	**-0.80%**	**-4.62%**	
	Pdn Mx 1980	445,083	61,260	528,626	945,358	12,373,978	4,689,178	320,848	2,780,055	
	Pdn Mx 2020	295,338	69,016	864,293	1,056,071	27,424,528	4,703,701	246,019	2,986,689	
Change Total Pdn (Tons)										
	1980 vs 2020	**-149,745**	**7,756**	**335,667**	**110,713**	**15,050,550**	**14,523**	**-74,829**	**206,634**	
	Change % Pdn	**-34%**	**13%**	**63%**	**12%**	**122%**	**0.31%**	**-23%**	**7%**	

Source: Own elaboration with information from SIAP (2022)

In the comparative analysis of imports, sorghum, barley and beans were reduced respectively by 85%, 75% and 68% (1980 vs. 2020); Rice increased the imported volume by 12,249% (782,237 tons), oats by 2,361% (100,071 tons), corn by 322% (12,176,016 tons), soybeans by 648% (3,378,649 tons) and wheat by 353%. (2,903,456 tons).

2,127,909 tons were stopped being imported (sorghum, barley and beans); On the other hand, imports (rice, oats, corn, soybeans and wheat) increased by 19,340,000 tons.

The grains that had the greatest increase in productivity—rice, oats, corn, and wheat (with the exception of soybeans)—did not satisfactorily meet domestic demand; The deficit in its production represents the almost exponential increase in grain imports in Mexico compared to 1980 (rice + 12,249%, oats + 2,361%, corn + 322%, soybeans + 648% and wheat 353%). In contrast, the products with the "smallest increase" in productivity were those that allowed imports to be substituted in a more or less "acceptable" manner (barley -75%, beans -68% and sorghum -85%). See table 10.

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Table 10. Share by crop in the cumulative total of grain imports in Mexico (1980-2020)

	Total Imp 8 Grains Mx	Rice	Oat	Barley	Bean	Corn	Sorghum	Soy	Wheat	
1980	8,074,569	0.08%	0.05%	3.01%	5.50%	46.78%	27.93%	6.46%	10.19%	**100%**
1990	8,665,602	0.21%	0.05%	1.28%	3.81%	47.36%	33.02%	10.35%	3.91%	**100%**
2000	18,173,849	3.06%	0.28%	1.15%	0.48%	29.42%	28.29%	21.93%	15.38%	**100%**
2010	18,386,037	4.20%	0.41%	0.29%	0.64%	42.69%	12.25%	20.52%	19.01%	**100%**
2020	25,004,388	3.15%	0.42%	0.24%	0.57%	63.80%	1.31%	15.60%	14.90%	**100%**
	Change % (1980 vs 2020)	**3.07%**	**0.36%**	**-2.77%**	**-4.93%**	**17.02%**	**-26.62%**	**9.14%**	**4.71%**	
	Imp Mx 1980	6,386	4,239	243,112	444,306	3,777,277	2,255,028	521,552	822,669	
	Imp Mx 2020	788,623	104,310	60,482	143,529	15,953,293	327,825	3,900,201	3,726,125	
Change Imp Total (Tons)										
1980 vs 2020		**782,237**	**100,071**	**-182,630**	**-300,777**	**12,176,016**	**-1,927,203**	**3,378,649**	**2,903,456**	
Change % Imp		**12249%**	**2361%**	**-75%**	**-68%**	**322%**	**-85%**	**648%**	**353%**	

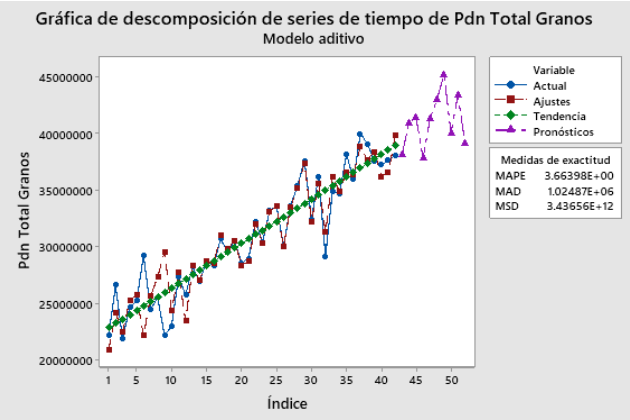
Source: Own elaboration with information from the FAO Statistics Division (2022)

Trend analysis and medium and long-term forecast (2025-2030): grain production and import in Mexico

With the support of Minitab software, statistical trend analyzes and forecasts (medium and long term) of time series were applied regarding the evolution of grain production and import.

Once the time series predictive methods were applied, and the results of each of these were analyzed, the one that offered a higher level of certainty and adjustment to the graphed information of each variable was selected. Below are the models that had a better fit to determine the most reliable forecast according to the software results:

Figure 2. Forecast of grain production in Mexico (2025-2030)



Source: Own elaboration with information from Minitab software

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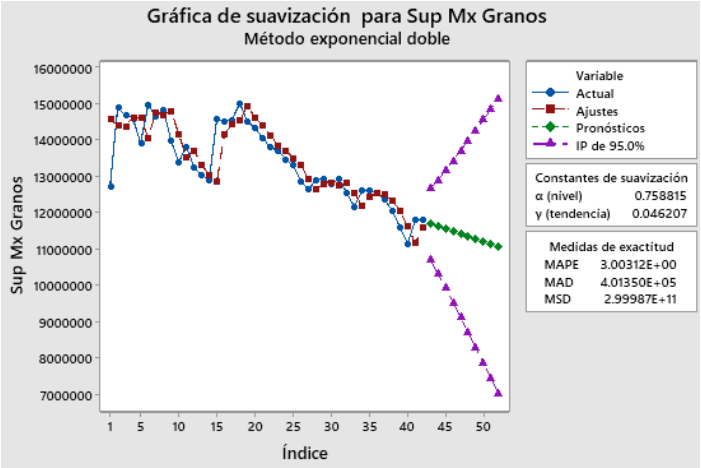
Period 46 corresponds to the year 2025; Period 51 corresponds to the year 2030

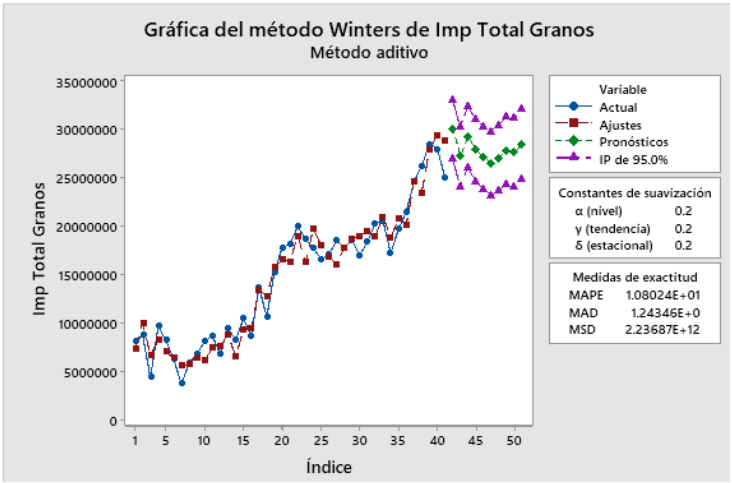
Figure 3. Forecast of area dedicated to grain cultivation in Mexico(2025-2030)



Source: Own elaboration with information from Minitab software

Period 46 corresponds to the year 2025; Period 51 corresponds to the year 2030

Figure 4. Forecast of total grain imports in Mexico(2025-2030)



Source: Own elaboration with information from Minitab software

Period 46 corresponds to the year 2025; period 51 corresponds to the year 2030

The values resulting from the forecasts for the years 2025 and 2030 of each indicator (figures 2,3 and 4) are presented in the accumulated table 11 and figure 5, which include the information from 1980 to 2020:

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Table 11. Forecast 2025-2030 of production, import and area dedicated to the cultivation of grains in Mexico. Percentage vs. base year comparison (1980)

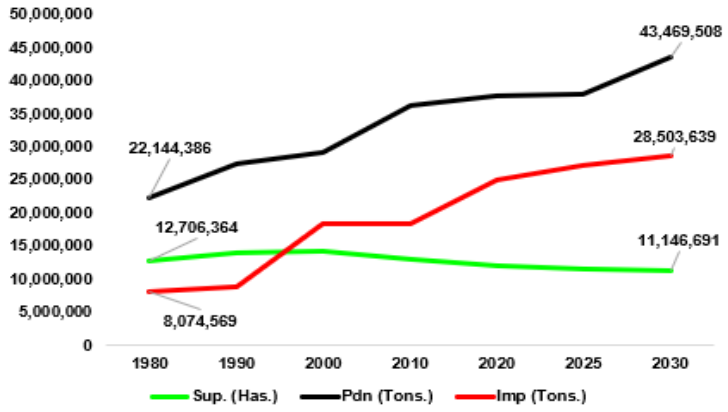
	Year	SIAP S. Total 8 Grains Mx Has.	Change % vs Year 1	SIAP Pdn Total 8 Grains Mx Tons.	Change % vs Year 1	FAO Imp Total 8 Grains Mx Tons.	Change % vs Year 1	Imp vs Pdn Mx %
Year 1	1980	12,706,364	n/a	22,144,386	n/a	8,074,569	n/a	36%
	1990	13,815,593	9%	27,378,734	24%	8,665,602	7%	32%
	2000	14,043,385	11%	28,979,154	31%	18,173,849	125%	63%
	2010	12,929,670	2%	36,242,904	64%	18,386,037	128%	51%
	2020	11,809,316	-7%	37,645,655	70%	25,004,388	210%	66%
Forecast	2025	11,480,554	-10%	37,848,101	71%	27,086,898	235%	72%
	2030	11,146,691	-12%	43,469,508	96%	28,503,639	253%	66%

Source: Own elaboration with information from Minitab software

According to the forecasts presented for the year 2030 (fifty years after the base year, 1980), the following is concluded:

1) The reduction in the agricultural area destined for grain production will be 12% (1,559,673 hectares).
2) Grain production will show an increase of 96% (21,325,122 tons).
3) The upward trend (and dependence on foreign products) in grain imports remains at 253% (20,429,070 tons).
4) The share of imports with respect to national production continues to rise: by 2030 its value will be approximately 66% in reference to national production.

Figures 5. Comparison of the historical performance and forecast of the total production and import of grains and area dedicated to their cultivation in Mexico 1980-2030



Source: Own elaboration with information from Minitab software

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Discussion

This research clearly demonstrates that the production of basic grains in Mexico is insufficient to meet internal demand. In fact, this situation is accentuated as the area dedicated to this activity is increasingly reduced. Likewise, and apart from the technological advances that have allowed increasing productivity in various crops, the historical deficit has been covered through imports.

In this sense, it can be indicated that the failure of the policy for food self-sufficiency of the Mexican State is the result of a series of situations, both social and economic, that were accentuated in the last 40 years, in which the change in policy government towards the producing sector and the macroeconomic effects of globalization catalyzed national agricultural activity towards a commercial perspective that was profitable and attractive for invasion, regardless of the food needs and socioeconomic status of the population.

On the other hand, the analysis of various studies that describe historical moments that affected the agricultural sector in Mexico (Warman, s. f.) allowed us to understand the evolution of this activity in almost a century, that is, the implementation of the peasant policy by President Lázaro Cárdenas in the period from 1934 to 1940 (Azpeitia, 1987), his failure officially recognized in 1992 with the modification of article 27 of the Constitution - which put an end to agrarian distribution and the impact on private property (Gómez de Silva Cano, s. f.)—and the signing (1994) of the North American Free Trade Agreement (NAFTA), which opened national production to competition from abroad, which finally justified the change in the focus of the Mexican producer towards an activity with financial attractiveness with the cultivation of fruits and vegetables.

Finally, when applying the time series predictive methods in the Minitab software to the variables of interest, the trend remains more or less at the historical pace of the period that was quantitatively studied (40 years). In other words, the objective of achieving food self-sufficiency, from the perspective of basic grains, will not be possible in the next 10 years, a period in which—according to the forecasts presented—it will even worsen.

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Conclusion

The results of this investigation confirm Mexico's dependence on imported grains. In other words, the accumulated increase in productivity is not enough to satisfy internal demand nor does it address the reduction in the area dedicated to its production. The Minitab software forecast presents a sustained perspective regarding the historical trend of more than 40 years of the dynamics of the variables that were studied (area dedicated to the cultivation of grains, its production and import), which demonstrates that the objective of achieving Food self-sufficiency in Mexico is very far from being a reality. Furthermore, with the increasingly frequent economic, social, health, environmental and political crises of the international geopolitical context, it will be systematically more difficult to reverse the need to import these foods.

It is proven, therefore, that the focus on the production of more profitable fruits and vegetables gained strength and growth in Mexico once article 27 of the Constitution was modified, which gave solid legal guarantees to the owners and investors of this sector.

From 1980 to 2020, the accumulated production of grains in Mexico increased just over 72% (15.5 million dollars). In contrast, imports increased 210% (16.9 million dollars), which explains the systematic loss of food self-sufficiency in the domestic market and the increasing dependence on imports (in 1980 imports represented 36% vs. national production of the 66% by 2020, despite the increase in productivity).

By applying time series predictive methods (with Minitab software) to the historical information (1980-2020/21) of the surface, production and import indicators of grains in Mexico to forecast their dynamics for the next 10 years, it resulted (comparative of the forecast for the year 2030 vs. the base year 1980) in the reduction of 12% of the agricultural area destined for grain production (1,559,673 hectares); Furthermore, grain production shows an increase of 96% (21,325,122 tons) and finally the upward trend (and dependence on foreign products) in grain imports continues: 253% higher (20,429,070 tons).

Future lines of research

When Mexico's increasing dependence on grain imports was confirmed (a result of the deficit in the production of the national agricultural sector), it was identified as an important area of opportunity to investigate and present a comparative analysis of Mexico vs. the international context of the dynamics of the variables that make up the basic grains market, as well as the external economic-commercial elements that contribute or affect its value. In this way, it will be possible to determine the level of competitiveness of the Mexican agricultural sector (price-productivity) and the differential of its price per ton to design/propose (through statistical analysis tools and causality forecasting methods) strategies that allow the Grain cultivation in Mexico will be a profitable and attractive business for the country's producer, which will help achieve food self-sufficiency.

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