Colegio de Postgraduados

Current and potential demand of fertilizers in Mexico

Álvarez-González, Xochitl[1]; García-Salazar, J. Alberto[1*]; Omaña-Silvestre, J. Miguel[1]; Mora-Flores, J. Saturnino[1]; Almeraya-Quintero, S. Xóchitl[2]; Borja-Bravo, Mercedes[3]

[1] Colegio de Postgraduados, Campus Montecillo, Economía.
[2] Desarrollo Rural, C.P. 56264, Montecillo, Estado de México. (alvarez.xochitl@colpos.mx), (jsalazar@colpos.mx), (saturmf@colpos.mx), (miguelom@colpos.mx), (xalmeraya@colpos.mx).
[3] Campo experimental Pabellón-INIFAP, Carretera Aguascalientes-Zacatecas, Pabellón de Arteaga. 2067, Aguascalientes, México. (borja.mercedes@inifap.gob.mx).
* Correspondence: jsalazar@colpos.mx

ABSTRACT

Objective: To diagnose the market situation of fertilizers through the statistical analysis of the main market variables, considering the importance of fertilizers as a strategic input for increasing productivity in the agricultural sector.

Methodology: The growth of the apparent domestic consumption of fertilizers for the 2007-2020 period, the variables that determine it, and the current and potential demand per state in 2019 were estimated.

Results: During the period under analysis, fertilizer consumption grew at an annual rate of 4.8%, reaching 6.3 million tons in 2020. Almost 75% of consumption was supplied by imports and only 25% was supplied by domestic production. If 100% of the sown area was fertilized, the potential demand for fertilizers would exceed 8 million tons.

Implications: The country's heavy dependence on fertilizer imports means that the Mexican agricultural sector is vulnerable to a potential increase in fertilizer prices, as a result of the crisis that the global agrochemicals market is currently facing.

Conclusions: Given Mexico's dependence on fertilizer imports, the domestic industry must be strengthened, in order to increase production and satisfy a greater percentage of the domestic demand.

Keywords: fertilizers, apparent national consumption, potential demand, imports.

Citation: Álvarez-González, X., García-Salazar, J. A., Omaña-Silvestre, J. M., Mora-Flores, J. S., Almeraya-Quintero, S. X., & Borja-Bravo, M. (2023). Current and potential demand of fertilizers in Mexico. *Agro Productividad*. https://doi.org/10.32854/agrop.v15i4.2352

Academic Editors: Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

Received: July 23, 2022.
Accepted: March 19, 2023.
Published on-line: June 08, 2023.

Agro Productividad, 16(4). April. 2023. pp: 149-156.

INTRODUCTION

Rapid population growth is a global problem that has required innovation and growth in agricultural activity, because this sector is responsible for generating the food required by the population. In this context, chemical fertilizers take center stage. Since the Green Revolution, chemical fertilizers have been complemented by genetically modified seeds and the use of mechanical means to modernize agricultural activity (Picado, 2008). Chemical fertilizers are also responsible for a 40% increase in food production over the last 40 years (FAO, 2011).

According to Medina *et al.* (2018), yields in grain maize crops to which fertilizers have been applied have increased by 29.3% with respect to fertilizer-free crops.

Image by Samuel Faber at Pixabay

In terms of production, the boom of the chemical fertilizer industry in Mexico started in the 1970s and 1980s. In 1978, this industry was nationalized and became Fertilizantes Mexicanos (FERTIMEX), a public company which promoted fertilizer production, marketing, distribution, and supply, through a single price policy for the whole country. In 1992, FERTIMEX was privatized and the fertilizer industry —which until that point had been ruled by national policies— began a new stage that, to put it succinctly, consisted of the gradual reduction of agrochemical production and the constant growth of imports (CE, 1990).

Chemical fertilizers are indispensable inputs for agricultural activity; therefore, they represent a significant percentage of production costs. However, despite their importance, there are few studies that analyze their behavior.

Fertilizer market analysis is important for the following reasons: a) fertilizers are one of the main inputs for the increase of agricultural productivity; b) they are the main instrument for the increase of agricultural production, lowering the dependence on food imports; c) the dependence of this market on imports makes it vulnerable to the likely increase in international prices; and d) the current crisis in fertilizer exporting countries (*e.g.*, Ukraine and Russia) will have a strong impact on the international market.

Considering their importance as an essential input for the increase of productivity in the agricultural sector, the objective of this work was to estimate the current demand for fertilizers in Mexico. The potential demand for fertilizers was also quantified to measure the challenge that the Mexican agricultural sector would face if the input was used on 100% of the sown agricultural area.

MATERIALS AND METHODS

The apparent national consumption of fertilizers was estimated in order to determine the research objectives. In economic terms, apparent national consumption (ANC) is the amount of goods that the market requires or demands. It is the main indicator used to analyze demand.

Afterwards, the annual data from the following indicators were used to calculate the ANC of fertilizers for the 2007-2020 period: a) total production of chemical fertilizers, taken from the Monthly Survey of the Manufacturing Industry (INEGI, 2021); and b) total imports and exports of chemical fertilizers, taken from the Online Tariff Information System (SIAVI) of the Ministry of Economy (SIAVI, 2021).

According to Miranda (2005), the ANC of year a was calculated using the following formula:

$$ANCa = Pa + Ma - Xa \quad (1)$$

Where Pa is the domestic production of chemical fertilizers in year a; Ma are the imports of fertilizers in year a and; Xa is the national exports of fertilizers in year a.

To estimate the demand by state, the fertilized area by state for the year 2019 —obtained from the Agrifood and Fisheries Information Service (SIAP)— was taken as a weighting factor (SIAP, 2021).

The following procedure was used to determine the fertilizer demand by state. First, the average consumption of fertilizers per hectare in year *a* (AFC*a*) was obtained, dividing the apparent national consumption of fertilizers (ANC*a*) by the fertilized national area (FNA*a*) and using the following formula:

$$AFCa = \frac{ANCa}{FNAa} \quad (2)$$

Subsequently, the following formula was used to determine the potential fertilizer demand per state, multiplying the average consumption of fertilizers per hectare by the total area sown in each state:

$$PDFSi = AFCa \times TSASi \quad (3)$$

Where *PDFSi* is the potential demand of fertilizers in the state *i* and *TSASi* is the total area sown in the state *i*.

RESULTS AND DISCUSSION

Table 1 shows the apparent national consumption. The data suggest that the ANC of chemical fertilizers in Mexico had an average annual growth of 68.3% during the 2007-2020 period (from 3,754 to 6,319 thousand tons), representing an average annual growth of 4.8%.

Factors that could explain such an impressive growth in consumption are related to the use of the input to increase productivity in the agricultural sector. Increasing the production of the agricultural sector is a challenge that must be met through the increase in yields and it requires an increased use of fertilizers.

The analysis of the behavior of the variables that determine apparent national consumption leads to the following observation: during the 2007/2009-2018/2020 period, production grew by 65.4%, from 1,458 to 2,411 thousand tons (an average annual growth of 4.7%). During the same period, imports grew by 61.5%, from 2,885 to 4,658 thousand tons (an average annual growth of 4.5%). Fertilizer exports grew by 27.5%, from 587 to 751 thousand tons (an average annual growth of 2.2%). The above data reflect the country's heavy dependence on fertilizer imports, which leaves the country vulnerable to the behavior of the global agrochemicals market.

The growing behavior of the ANC of fertilizers during the 2007-2020 period and its related factors can help to explain the behavior of fertilizer demand during the last few years, which can be attributed to changes in the said factors. As the main input for agriculture, the increase in arable land has been a determining factor; while 17.9 million ha were sown in 2018, by 2021 this area had increased to 20,665 thousand ha (SIAP, 2022).

Experience shows that farmers in developed countries are hardly affected by the increase in nitrogen fertilizer prices, while farmers in developing countries would face

Table 1. Apparent national consumption of fertilizers in Mexico (2007-2020) in thousands of tons.

Year	Production	Imports	Exports	Consumption
2007	985	3,270	286	3,969
2008	1,427	2,735	688	3,474
2009	1,963	2,649	792	3,820
2010	2,163	2,807	677	4,293
2011	2,062	3,772	270	5,564
2012	2,102	3,385	1,015	4,472
2013	2,734	3,275	988	5,021
2014	2,721	3,615	926	5,411
2015	2,608	3,655	784	5,479
2016	2,458	4,209	742	5,924
2017	2,522	4,491	716	6,296
2018	2,400	5,055	792	6,664
2019	2,505	4,090	809	5,786
2020	2,329	4,830	651	6,507
Average 07/09	1,458	2,885	589	3,754
Average 18/20	2,411	4,658	751	6,319
GR (%)	65.4	61.5	27.5	68.3
AAGR (%)	4.7	4.5	2.2	4.8

GR (TC)=Growth rate; AAGR (TCMA)=Average annual growth rate.
Source: Table developed by the authors based on data from INEGI (2021) and SIAVI (2021).

lower availability and would be forced to reduce their application. For example, from 2008 to 2009, the use of nitrogen fertilizer in Africa fell by 13%. International reference prices for fertilizers increased throughout 2021, with many estimates reaching all-time highs. The price of nitrogen fertilizers has recorded the most significant increase. The price of urea, a major nitrogen fertilizer, more than tripled in the last 12 months (FAO, 2022).

Variations in the price of the inputs used in the technological package (including fertilizers) have a strong impact on the adoption rate of the input. A decrease/increase in the price of these variables would increase/decrease the adoption rate and reduce/increase the gap between total observed consumption and potential consumption (García *et al.*, 2018).

Table 2 shows the production of fertilizers in Mexico in 2021 per agrochemical group. During that year, the country produced 2.08 million tons, out of which 46.7% were phosphate fertilizers, 26.9% acid fertilizers, and 26.4% nitrogen fertilizers. Therefore, Mexico specializes in the production of the said group of fertilizers.

Apparent national consumption suggests that demand is highly dependent on imports. Table 3 shows fertilizer imports and exports by group. In 2019, Mexican imports reached 4.83 million tons. Considering the different groups of imported fertilizers, the most important are: nitrogenous fertilizers (61.5% of the total imports), followed by complex fertilizers (28.9%) and potassium fertilizers (6.2%).

Table 2. Production of fertilizers in Mexico (2021) in tons.

Group	Production	%
Nitrogenous	548,869	26.4
Phosphatide	972,310	46.7
Acids	561,013	26.9
Total	2,082,192	100.0

Source: Table developed by the authors based on data from INEGI (2022).

Table 3. Imports and exports of fertilizers in Mexico (2019) in thousands of tons.

Group	Fertilizer	Imports		Exports	
		Volume	%	Volume	%
Nitrogenous	Urea	1,911	39.6	14	2.2
	Ammonium sulfate	280	5.8	1	0.1
	Ammonium nitrate	20	0.4	1	0.2
	Sodium nitrate	3	0.1	0	0.0
	Others	756	15.7	2	0.3
	Total	2,970	61.5	18	2.8
Phosphatide	Super phosphates	6	0.1	89	13.6
	Others	3	0.1	0	0.0
	Total	9	0.2	89	13.6
Potassium	Potassium chloride	299	6.2	5	0.8
	Potassium sulfate	0	0.0	0.00	0.0
	Others	156	3.2	0.5	0.1
	Total	455	9.4	6	0.9
Complex	Di-ammonium phosphate	249	5.2	149	22.9
	Mono-ammonium phosphate	156	3.2	347	53.3
	NPK	332	6.9	24	3.8
	Others	659	13.6	18	2.7
	Total	1,396	28.9	539	82.7
Grand total		4,830	100.0	651	100.0

Source: Table developed by the authors based on data from SIAVI (2021).

Although Mexico depends on imports to supply apparent domestic consumption, it exports a considerable volume of fertilizers. However, foreign sales have decreased significantly in recent years (Table 1). Table 3 details fertilizer exports by agrochemical group and shows that Mexico exported 651 thousand tons in 2019.

The foreign sales of fertilizers per agrochemical group were divided as follows: 82.7% were complex fertilizers, 13.6% phosphate fertilizers, 2.8% nitrogen fertilizers, and only 0.9% potassium fertilizers.

Table 4 shows the results of the calculation of potential consumption at the state level. The demand for fertilizers in Mexico is directly related to the arable and fertilized land.

Table 4. Current and potential demand of fertilizers by state (2019). Thousands of hectares and tons.

State	Area			Consumption	
	total	fertilized	%	actual	potential
	hectare			thousands of tons	
Aguascalientes	128	107	83.6	42	50
B. California	180	161	89.4	63	70
B. Cal. Sur	41	38	92.7	15	16
Campeche	340	276	81.2	108	133
Chiapas	1,360	772	56.8	301	531
Chihuahua	1,036	1,002	96.7	391	404
Cd.de México	16	15	93.8	6	6
Coahuila	252	140	55.6	55	98
Colima	162	120	74.1	47	63
Durango	576	365	63.4	142	225
Guanajuato	948	830	87.6	324	370
Guerrero	902	656	72.7	256	352
Hidalgo	529	222	42.0	86	207
Jalisco	1,650	1,306	79.2	509	644
México	747	696	93.2	272	291
Michoacán	1,119	1,057	94.5	412	437
Morelos	137	133	97.1	52	54
Nayarit	370	250	67.6	98	144
Nuevo León	330	61	18.5	24	129
Oaxaca	1,254	610	48.6	238	489
Puebla	939	768	81.8	300	366
Querétaro	137	124	90.5	48	53
Q. Roo	118	92	78.0	36	46
San Luis Potosí	638	295	46.2	115	249
Sinaloa	1,059	1,044	98.6	407	413
Sonora	603	599	99.3	234	235
Tabasco	266	184	69.2	72	104
Tamaulipas	1,326	850	64.1	332	517
Tlaxcala	235	232	98.7	91	92
Veracruz	1,515	1,053	69.5	411	591
Yucatán	699	72	10.3	28	273
Zacatecas	1,051	703	66.9	274	410
National	20,665	14,832	71.8	5,786	8,061

Source: Table developed by the authors based on data from SIAP (2021), INEGI (2021) and SIAVI (2021).

In 2019, 20.67 million ha were sown in Mexico, 14.83 million ha of which were fertilized, indicating a 71.8 % use rate of fertilizers. This rate varies in the different states of the country.

In 2019, the states with the highest percentage of the total sown area were: Jalisco (8.0%), Veracruz (7.3%), Chiapas (6.6%), Tamaulipas (6.4%), and Oaxaca (6.1%) (Table 4).

The states with the highest fertilized area in relation to their sown area were: Sonora, Tlaxcala, Sinaloa, Mexico City, Morelos, Chihuahua, Michoacán, State of Mexico, Baja California, and Queretaro, all of which fertilized more than 90% of their sown area the said year.

The states with the highest fertilizer consumption in 2019 were: Jalisco (8.8%), Michoacán (7.1%), Veracruz (7.1%), Sinaloa (7.0%), Chihuahua (6.8%), and Tamaulipas (5.7%).

Table 4 shows the potential demand for fertilizers. If the entire sown area were to be fertilized, more than 8 million tons of fertilizers would be needed. This would be a great challenge, considering the dependence of the country on imports and the situation of the international fertilizer market. The main potential consumer states would be Jalisco, Veracruz, Chiapas, Tamaulipas, Oaxaca, and Michoacán, which together would account for 39.8% of the total potential demand (Table 4).

CONCLUSIONS

As a result of its use as one of the main inputs for increasing productivity, the apparent national consumption of fertilizers has recorded a strong growth during the last few years. Such growth has been closely related to a sharp increase in agrochemical imports, in response to the decrease in the domestic production available for national consumption. As a consequence of the increased dependence on imports, the fertilizer industry has become vulnerable to changes in the international prices resulting from fluctuations in the international fertilizer market. The consumption of fertilizers currently amounts to almost 6 million tons of fertilizers and the efforts to fertilize the entire national agricultural area represent a huge challenge for the fertilizer industry, which must supply the potential demand (estimated at just over 8 million tons). Policies that contribute in the short term to increase fertilizer production must be implemented; otherwise, in the future, the situation will be increasingly difficult for national producers, who will face rising prices of one of the main inputs used to increase agricultural productivity.

ACKNOWLEDGEMENTS

The authors would like to thank the National Council for Science and Technology (CONACyT) for their support for the completion of their PhD studies.

REFERENCES

CE (Comercio Exterior). 1990. Sección nacional: Sector agropecuario y pesca. Revista interactiva BANCOMEXT. http://revistas.bancomext.gob.mx/rce/magazines/160/3/RCE3.pdf

FAO (Organización de las Naciones Unidas para la Alimentación y la Agricultura). 2011. Ahorrar para crecer: 3 La salud del suelo. https://www.fao.org/ag/agp/save-and-grow/es/3/index.html

FAO (Organización de las Naciones Unidas para la Alimentación y la Agricultura). 2022. El mercado mundial de fertilizantes: balance de la situación de un mercado en dificultades. https://www.fao.org/3/ni280es/ni280es.pdf

García-Salazar, J. A., Borja-Bravo, M., and Rodríguez-Licea, G. 2018. Consumo de fertilizantes en el sector agrícola de México: un estudio sobre los factores que afectan la tasa de adopción. *Revista*

Interciencia. 43:505-510. https://www.interciencia.net/wp-content/uploads/2018/07/505-GARCIA-SALAZAR-43_07.pdf

INEGI (Instituto Nacional de Estadistica y Geografía). 2021. Banco de Información Económica BIE. Encuesta Mensual de la Industria Manufacturera (EMMIM) Base 2013. https://www.inegi.org.mx/app/indicadores/?tm=0#bodydataExplorer

Medina-Mendez, J., Alejo-Santiago, G., Soto-Rocha, J. M., and Hernández-Pérez, M. 2018. Rendimiento de maíz grano con y sin fertilización en el estado de Campeche. *Revista Mexicana de Ciencias Agrícolas*. 21:4306-4316. Doi: https://doi.org/10.29312/remexca.v0i21.1532

Miranda, J. J. 2005. Gestión de Proyectos: evaluación financiera económica social ambiental. 4ª ed. Bogotá, Colombia: MM editores. https://leidanoguera.files.wordpress.com/2014/04/gestic3b3n-de-proyectos-juan-josc3a9-miranda.pdf

Picado, W. 2008. Ciencia y geopolítica en los orígenes de la revolución verde. *Revista de ciencias ambientales*. Doi: https://doi.org/10.15359/rca.36-2.6

SIAP (Servicio de Información Agropecuaria y Pesquera). 2021. Estadística de uso tecnológico y de servicios en la superficie agrícola: Fertilizada. https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119

SIAP (Servicio de Información Agropecuaria y Pesquera). 2022. Produccion agricola: avances de siembras y cosechas. https://nube.siap.gob.mx/avance_agricola/

SIAVI (Servicio de Informacion Arancelaria Via Internet). 2021. Estadisticas anuales; Abonos. http://www.economia-snci.gob.mx/