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Market Research on the Consumer Preference of Biofertilizers in Mexico

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ABSTRACT

Objective: To understand the preferences of agricultural and fruit producers regarding the use of mineral fertilizers, organic fertilizers, or biofertilizers.

Design/Methodology/Approach: The consumer behavior theory was complemented with the ABC model of attitude: affective, behavioral, and cognitive. The tastes, preferences, and attitudes of producers were recorded regarding the use of different types of fertilizers. For this purpose, structured questionnaires, focus meetings, and direct observation were applied to a total sample of 100 producers.

Results: The analysis recorded negative signs in the years_p (years as producer) and years_c (years with the same crop) coefficients, showing that a greater number of years in both variables resulted in a higher probability of a null preference for the application of biofertilizers; however, farmers with 0 + to 20 years of experience who sow certain cereals are more likely to apply biofertilizers. For their part, producers of perennial crops (*e.g.*, fruit trees) did not show any preference for biofertilizers.

Study Limitations/Implications: External factors (*e.g.*, the local availability of biofertilizers, institutional support, or economic incentives) which could influence the decision of more experienced producers or producers who work with perennial crops to adopt biofertilizers were not taken into account.

Findings/Conclusions: Producer experience and their likelihood to use biofertilizers had an inverse relationship, suggesting that deeply-rooted traditional practices are a barrier to the adoption of sustainable technologies.

Keywords: Biofertilizers, market research, tastes, and preferences.

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INTRODUCTION

Biofertilizers have achieved international acceptance, given their multiple benefits to agriculture. Although they have been successfully applied in many developed countries, several factors have limited their use and approval by the agricultural industry of developing countries (Grageda-Cabrera *et al.*, 2012). In the last decades, several researches have been carried out in Mexico focused on their development, innovation, and validation (Chávez-Díaz *et al.*, 2020). These bio-inputs have improved soil fertility, optimized nutrient absorption, and reduced the environmental impact of synthetic fertilizers (Moreno Reséndez *et al.*, 2018).

The development and application of biofertilizers is an effective option to partially or fully replace mineral fertilizers (Grageda-Cabrera *et al.*, 2012). However, despite their advantages, their adoption in the global market has been limited and they only account for 5% of the world fertilizer market (Timmusk *et al.*, 2017). In Mexico, biofertilizers are currently produced by small companies and educational and research institutions. The Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP) has also been involved in the process, with the support of federal and state governments (Infante-Jiménez *et al.*, 2020). During the presidency of Ernesto Zedillo Ponce de León (1994-2000), the first microbial biofertilizers were distributed in the Mexican countryside, through the Alianza para el Campo program. This initiative was implemented by INIFAP, during the 1999 spring-summer (SS), 1999-2000 autumn-winter (AW), and 2000 SS agricultural cycles (Aguirre-Medina *et al.*, 2009). The National Biofertilizer Program (PNB) was created in 1998 to exploit beneficial microorganisms that improve plant nutrition. Its main purposes were: 1) to expand research and technology validation into various crops of interest in several of the country's agroecological regions; 2) to promote and spread the use of biofertilizers; and 3) to train technician and civil servants of the Mexican agricultural sector (Garza *et al.*, 2003).

Within this context, the aim of this program was to promote and spread the use of biofertilizers, which at the time were little known and hardly used by Mexican farmers. An experimentation and training process focused on demonstrating their efficiency and facilitating their adoption was implemented to benefit a greater number of producers. This was a key strategy, because many farmers evaluated biofertilizers based on their short-, medium-, and long-term cost-benefit ratio and final users remained skeptical (Cruz-Cárdenas *et al.*, 2021). On 2011, upon the request of the Ministry of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA, currently SADER, the Ministry of Agriculture and Rural Development), INIFAP started a research and technology transfer project focused on the use of biofertilizers and organic fertilizers in agriculture. The aim of this project was to provide information about the biofertilizers available in the market, to evaluate their impact on crop yield, and to promote the reduction of both the use of synthetic fertilizers and production costs.

Doubtlessly, a successful transference depends on the adoption of the technology. At the time, it was an even harder task, because biofertilizers faced a strong competition from mineral fertilizers. In this context, adoption is defined as the decision of producers to use (or refrain from using) a given technology, taking into consideration such factors as the price of the product, innovation, market availability, and the obstacles for the adoption of the said innovation (Sagastume *et al.*, 2006). Therefore, the objective of this research was to determine the preferences of agricultural and fruit producers —whether they preferred mineral, organic, or biological fertilizers. The research assumed that the answers of the producers would be biased, given their lack of information about biofertilizers. To rectify this situation, the research team provided an exhaustive explanation about the product, its function, its application, and its contribution to healthy environment and soils. The purpose was to determine their receptiveness to this "new product" and the arguments which backed their decision.

MATERIALS AND METHODS

Research Design

Exploratory research was developed in 2011, based on macroeconomic theory (specifically, consumer behavior). This approach is focused on the tastes and preferences of the consumer, determining, along with other aspects, what products the consumer would be willing to purchase (Nicholson, 1997). Consumer decisions were analyzed based on their own preferences. Likewise, consumer attitudes were analyzed in face of certain market events: 1) affective component; 2) behavioral component; and 3) cognitive component (Kinnear, 2003).

The research included both desk and field work. Field techniques (focal meetings, direct observation, and questionnaires) were defined and designed during the desk work stage. Likewise, the strategies that would be used to apply each technique and the methodology that would be used for the analysis of the collected data were defined. During the field work stage, the questionnaires were tested and the three techniques were applied.

Two types of non-probabilistic statistical sampling were chosen for the application of the questionnaires: purposive (Kerlinger, 1975; Otzen and Manterola, 2017) and volunteer (Pimentel Lastra, 2000). Purposive samplings were used with producers who had already cooperated with INIFAP, while volunteer sampling was applied with producers who were present when the plot was established and who voluntarily agreed to participate. The total sample was obtained from the application of questionnaires to 100 producers (Table 1). The personal characteristics and experience of the 47 cooperating producers were similar to those describe for the remaining 53. Consequently, all the questionnaires (100) were subjected to data analysis, increasing the statistical certainty of the results.

During the focal meetings, the research team and the producers discussed the traditional fertilization methods (mineral fertilizers), their effects on plants, and their consequences for the soil and the water table, as well as the application and benefits of biofertilizers. The producers who attended the focal meetings were part of the 100-producer sample.

The direct observation consisted of several stages. Once the plot had been established and after both guest and cooperating producers had attended a talk about biofertilizers, a visit to an agricultural product shop was simulated. Since they usually receive guidance and advise from the shop clerk, they were asked to pretend that the clerk could not provide them any information about the available biofertilizers. Therefore, they would have to make the decision on their own. All the biofertilizers used in the plots were placed at the same level and at the same distance from the producers, who were then asked to make their choice. This was mostly an individual exercise, to prevent producers from influencing each other's responses.

In this hypothetical situation, observation was focused on the following questions: 1) does the producer read the product formula; 2) does the producer read the instructions; 3) does the producer ask for the price; and 4) does the producer buy the product.

A descriptive analysis of the study population was based on the information collected. Subsequently, a discriminant analysis was applied to identify the variables that explain the preference of the producers (chemical fertilizers, organic fertilizers, or biofertilizers). An analysis of contingency tables was then used to examine the statistical relationship between the variables, with the aim of explaining the choice of biofertilizers during the shopping simulation. Finally, relative frequencies were analyzed to identify the reasons that backed up the choice of biofertilizer.

The commercial biofertilizers evaluated in this study were defined and chosen based on the guidelines of SAGARPA. The inclusion of the said products was a response to the request made by several biofertilizer manufacturers, who wanted to subject their products to a technical evaluation. Once they were approved by the Ministry, their products could be included in different agricultural support programs.

RESULTS AND DISCUSSION

The average age of the overall sample was 51 years (mode: 60 years). Ninety-one percent of the participants were men. When they were asked if they knew how to read or write, 45% of the interviewees answered the question (93% of the said percentage replied “yes”). The study assumed that agricultural producers have an empirical understanding of fertilizers, their mixtures, application, and impact on crop development. To include this variable on the analysis, the following elements were taken into account: 1) their years of experience as agricultural producers (years_p); and 2) the period they had worked with the crop (years_c) to which the biofertilizer was applied. This information would increase the veracity of their observations about crop development, as well as their choice and satisfaction with the biofertilizers used. Nine of the producers interviewed grew perennial crops, while the rest used annual species (mainly maize). Agricultural production experience ranged from 2 to 66 years, with a mean and mode of 30 years. The time which the producers had worked with the crop to which the biofertilizer had been applied ranged from 2 to 66 years (mean: 26 years).

The focal meetings took place in four maize-producing areas: Tlahuac, Federal District (currently Mexico City); San Agustín Tlaxcala, Hidalgo; the municipality of Loma Alta, Chapa de Mota, State of Mexico, and the municipality of Hecelchakan, Campeche. The meeting in the Federal District included a cooperating producer —who did not conclude his agricultural engineering studies and had owned an agrochemical product shop for several years—, two agricultural engineers, and three guest producers.

The meeting in Hidalgo recorded the highest number of participants: 30 producers (40+ years old), who sow native maize in strictly rainfed plots. Meanwhile, in addition to the INIFAP technicians and researchers, ten producers attended the meeting at Lomas Altas. The producers were young (average age: 30 years) and had worked on agriculture for a few years, which increased their receptiveness. In Hecelchakan, Campeche, four producers —a father (65 years old) and his sons (34, 32, and 27 years old)— who only applied mineral fertilizers to maize participated in the meeting.

Demonstration plots were established with cooperating producers who had been previously chosen by INIFAP. These plots were supervised by a team of experts on biofertilizers from the said institute. The furrows were divided into control and treatments. The mineral fertilization formula that the cooperating producers normally used was applied to the control. In the treatment furrows, 50% of the mineral fertilizers were replaced with biofertilizers (one per each two furrows). Table 1 shows the plots that were included in this study.

Table 1. Demonstration plots, crops, biofertilizers, state, and number of cooperating producers.

Federal entity	Cultivation	Number of producers	Commercial biofertilizers*
Aguascalientes	Corn	1	Micorriza INIFAP®, BiofertiBuap Zea®+ BiofosfoBuap®, Bio-Radix® + Spectrum Mico® + Nutripro® Forte + Nutripro® Xtra Alga
Campeche	Rice	1	Micorriza INIFAP®, BiofertiBuap®, AlgaEnzims®
	Corn	2	Micorriza INIFAP®, Bacteriano2709®, FerbiliQ®, BiofertiBuap Zea®+ BiofosfoBuap®
Chiapas	Corn	3	Micorriza INIFAP®, Bio-Radix®+ Spectrum Mico®, FerbiliQ®
	Bean	5	Micorriza INIFAP®, BiofertiBuap Leg® + BiofosfoBuap®, Endospor®
	Sugarcane	1	Micorriza INIFAP®, Bio-Radix® + Spectrum Mico® y FerbiliQ®
Ciudad de México	Corn	1	Micorriza INIFAP®, FerbiliQ®, BiofertiBuap Zea®
Estado de México	Corn	2	FerbiliQ®, Micorriza INIFAP®, Bacteriano2709®, BiofertiBuap Zea® + BiofosfoBuap®
Guanajuato	Bell pepper	1	Micorriza INIFAP®, BiofertiBuap®, Bio-Radix®+ Spectrum Mico®, Nutripro® Forte + Nutripro® Xtra Alga
	Corn	4	Bacteriano2709®, Micorriza INIFAP®, BiofosfoBuap® + BiofertiBuap Zea®, Bioradix + Spectrum Mico®
	Bean	1	Bacteriano2709®, Micorriza INIFAP®, BiofosfoBuap® + BiofertiBuap Leg®, Bioradix + Spectrum Mico®
	Sorghum	2	Micorriza INIFAP®, BiofosfoBuap® + BiofertiBuap Sorghum®, Bio-Radix® + Spectrum Mico®
Guerrero	Corn	2	Micorriza INIFAP®, BiofertiBuap Zea®+ BiofosfoBuap®, FerbiliQ®
Hidalgo	Orange	1	Micorriza INIFAP®, BiofertiBuap®, FerbiliQ®, Bacteriano2709®
	Barley	2	Micorriza INIFAP®, Bacteriano2709®, BiofertiBuap Hord®, AzoN® + Mycorfos®
	Corn	2	BiofertiBuap Zea®, Micorriza INIFAP®, Bacteriano2709®, Endospor®
Morelos	Poinsettia	1	Micorriza INIFAP®, Bio-Radix® + Spectrum Mico® + Nutripro® Forte + Nutripro® Xtra Alga, BiofertiBuap®
	Tomato	1	Micorriza INIFAP®, Biofertibuap®, Bio-Radix® + Spectrum Mico® + Nutripro® Forte + Nutripro® Xtra Alga
Nuevo León	Sorghum	1	Micorriza INIFAP®, FerbiliQ®, Bio-Radix® + Spectrum Mico®, BiofosfoBuap®, Bacteriano2709®
	Grasses	1	Micorriza INIFAP®, FerbiliQ®, Fosfonat®, Bacteriano2709®
	Citrus fruits	1	Micorriza INIFAP®, FerbiliQ®, Endospor®, Bacteriano2709 INI®, Bio-Radix®+ Spectrum Mico®
Oaxaca	Corn	6	Micorriza INIFAP®, BiofertiBuap Zea®+ BiofosfoBuap®, FerbiliQ®
Tlaxcala	Corn	1	AzoN® + Mycorfos®, Micorriza INIFAP® Micorriza INIFAP®, Bacteriano2709®
	Barley	1	Micorriza INIFAP®, Bacteriano2709®, BiofertiBuap Zea®, BiofosfoBuap®, Bio-Radix®+ Spectrum Mico®
Veracruz	Corn	1	Micorriza INIFAP®, BiofertiBuap Zea®, Spectrum MicoBac® y FerbiliQ®
Yucatán	Corn	1	Micorriza INIFAP®, BiofertiBuap Zea®, FerbiliQ®, Bacteriano2709®.
	Orange	1	Micorriza INIFAP®, BiofertiBuap®, AlgaEnzims®
TOTAL		47	

*Commercial biofertilizers: AlgaEnzims® (PalauBioquim, S.A. de C.V.); Micorriza INIFAP® (INIFAP); BiofertiBuap® (Benemérita Universidad Autónoma de Puebla); FerbiliQ® (Biosustenta S.A. de C.V.); Bacteriano2709® (INIFAP); BiofertiBuap Zea® (Benemérita Universidad Autónoma de Puebla); BiofosfoBuap® (Benemérita Universidad Autónoma de Puebla); Nutripro® Xtra Alga (Promotora Técnica Industrial, S.A. de C.V.); Nutripro® Forte (Promotora Técnica Industrial, S.A. de C.V.); Spectrum Mico® (Promotora Técnica Industrial, S.A. de C.V.); Bio-Radix® (Promotora Técnica Industrial, S.A. de C.V.); BiofertiBuap Leg® (Benemérita Universidad Autónoma de Puebla); AzoN® (BioFertilizar, S.A.S.); Mycorfos® (BioFertilizar, S.A.S.); Endospor® (Koppert); Fosfonat® (Tecnologías Naturales Internacional, S.A. de C.V.); BiofertiBuap Hord® (Benemérita Universidad Autónoma de Puebla); BiofertiBuap Sorghum® (Benemérita Universidad Autónoma de Puebla).

The producers expressed several concerns during the establishment of the plots. They were particularly insistent on the compatibility of biofertilizers with hybrid and native maize seeds, as well as their effectiveness with barley and wheat. Other concerns include the doses that must be applied according to the crop and number of seeds, as well as the mineral fertilizers that must be applied along with biofertilizers.

Producer preferences: chemical fertilizers, organic fertilizers, or biofertilizers

Determining consumer preference is fundamental, as it opens market opportunities and has a significant economic impact (Ramírez León, 2013). Their choices are supported by the experience they have acquired throughout their work. They clearly prefer mineral fertilizers, given their availability, ease of application, and quick and clear effect on crop yield. Additionally, handling experience and customs decisively influence their choice.

Therefore, biofertilizers face a daunting challenge, despite the argument in their favor that, unlike mineral fertilizers, they provide benefits to the soil and the environment (Chávez-Díaz *et al.*, 2020). Although mineral fertilizers increase the productivity of the crops during the first years of application, they are not as ideal as they are believed to be: they also have harmful effects, both on human health and the environment (Calderón *et al.*, 2019). Fertilization is not only expensive, but most producers make an inefficient use of these products (Ávila Marioni *et al.*, 2011).

Producers backed up their choice of mineral fertilizers as follows: 1) they are accessible; 2) they guarantee a safe and quick yield; 3) producers have experience handling the product; 4) they provide clear results in a short time; 5) they are widely available; 6) organic fertilizers are scarce; 7) less chemical fertilizers must be applied compared with organic fertilizers; 8) they are easy to apply, provide quick results, and are readily available in the market; 9) they are easier to apply with machinery; 10) they improve crop development and increase leaf area, height, and stem width; 11) their use is customary; and 11) the producers are unaware of other methods.

In the case of biofertilizers, the producers mentioned the following reasons: 1) they guarantee yield, without stimulating undergrowth (unlike organic fertilizers); 2) they remain effective, even under water excess conditions (unlike organic fertilizers, which can cause yellow leaves); 3) they are easier to apply and transport than organic fertilizers; 4) they are cheaper and do not depend on importations; 5) they do not harm the environment (unlike chemical fertilizers, which additionally can harm the humans who consume the harvest); 6) they reduce production costs; 7) they contribute to the retention of soil moisture and they are harmless and unexpensive; 8) they are efficient and are easily applied and transported (smaller volumes are required); 9) they are not toxic; 10) they reduce the use of chemical fertilizers; 11) they break down easily; and 12) they innovate agricultural handling.

Finally, the reasons to choose organic fertilizers included: 1) they improve yield; 2) they are a healthier and less expensive option; 3) manure is an excellent natural fertilizer; 4) they do not pollute the environment; 5) they do not involve a health risk for the persons who apply them; 6) they guarantee the safety of cattle that eat the feed prepared from the harvest; 7) they do not impact native plants; 8) unlike biofertilizers, they require less care and are more resistant to heat and sun; 9) they have better results than chemical fertilizers; 10) they are less sensitive to weather conditions than biofertilizers; 11) the manure from the producer's cattle can be used as fertilizer; 12) they are rich in essential nutrients for the soil and the crops; 13) they have long-term beneficial effects; and 14) they improve soil texture and structure.

Biofertilizers were first used in Mexico in 1970 (Armenta-Bojórquez, 1986; 1990, cited in Armenta-Bojórquez *et al.*, 2010). Several biofertilizer brands were available on the market by 2011, when the federal government —through SAGARPA, supported by INIFAP— renewed their promotion throughout the nation. Since 2021, the Producción para el Bienestar program and the Estrategia de Acompañamiento Técnico (EAT) have trained producers in agroecological and sustainable practices (SADER, 2024), including the use of biofertilizers (http://bioinsumos-agricultura.mx). Consequently, the use of biofertilizers is now better known, as well as their benefits to human health and the soil.

A discriminant analysis determined producer preferences, using "preference for the use of biofertilizers" as a dichotomous variable (0=does not prefer them; 1=prefers them). The explanatory variables were treated as numerical variables and included: age of the producer; years of experience in farming; and years during which the crop on which the biofertilizer was applied was sown. All the producers who expressed their preference for biofertilizers sow annual crops, while no producers of perennial crops preferred this type of fertilizer (Table 2).

Based on this information, the discriminant analysis clearly identified two groups: those who prefer biofertilizers and those who do not (Table 3).

Almost 60% of the producers who declared that they do not prefer biofertilizers (41 of 69) and 72% of those who do (18 of 25) are properly classified. Table 4 shows the discriminant function of each group. The coefficients are very similar (particularly the age coefficient).

The discriminant function minimizes the likelihood of an error in the classification of the individuals of each group. The aim of generating each group is to establish a lineal relation between the study variables. The negative signs of the years_p (years as producer) and years_c (years with the crop) show that, the longer that producers have worked with

Table 2. States and crops of the statistically-chosen producers who replied affirmatively to the use of biofertilizers.

Federal entity	Crops									Total
	Oat	Barley	Pepper and Corn	Bean	Corn	Bell pepper[1]	Sorghum	Wheat	They did not declare crops	
Chiapas				1						1
Estado de México	1			1						2
Guanajuato						2				2
Nuevo León							1	1		2
Tlaxcala		1								1
Veracruz			1		9		4		1	15
Yucatán					1					1
Total	1	1	1	2	10	2	5	1	1	25

[1] Pepper is a perennial crop that is managed as an annual crop.

Table 3. Summary of the discriminant function.

True bio	Classified		Total
	0	1	
0	41	28	69
	59.42	40.58	100.00
1	7	18	25
	28.00	72.00	100.00
Total	48	46	94
	51.06	48.94	100.00
Priors	0.5000	0.5000	

Table 4. Discriminant function.

bio	0	1
age	.555558	.551945
years_p	−.135597	−.179427
years_c	−.075680	−.057740
gender	11.012400	11.292030
constant	−16.37098	−15.63704
Priors	.5	.5

a given crop and the longer their experience (years), the likelihood that they will have a negative reaction to biofertilizer is greater (negative signs).

Choice of biofertilizer that producers would buy

The most frequent reasons to choose a biofertilizer were: 1) the material, design, and information in the package; 2) ease of application; and 3) its components. In total, 63 reasons were given (Table 5). In this regard, the reason with the highest relative frequency was "the material, design, and information in the package" (12%, Micorriza INIFAP®), followed by "because it's easily applied" (FerbiliQ®) and "for its components" (BUAP biofertilizers), which accounted for 14% of all the reasons (7% each).

Table 5. Factors that determined the choice of biofertilizers.

Biofertilizer/Reasons	1	2	3	4	5	6	7	8	9	10	Frequency
Material, design, and labeling of the packaging	8 0.12	1 0.01	6 0.09	1 0.01	0	5 0.07	4 0.06	0	1 0.01	0	26
Because it is easy to apply	3 0.04	1 0.01	4 0.06	0	0	5 0.07	3 0.04	0	0	0	16
Due to its components	1 0.01	0	5 0.07	0	1 0.01	3 0.04	1	1 0.01	0	1 0.01	13
Because it is liquid/ powder	2 0.03	1 0.01	1 0.01	0	0	4 0.06	0	0	0	0	8
Total	14	3	16	1	1	17	8	1	1	1	63

1: Micorriza INIFAP®. 2: Bacteriano2709®. 3: BiofertiBuap. 4: Endospor®. 5: AlgaEnzims®. 6: FerbiliQ®. 7: Bio-Radix®. 8: Spectrum Mico®. 9: BactoCrop. 10: AzoN® and Mycorfos®.

During the simulation exercise (the agricultural input shop), the producers were highly puzzled by the lack of verbal information about the product from the shop clerk. Some participants said that they would not buy anything, until the shop technician suggested a product. In those cases, the producers did not check the product or looked at it only briefly. Other producers paid more attention to the packages, read the information, and mainly asked about the doses for different crops. When they were told that the clerk could not provide any information, they hesitantly made their choice. Except in a few cases, the producers did not check for an expiration date.

CONCLUSIONS

The aim of this exploratory study was to identify relevant aspects and problems that can guide future research lines in this area. Since this study was based on a non-probabilistic sample, the results can only be applied to the 100 participating producers. Statistical analysis revealed that more experienced agricultural producers are less likely to apply biofertilizers to their crops.

This phenomenon could be explained by the following hypothesis: deep-rooted practices or knowledge acquired throughout the years are difficult to change. Consequently, during the transference activities, experts must insist on the need for agricultural and fruit-growing activities that involve soil restoration, that do not pollute the water and the environment, and that do not harm consumer health. Biofertilizers are a good ally in the struggle to dismantle the entrenched belief that economic growth involves environmental degradation. During the simulated shopping for biofertilizers, the producers were mainly interested in acquiring a product that does not damage the soil.

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REFERENCES

Grageda-Cabrera, O.A., Díaz-Franco, A., Peña-Cabriales, J., y Vera-Nuñez, J. (2012). Impacto de los biofertilizantes en la agricultura. *Revista mexicana de ciencias agrícolas 3*(6): 1261-1274.

Chávez-Díaz, I.F., Zelaya-Molina, L.X., Cruz-Cárdenas, C.I., Rojas-Anaya, E., Ruíz-Ramírez, S., & Santos-Villalobos, S.D.L. (2020). Consideraciones sobre el uso de biofertilizantes como alternativa agro-biotecnológica sostenible para la seguridad alimentaria en México. *Revista mexicana de ciencias agrícolas 11*(6): 1423-1436.

Moreno-Reséndez, A., Carda-Mendoza, V., Reyes-Carrillo, J.L., Vásquez-Arroyo, J., & Cano-Ríos, P. (2018). Rizobacterias promotoras del crecimiento vegetal: una alternativa de biofertilización para la agricultura sustentable. *Revista Colombiana de Biotecnología 20*(1): 68-83. https://doi.org/10.15446/rev.colomb.biote.v20n1.73707

Timmusk, S., Behers, L., Muthoni, J., Muraya, A., & Aronsson, A.C. (2017). Perspectives and challenges of microbial application for crop improvement. *Frontiers in Plant Science* 8: 49. https://doi.org/10.3389/fpls.2017.00049

Infante-Jiménez, Z., Ortega-Gómez, P., & Coutiño-Puchuli, A.E. (2020). Las Biofábricas y su relación con el desarrollo sostenible en Michoacán, México. In: Factores críticos y estratégicos en la interacción territorial desafíos actuales y escenarios futuros. Volumen II. Sarmiento Franco, J.F., Valles-Aragón, M.C., y Mota-Flores, V.E. (eds.). Universidad Nacional Autónoma de México. Ciudad de México, México. pp: 401-418.

Aguirre-Medina, J.F., Irizar-Garza, M.B., Durán-Prado, A., Grageda-Cabrera, O.A., Peña-del Rio, M.A., Loredo-Osti, C., Gutiérrez-Baeza, A. (2009). Los Biofertilizantes microbianos: alternativa para la agricultura en México. Folleto técnico N°. 5. Instituto Nacional de Investigaciones, Forestales, Agrícolas y Pecuarias. Campo Experimental Rosario Izapa. Tuxtla chico, Chiapas, México. 58 p.

Garza, M.B.I., Vázquez, P.V., García, D.G., Tut, C., Martínez, I.R., Campos, A.T., García, R.S., Aguirre, D.M., Martínez, J.C.G., Alvarado, S.M., Grageda, O.G., Valero, J.G., Aguirre-Medina, J.F. (2003). Respuesta de cultivos agrícolas a los biofertilizantes en la región central de México. *Agricultura técnica en México 29*(2): 213-225.

Cruz-Cárdenas, C.I., Zelaya-Molina, L.X., Sandoval Cancino, G., Santos Villalobos, S.D.L., Rojas Anaya, E., Chávez Díaz, I.F., & Ruíz-Ramírez, S. (2021). Utilización de microorganismos para una agricultura sostenible en México: consideraciones y retos. *Revista mexicana de ciencias agrícolas 12*(5): 899-913.

Sagastume, N., Rodríguez, R., Obando, M., Sosa, H., y Fishler, M. (2006). Guía para la elaboración de estudios de adopción de tecnologías de manejo sostenible de suelos y agua. Programa para la Agricultura Sostenible en Laderas de América Central, Manejo de Recursos Naturales Economía Rural Gobernalidad Local y Sociedad Civil y Agencia Suiza para el Desarrollo y Cooperación. Tegucigalpa, Honduras. 29 p.

Nicholson, W. (1997). Teoría Microeconómica. McGraw-Hill. España. 599 p.

Kinnear, T.C. y Taylor, J. R. (2003). Investigación de mercados. McGraw Hill. Colombia. 874 p.

Kerlinger, F.N. (1975). Investigación del comportamiento. Técnicas y Metodología. Ed. Interamericana. México. 525 p.

Otzen, T. y Manterola, C. (2017). Técnicas de Muestreo sobre una Población a Estudio. *International Journal of Morphology 35*(1): 227-232. http://dx.doi.org/10.4067/S0717-95022017000100037

Pimentel-Lastra, R. (2000). Encuestas probabilísticas vs. no probabilísticas. Universidad Autónoma Metropolitana Unidad Xochimilco. *Política y Cultura* 13: 263-276. https://www.redalyc.org/pdf/267/26701313.pdf

Ramírez-León, C. (2013). La importancia de la estrategia corporativa en el desarrollo del producto: una propuesta. *Pensamiento & Gestión* 35: 182-205.

Calderón, F.E.J., Guerra, J.W.C., & Lucio, D.A.O. (2019). Impacto ambiental provocado por el inadecuado uso de fertilizantes quimicos en cultivos de maíz. *UNESUM-Ciencias. Revista Científica Multidisciplinaria 3*(1): 61-72. https://doi.org/10.47230/unesum-ciencias.v3.n1.2019.128

Ávila Marioni, M.R., Espinoza Arellano, A.J., González Ramírez, H., Rosales Serna, R., Pajarito Ravelero, A., & Zandate Hernández, R. (2011). Caracterización de los productores, adopción e impacto económico del uso de la variedad de frijol "Pinto Saltillo" en el norte centro de México. *Revista Mexicana de Agronegocios* 29: 682–692.

Armenta-Bojórquez, A.D., García-Gutiérrez, C., Camacho-Báez, J.R., Apodaca-Sánchez, M.A., Gerardo-Montoya, L., Nava-Pérez, E. (2010). Biofertilizantes en el desarrollo agrícola de México. *Ra Ximhai 6*(1): 51-56. https://www.redalyc.org/pdf/461/46112896007.pdf

SADER, Secretaría de Desarrollo Rural (2024). Fomentando la agricultura sostenible con la Estrategia de Acompañamiento Técnico. (EAT) https://www.gob.mx/agricultura/articulos/fomentando-la-agricultura-sostenible-con-la-estrategia-de-acompanamiento-tecnico-eat (Marzo, 2024).