Revista Mexicana de Ciencias Agrícolas
REMEXCA
DOI: https://doi.org/10.29312/remexca.v15i6.3246
Article

Effects of climate change on regional agriculture. Case of the Cuitzeo basin, Michoacán

---

Agustín Hernández Santoyo[1]
Jorge Víctor Alcaraz Vera[2]
Carlos Francisco Ortiz-Paniagua[2,§]

1 Investigador por México comisionado a la Dirección Regional 6 Occidente del CONAHCYT, México. (0455377h@umich.mx).

2 Instituto de Investigaciones Económicas y Empresariales-Universidad Michoacana de San Nicolás de Hidalgo. México (jorge.alcararaz@umich.mx).

Autor para correspondencia: carlos.ortiz@umich.mx.

Abstract

Currently, more than eight billion inhabitants seek to meet their food needs. Nonetheless, phenomena such as climate change are affecting agricultural production capacities. It is therefore essential to generate information on the most likely effects. This research aimed to analyze the effect of climate change on productive capacities (yield and production) in the Cuitzeo Basin Region of the state of Michoacán, Mexico. First, the presence of climate change was sampled; and secondly, what has happened with agricultural yield and production was identified. The results indicated that: 1) the signal of climate change is present in the region; and 2) significant differences were found between rainfed crops that showed a trend of climate change.

Keywords:

climate change signal, Lake Cuitzeo basin, productive capacities.

Introduction

Socioenvironmental uncertainty accelerates with global change, posing important challenges in the different dimensions of social organization (Nigthtingale *et al*., 2021), such as the need to expand the world's food production capacities due to the fact that the human population currently exceeds eight billion people (WorldoMeter [WM], 2024). Added to this is the deterioration of natural and environmental resources for food production (water, soil, air, and biodiversity (pollinators) (Pimentel *et al*., 1994; Nathaniel, 2021). Therefore, one of the main challenges is to rescue and replicate production techniques compatible with ecosystems and their regeneration (Rehberger *et al*., 2023).

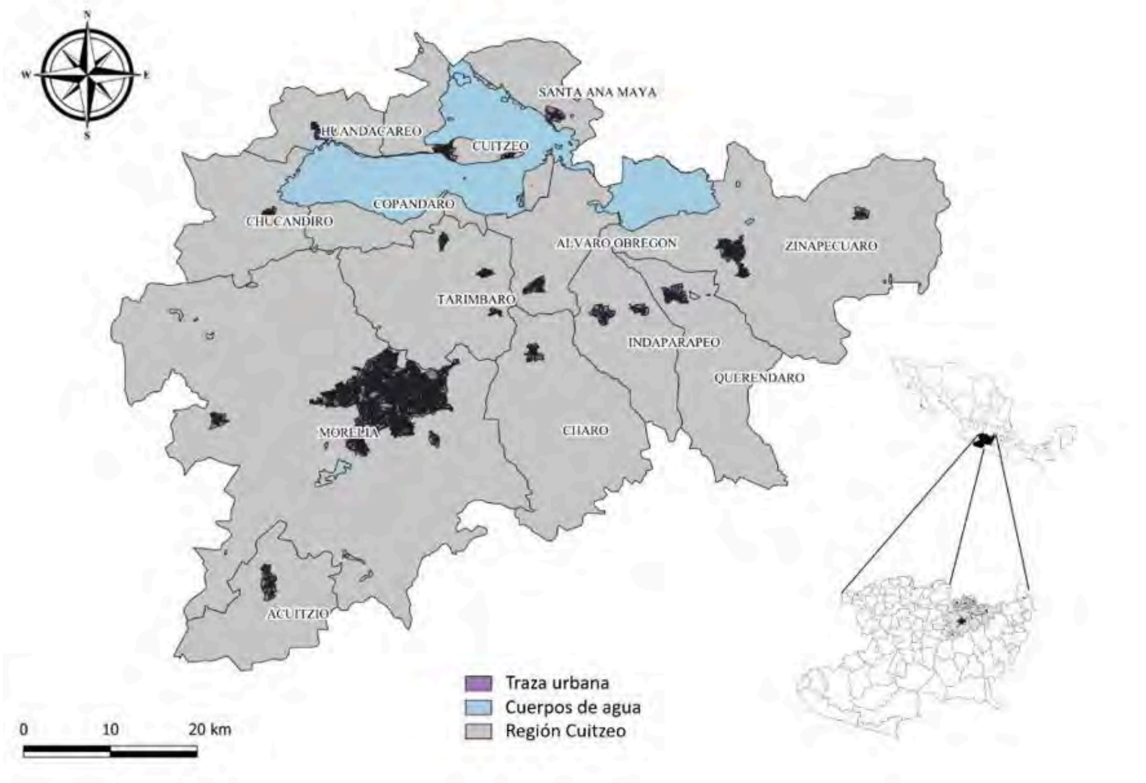
It was estimated that 40% of cropland is affected by soil erosion each year (Tal, 2018) and three billion people depend on the countryside and are exposed to the effects of climate change (CC) (Houtart, 2014). In Mexico, 21% of its population lives in rural areas; it is one of the world's leading producers of fruits and vegetables and is also the main importer of corn worldwide (SADER, 2019). This showed profound contrasts between regions of high productivity and others that are severely depressed, with different degrees of vulnerability (Caso *et al*., 2021).

Specifically, for the Cuitzeo Basin Region (CBR) of Michoacán, agriculture employs 22% of the population and contributed 6% of the Gross Domestic Product (GDP) (Ortiz *et al*., 2017). So, for the present, the objective was to identify the effects of CC on agricultural production. To this end, the CC signal was analyzed using the MK test, after which the means test for non-parametric data was performed through contrasts between crop yields.

Characterization of the Cuitzeo Basin Region, Michoacán

Using the regionalization decreed in Michoacán in 2004, the Cuitzeo Basin Region (CBR) is recognized as a functional physical entity within the scope of public administration and covers 15 municipalities (Indaparapeo, Morelia, Queréndaro, Santa Ana Maya, Tarímbaro, Acuitzio, Álvaro Obregón, Copándaro, Cuitzeo, Charo, Chucándiro, Huandacareo, and Zinapécuaro) (CELEM, 2004) (Figure 1).

Figure 1. Cuitzeo Basin Region, Michoacán.



The CBR is located in the Trans-Mexican Volcanic Belt, covering the coordinates between 19° 30’ and 20° 05’ north latitude and 100° 35’ and 101° 30’ west longitude, with an elevation of 1 800 masl. With an area of 3 944.865 km^2, this basin represents approximately 7% of the total area of the state. With 1 004 723 inhabitants, it is the most densely populated region of Michoacán.

The predominant economic activity in this region is commerce, particularly in the municipalities of Morelia and Cuitzeo, which are the most urbanized areas. In contrast, the manufacturing industry is prominent in the surrounding municipalities of Charo and Indaparapeo; primary activities predominate in the rest of the municipalities.

Materials and methods

The national climatological database (CLICOM, 2020) was used to identify the meteorological observation of the CBR in meteorological stations (MSs). Twenty-five MSs were detected in the CBR, daily data for each MS were obtained, and the information was validated for a period of at least 25 years according to Ortega *et al*. (2018) procedure. Then, the following variables were obtained: precipitation (Prec) (mm), mean temperature (Tmea) (°C), maximum temperature (Tmax) (°C), and minimum temperature (Tmin) (°C). Eighteen of the 25 MSs met the selection criteria.

Subsequently, the information was integrated into the Clic-MD software following Bautista *et al*. (2011) procedure. When plotting the information from Tmax, Tmea, and Tmin, the behavior of the data was observed and possible outliers with the potential to bias the results were detected. These data were confirmed or rejected with secondary information validating the information.

Geary’s coefficient, the Shapiro-Wilk test, the sequence test, Bartlett’s test, and Pettit’s test were applied (Bautista *et al*., 2016). The data had to pass at least one test, then underwent homogenization tests. This procedure is applied to ensure that their fluctuations are influenced solely by climatic factors. This isolates the information from any bias caused by equipment, human, or other errors (Bautista *et al*., 2016).

The homogeneity tests applied by the software were: Buishad, Herlmert, Neuman, Anderson, Spearman, and Kolmorogov-Smirnov. Once this test is passed, showing homogeneity in at least one, the analysis can be deepened by using the MK correlation coefficient to detect CC (Gómez-Gómez *et al*., 2003) or non-normal (Bautista *et al*., 2011) trends.

The Z-test statistic was calculated using the following formula:

$$Z=\begin{cases}\frac{S-1}{\sqrt{Var(S)}} S>0\\ 0\ S=0\\ \frac{S+1}{\sqrt{Var(S)}} S<0\end{cases} \qquad Var(S)=n(n-1)\ (2n+5)\ /\ 18$$

1). Specifically, if α is set to 0.05, the null hypothesis is rejected when |Z| is greater than 1.96. The correlation coefficient τ for MK can be formally defined as:

$$\tau=\frac{S}{\frac{n\ (n-1)}{2}}$$

2). This is particularly advantageous in the field of climatology, but it was also applied to production variables, since it allows the incorporation of missing values by adjusting the variance formula (S) by grouping data by means of the following formula:

$$Var(S)=\frac{n(n-1)(2n+5)-\sum_{i=1}^{n} t_i i(i-1)(2i+)}{18}$$

3). For the study of agricultural production in the CBR, the Agrifood Information Consultation System (SIACON-NG, for its acronym in Spanish) was used and based on its information, the crops with the highest value of the production with information from 2003-2019 were chosen. The coefficient of variation (CV) was used, employing the yield (t ha^{-1}) for 2003-2019 as a reference, since it measures the percentage of variation of a variable in relation to its mean (Vargas, 1995).

Therefore, it is feasible to assume that alterations in crop yields may be associated, among other factors, with CC. With this, two types of contrasts were designed for crop yield: 1) irrigation vs. rainfed (baseline or reference point); and 2) rainfed with a trend of up to 13 months vs. rainfed with a trend of more than 13 months. High variation denotes growth in uncertainty, which, added to the presence of a CC trend, suggests that it is an effect of the latter; it would also be expected that the variation as well as the mean will be higher in the first months and as time progresses, the average yield decreases and so does the variability (CV).

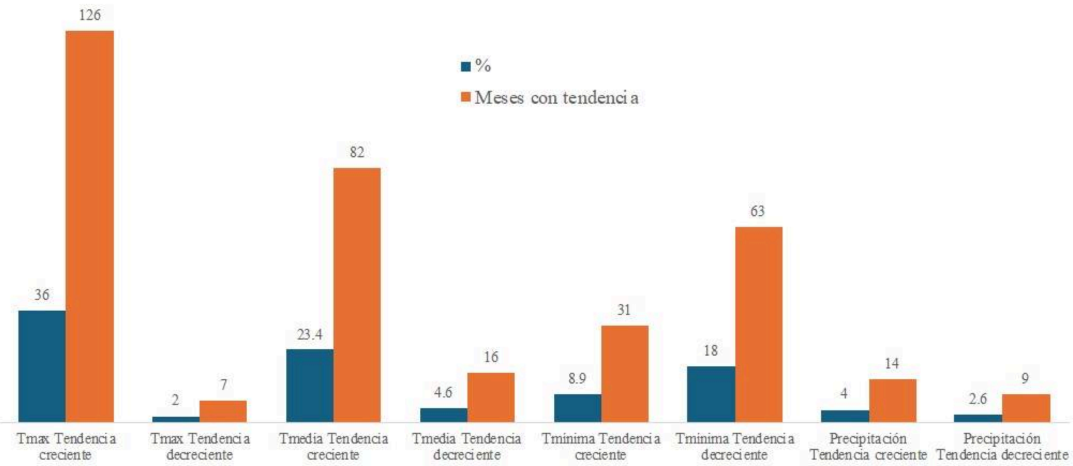
Results and discussion

Climate change trend and agricultural production

In the 18 MSs, some CC trend was identified, that is, the results show variation and number of months in which this trend occurs for maximum temperature (Tmax), mean temperature (Tmea), minimum temperature (Tmin), and precipitation (Prec). There were 12 months for each of the four variables mentioned above, so the maximum was 48 months, in which, according to this analysis, a CC trend could be observed. Increasing Tmax was the most frequent trend in 36% of the total months, followed by increasing Tmea with 23.4%, and decreasing Tmin in 18% (Figure 2).

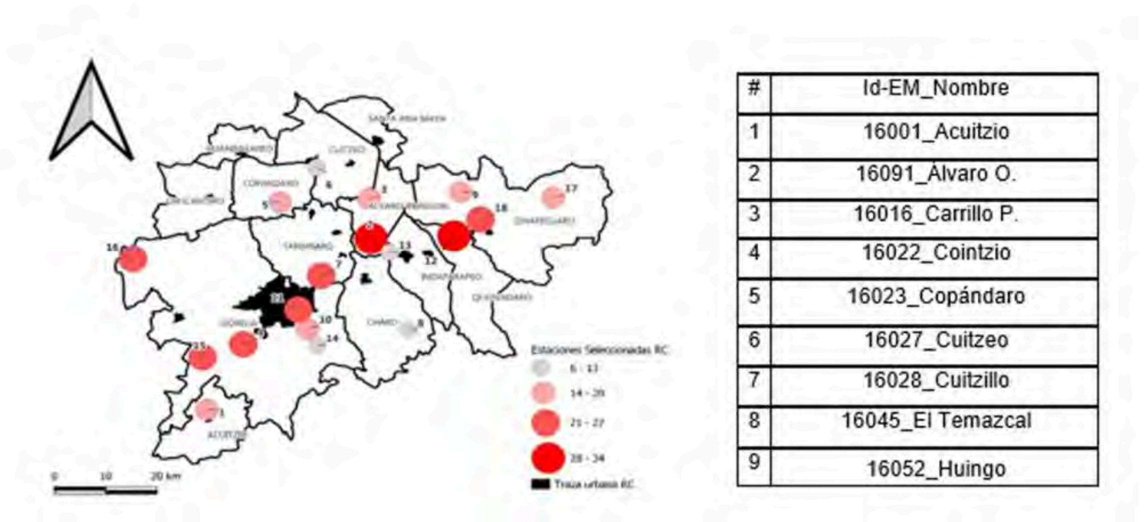
DOI: https://doi.org/10.29312/remexca.v15i6.3246

Figure 2. Percentage of CC trends identified in the CBR.



The MS 16096 ‘Presa Malpaís’ showed the highest trend, with 34 consecutive months showing the CC signal, MSs 16027 and 16114 showed the lowest trends, with six months. Figure 3 shows the MSs selected for the study and a color gradient showing MSs grouped into four sets based on the number of months of identified CC trends, which range from six months of trend. It is worth mentioning that the largest number of MSs (10) showed trends between 14 and 27 months.

Figure 3. Number of months with observed CC trend by meteorological station.



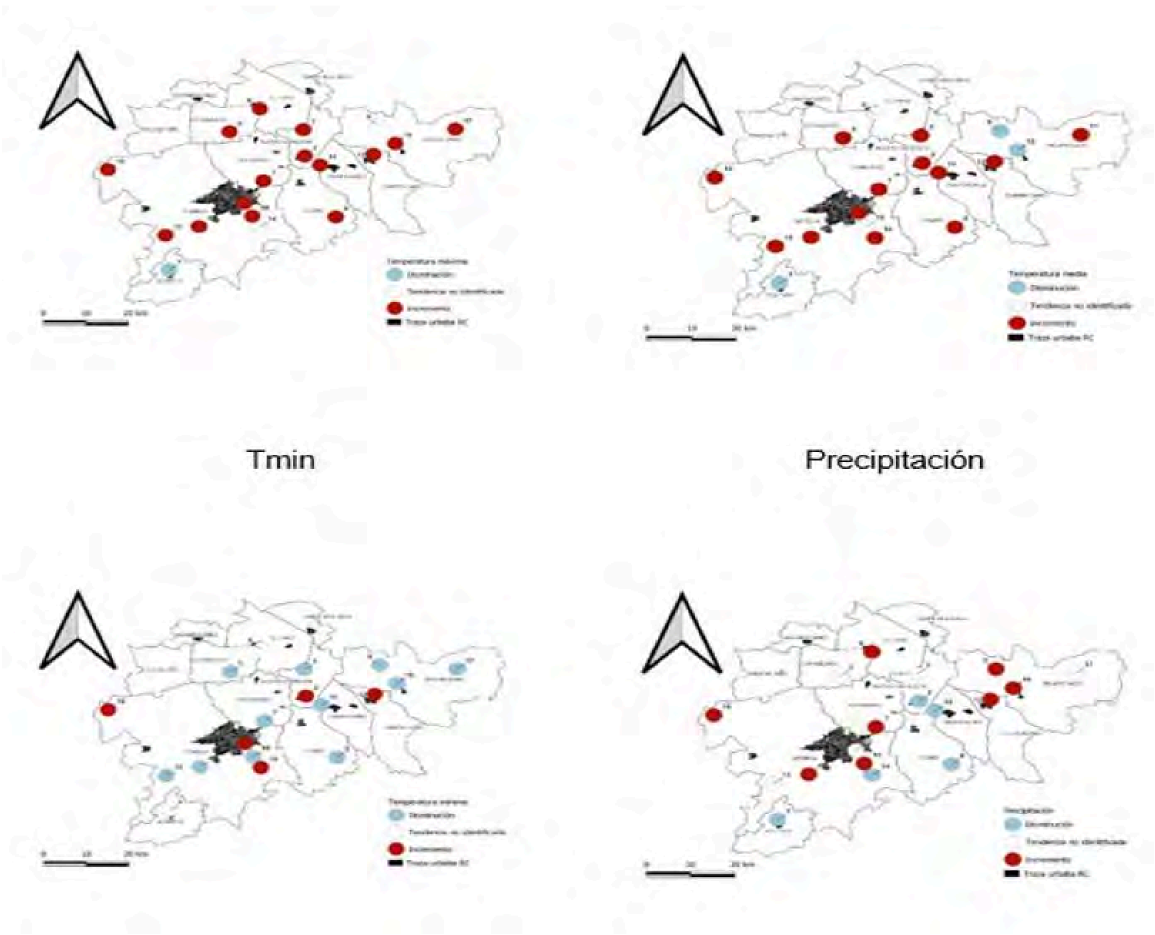
#	Id-EM_Nombre
1	16001_Acuitzio
2	16091_Álvaro O.
3	16016_Carrillo P.
4	16022_Cointzio
5	16023_Copándaro
6	16027_Cuitzeo
7	16028_Cuitzillo
8	16045_El Temazcal
9	16052_Huingo

The CC signal represents a variation that, in geographical referencing, does not present itself in a unidirectional or homogeneous way. The effects of Tmax show an increase, except for MS 16001, which registered a reduction, and in stations 16114 and 16052, no trend was detected. On the other hand, in the Tmin, five stations showed an increase in the minimum temperature; precipitation stands out since of the stations in which some trend was found (13), in eight of them, changes in precipitation patterns were detected, with evidence of a decrease in five MSs, while no clear orientation was identified in the remaining five stations.

DOI: https://doi.org/10.29312/remexca.v15i6.3246

Figure 4 shows the results integrated by variable (Tmax, Tmea, Tmin, and Prec); highlighted in blue if the trend identified in that particular MS is a decrease, in white if no trend has been detected and in red if the propensity is to increase (Figure 4).

Figure 4. Observed trends by variable (CBR).



It is highlighted that an upward trend predominate in Tmax and Tmea and a downward trend in Tmin, that is, the climate tends to extreme temperatures. This provides evidence that, in general, the region shows an orientation towards warming, which has repercussions in productive terms for the primary sector and the rest of the economy. On the other hand, precipitation is the most heterogeneously distributed since no trend is identified in five MSs.

The selection of the CBR crops resulted in 43 irrigated and rainfed crops, out of a total of 203 crops (142 are irrigated and 61 rainfed). Table 1 shows that grain corn is grown in 13 municipalities, under irrigation and rainfed conditions, while sorghum appears in 11 municipalities with irrigation and 12 municipalities under rainfed conditions.

Table 1. Main agricultural products by number of municipalities in the CBR.

Crop (# municipalities with irrigation= I, # municipalities under rainfed conditions= R)
Grain corn (13I and 13R); fresh forage oats (13I and 6R); fresh alfalfa (11I and 0R); grain sorghum (11I and 12R); grain wheat (10I and 2R); avocado (7I and 5R); onion (7I and 1R); vetch (6I and 2R); tomato (6I); grain chickpeas (5I); zucchini and green chili (4I); husk tomato (4I and 2R); peaches (3I and 1R); lettuce (3I); cabbage, cauliflower, strawberry, baby's breath (bunch), cucumber, and Mexican marigold (bunch) (2I); beans (2I and 8R); beet, broccoli, sweet potato, grain barley, peas, dried chili, cilantro, green beans, tender ears of corn, spinach, guava, jicama, apple, radish, seeds of grain corn, clover, and carrot (1I); plum, lentils, and nopalitos (1I and 1R); grasses and meadows (1I and 2R); agave, grain broad bean, pear, and prickly pear (1R).

SIACON (2021).

The production growth rate showed a greater increase in irrigated crops, such as lentils (282%) and grain barley (163%). The rainfed crops with the highest growth rate are grain sorghum (84%) and grain corn (76%). Irrigated crops show higher growth rates in production and yield compared to rainfed crops (Figures 5 and 6). The effect of the CC is mainly seen in rainfed crops; it showed a variability, measured with the coefficient of variation (CV), which was greater, as can be seen in (Table 2).

Figure 5. Average growth rate of the yield of CBR crops.

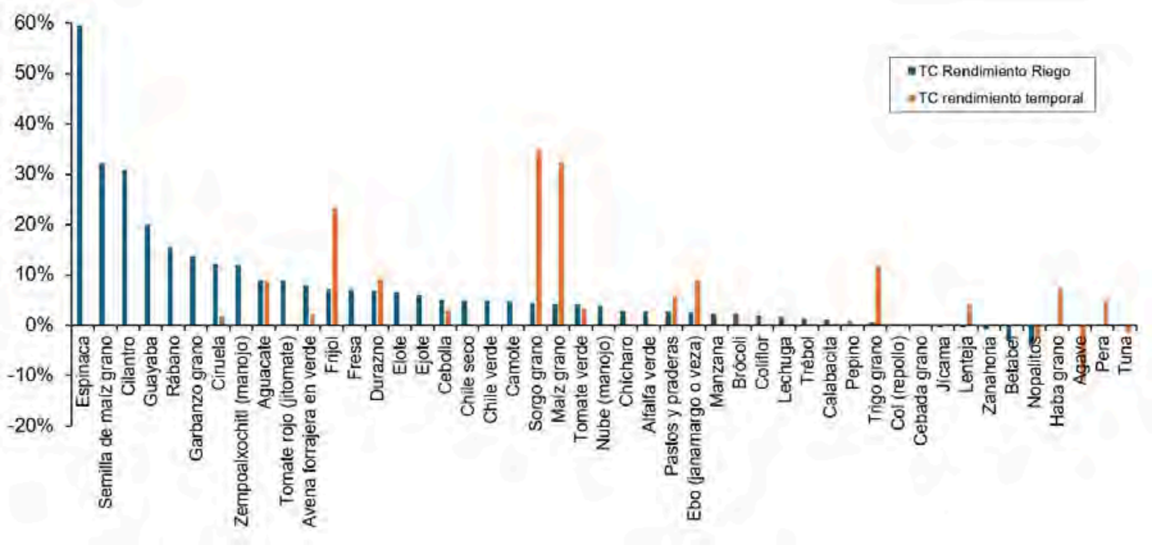
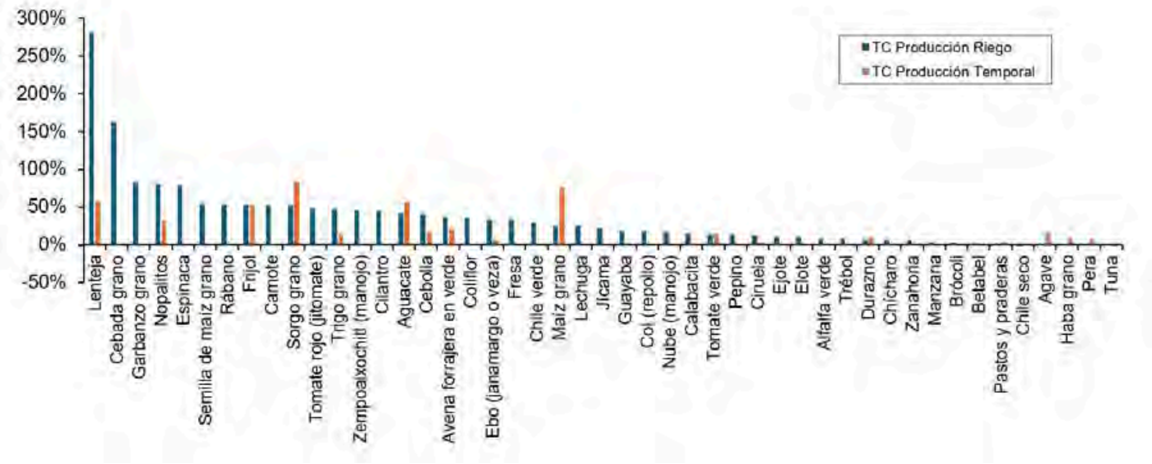


Figure 6. Average growth rate of the production of CBR crops.



Thus, the CV is higher in rainfed crops, with an average of 35% alteration, while irrigated crops register an average modification of 23%. In this case, a test of analysis of variance was applied using the t-test by accepting the alternative hypothesis of mean difference (*p*≥ 0.05) (Table 2). As a control exercise, it was found that the difference between the means of the CV of the crops was significant, while the CV data are normally distributed, according to the Shapiro-Wilk test (SW), which provides validity to the contrast.

Table 2. Coefficient of variation (CV) of yield.

CViy*	0.227	SW normality	CViy*
CVry**	0.352	W	0.671
Difference	0.125	*p*-value (two-sided)	<0.0001
z (observed value)	4.923	alpha	0.05
|z| (critical value)	1.96	SW normality	CVrt**
p-value (two-sided)	<0.0001	W	0.926
alpha	0.05	*p*-value (two-sided)	0.001
		alpha	0.05

iy*= irrigation yield; ry**= rainfed yield. Contrast of means between irrigation and rainfed (SIACON, 2021).

Once the CV was verified by comparing the means of irrigated and rainfed crops, the expected result was obtained, with a lower CV for irrigated crops in statistical terms. In this way, a hypothesis contrast is proposed between rainfed crops that show a trend of between six and 13 months with the presence of CC (increase in temperature and reduction in precipitation).

For this contrast, it was found that the information is not normally distributed based on the SW test, which coincides with a ratio of variances that indicates that they are different according to Levene's and Fisher's tests. From this perspective, since we talk about CC, the difference in means and variances would indicate that the variation in yields is greater in the first months and decreases in the long term but persists with variation, as expected, since the initial comparison denotes a greater loss of yields (Table 3).

Table 3. Coefficient of Variation (CV) of the yield for rainfed crops. Contrast of means for trends between six and 13 months versus more than 13 months.

CVry up to 13 months of trend	0.428		Fisher F-test	Levene’s test
CVry more than 13 months of trend	0.28	Ratio	3.436	
Difference	0.148	F (observed value)	3.436	8.072
z (observed value)	2.777	F (critical value)	2.234	4.038
|z| (critical value)	1.96	*p*-value (two-sided)	0.003	0.007
valor-*p* (two-sided)	0.005	Bartlett	0.003	
alpha	0.05		0.05	0.05
SW normality	Up to 13 months	More than 13 months		
W	0.957	0.963		
p-value (two-sided)	0.581	0.305		
alpha	0.05	0.05		

SIACON (2021).

Discussion

In this work, it is assumed that the phenomenon of CC occurs in the CBR of Michoacán, so it was considered as an intervening variable. This is important to clarify since it is a problem that occurs on a global scale; however, its effects are heterogeneous (Houtart, 2014) in place and sense.

In this regard, the research provides evidence that proves that the phenomenon of CC presents itself in a heterogeneous way within the CBR. Nonetheless, the main results of the climate analysis are consistent with those by Ortega *et al*. (2018), who, by using a similar methodology in the measurement of the CC signal, found that maximum and average temperatures tend to increase for the Tierra Caliente Region, Michoacán.

Similarly, these results are in line with what Hernández and Valdez (2004) mention regarding the drier and hotter climate in the country. On the other hand, the analysis of variance of the main crops of the CBR shows that the greater the exposure to CC (months of CC trend identified by station), the greater the variability, and the reduction in yield is greater in the first months of trend, a phenomenon already noticed by Conde *et al*. (2004), who have reported that the agricultural sector in the Mexican Republic is one of the most vulnerable sectors to this phenomenon.

Similarly, the IPCC (2014) points out that there is a reduction between the relationship between agricultural production and people’s quality of life and the increase in prices, which have grown by a little more than 32% in low-income countries, which can be attributed to increasingly intense droughts (Birgani *et al*., 2022).

It is worth highlighting the ecological (Altieri and Nicholls, 2010), economic, productive (Van, 2013) and cultural (Rosas, 2009) importance of peasant or smallholder agriculture, associated with seasonal crops due to its production characteristics (Uzcanga *et al*., 2015).

From this perspective, the analysis of the production and yield of the most important crops in the CBR for 2003-2019 reflects contrasting results, on the one hand, that it is rainfed agriculture that presents the greatest variation (35%) in the study period compared to irrigated agriculture (23%), therefore, it is the most vulnerable. Nevertheless, in the case of CBR, the yield growth rate is higher in rainfed crops (19%) than in irrigated crops (6%), and rainfed crop production is higher than irrigated crops.

The possible implications of the CC signal in the CBR are shown in the increase in the coefficient of variation in rainfed crops, with 35%, while for irrigated crops registered, it was 23% in the period

DOI: https://doi.org/10.29312/remexca.v15i6.3246

analyzed. The Z-test suggests the mean difference (*p*# 0.05). These ideas support the arguments that, even in the context of CC, small-scale production is the one that produces the largest amount of food (Van, 2013) under increasingly severe conditions, faces such changes with resistance and apparent inability (Altieri and Nicholls, 2010), develops complex adaptation processes (Adger *et al*., 2007), but it constituted to a large extent a healthy alternative for territorial occupation (Gómez-Olivier, 1995) and social functioning.

Conclusions

The CBR presented the CC signal; some type of trend was identified in 18 meteorological stations, confirming the presence, direction, and intensity of CC at the regional level and its effects on crop yield. The data obtained revealed an increasing trend in maximum temperature in 15 of the 18 MSs, while precipitation was the most heterogeneously distributed variable.

The hypothesis test in the number of months that revealed the tendency to CC showed statistical significance (*p*# 0.05) when contrasting the yields of the crops that presented tendencies to CC. The coefficient of variation in yield between rainfed crops, with a trend in maximum temperatures, was statistically higher for stations with up to 13 months of trend (42.8%) than those with more than 13 and up to 36 months of trend (28%). In the same sense and as expected, the coefficient of variation in yield was statistically significantly higher in rainfed crops (35%) than in irrigated crops (23%).

Bibliogaphy

1 Adger, W. N.; Agrawala, S.; Mirza, M. M. Q.; Conde, C.; O'Brien, K.; Puhlin, J.; Pulwarty, R.; Smit, B. and Takahashi, K. 2007. Assessment of adaptation practices, options, constraints, and capacity. *In* Climate Change: Impacts, Adaptation and Vulnerability. Ed). Cambridge University Press. Cambridge, United Kingdom. 717-743 pp. https://acortar.link/aFOb2H.

2 Altieri, M. A. y Nicholls, C. I. 2010. Agroecología: potenciando la agricultura campesina para revertir el hambre y la inseguridad alimentaria en el mundo. España. Revista de Economía Crítica. 10(2):62-74. https://acortar.link/KGPYU2.

3 Bautista, Z. F.; Bautista, H. D. A.; Álvarez, A. O. y Rosa, D. 2011. Sistema de análisis de datos para el monitoreo regional y local del cambio climático con índices agroclimáticos (MOCLIC). UNAM. México. 1-46 pp. https://doi.org/10.22201/ciga.9786070223686e.2011.

4 Bautista, Z. F. .; Pacheco, A.; and Bautista-Hernández, D. 2016. Climate change analysis with monthly data (Clic-MD). Ed. Skiu. México. 57 p.

5 Birgani, R. A.; Kianirad, A.; Shab-Bidar, S.; Djazayeri, A.; Pouraram, H. and Takian, A. 2022. Climate change and food price: a systematic review and meta-analysis of observational studies, 1990-2021. American Journal of Climate Change. 11(2):103-132. https://doi.org/10.4236/ajcc.2022.112006.

6 Caso, C. M. D. I.; Gonzáles, T. A.; Vermoden, T. F. y Gress, C. F. 2021. Municipios vulnerables al cambio climático. Ed. INECC, México. 60 p. https://acortar.link/VwPWxY.

7 CELEM. 2004. Periódico Oficial del Estado. https://acortar.link/ijhtWt.

8 CLICOM. 2020. Base de datos Climatológica Nacional. http://clicom-mex.cicese.mx/mapa.html.

9 Conde, C.; Ferrer, R. M.; Gay, C. y Araujo, R. 2004. Impactos del cambio climático en la agricultura en México. *In* Cambio climático: una visión desde México. Martínez, J. y Fernández, A. (comps.) SEMARNAT, México. 227-238 pp. https://acortar.link/Vabwph.

10 Gómez-Gómez, M.; Danglot-Banck, C. y Vega-Franco, L. 2003. Sinopsis de pruebas estadísticas no paramétricas. Cuando usarlas. México. Revista Mexicana de Pediatría. 70(2):91-99. https://acortar.link/XogDIp.

11 Gómez-Olivier, L. 1995. El papel de la agricultura en el desarrollo de México. Oficina Regional de la FAO para América Latina y el Caribe. 52 p.

12 Hernández, M. E. y Valdez, M. G. 2004. Sequia meteorológica. En: cambio, climático: una visión desde México. Martínez, J. y Fernández, A. (comps.). SEMARNAT, México. 315-326 pp.

13 Houtart, F. 2014. La agricultura campesina en la construcción de un paradigma poscapitalista. En: agriculturas campesinas en latinoamérica. Propuestas y desafíos. Hidalgo, F.; Houtart, F. y Lizárraga, P. (Coords.). IAEN, CLACSO, Bolivia. 297-308 pp. https://acortar.link/koctxR.

14 IPCC. 2014. Intergovernmental panel on climate change impact, adaptation and vulnerability. Part B, Regional Aspects. .. Contribution of working group II to the Fifth Assessment Cambridge University Press. Cambridge. 613-688 pp.

15 Nathaniel, S. P. 2021. Environmental degradation in ASEAN: assessing the criticality of natural resources abundance, economic growth and human capital. Environment Science Pollution Resources. 28(17):21766-21778. https://doi.org/10.1007/s11356-020-12034-x.

16 Ortega, G. A. M.; Ortiz-Paniagua, C. F. y Ortega, G. P. 2018. Proyección del efecto de cambio climático en la producción agrícola de temporal de la región tierra caliente de Michoacán al 2025. En: desarrollo regional sustentable y turismo. Pérez, E. y Mota, E. (Coords.). UNAM, México. 20 p. http://ru.iiec.unam.mx/3791/.

17 Pimentel, D.; Harman, R.; Pacenza, M. J.; Pecarsky and Pimentel, M. 1994. Natural resources and an optimum human population. Population and Environment. 15(5):347-369. https://doi.org/10.1007/BF02208317.

18 Rehberger, E. P. C.; West, P. C.; Spillane, P. C. and McKeown, P. C. 2023. What Climate and environmental benefits of regenerative agriculture practices? An evidence review, environmental research communications. 5(052001):1-14. https://doi.org/10.1088/2515-7620/acd6dc.

19 Rosas, B. M. 2009. Una contribución a la economía ecológica: actividades no-proletarias generadoras de ingresos. (Tesis de Doctorado, Universidad Autónoma Metropolitana). Repositorio Institucional de la Universidad Autónoma Metropolitana Unidad Xochimilco. 103-175 pp. https://repositorio.xoc.uam.mx/jspui/handle/123456789/1407.

20 Secretaría de Agricultura y Desarrollo Rural. 2019. Panorama Agroalimentario 2019. https://acortar.link/oQnX0H.

21 SIACON. 2021. Sistema de Información Agroalimentaria de Consulta. Secretaria de Agricultura y Desarrollo Rural. Gobierno de México. https://acortar.link/mI7x5V.

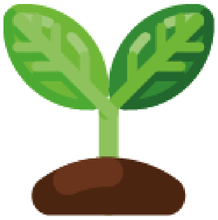
22 Tal, A. 2022. Making Conventional agriculture environmentally friendly: moving beyond the glorification of organic farming and the demonization of conventional farming. Sustainability. 10(4):1061-1078 pp. https://doi.org/10.3390/su10041078.

23 Uzcanga, N. G.; Cano, A J.; Ramírez, S. J. y Cruz, D. J. 2015. Características socioeconómicas y rentabilidad de los sistemas de producción de maíz bajo condiciones de temporal de la Península de Yucatán, México. México. Revista Mexicana de Agronegocios. 19(37):173-183. https://acortar.link/tZvWma.

24 Vargas, S. A. 1995. Estadística descriptiva e inferencial. Colección ciencia y técnica. Publicaciones de la Universidad de Castilla-La Mancha. 2ª Ed. España. 89-99 pp.

25 Van, P. J. 2013. Diez cualidades de la agricultura familiar. Perú. LEISA Revista de Agroecología. 29(4):6-8. https://acortar.link/ka24u2.

26 WorldoMeter. 2024. Población mundial actual. WorldoMeter. https://www.worldometers.info/.



Effects of climate change on regional agriculture. Case of the Cuitzeo basin, Michoacán

Journal Information
Journal ID (publisher-id): remexca
Title: Revista mexicana de ciencias agrícolas
Abbreviated Title: Rev. Mex. Cienc. Agríc
ISSN (print): 2007-0934
Publisher: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias

Article/Issue Information
Date received: 01 February 2024
Date accepted: 01 June 2024
Publication date: 18 October 2024
Publication date: Aug-Sep 2024
Volume: 15
Issue: 6
Electronic Location Identifier: e3246
DOI: 10.29312/remexca.v15i6.3246

Categories

Subject: Articles

Keywords:

Keywords:

climate change signal

Lake Cuitzeo basin

productive capacities

Counts

Figures: 6

Tables: 3

Equations: 6

References: 26

Pages: 0