Resilience of the *milpa* (*ich kool*) to climate change

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ABSTRACT
Objective: To prove that the milpa agroecosystem is resilient to extreme weather events, as a result of indigenous agricultural practices and lore.
Design/Methodology/Approach: A literature review was carried out on Google Scholar to identify relevant publications. The SCOPUS database was used to estimate scientific publication metrics, addressing the resilience of the milpa, under the climate change context.
Results: The milpa has been in constant evolution and change, as a result of the practices that the milperos have been carrying out to reduce the risks posed by climate change and consequently to keep growing basic food for their families.
Study Limitations/Implications: Further research about the milpa practices should be carried out, in order to determine how they have managed to survive to the present day.
Conclusions: The milpa agroecosystem has evolved in order to achieve food security. People acknowledge its value and seek to reduce risks, guaranteeing food production.

Keywords: polycultures, agroecosystem, culture, agricultural practices, cosmovision.

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INTRODUCTION

Food production is threatened by radical changes in temperature and rain patterns, as a result of global climate change. This situation jeopardizes food safety, both at local and worldwide levels (Altieri, 2012). Global climate change is an unequivocal phenomenon that includes extreme weather events, which have an impact on humans, their properties, and their physical well-being, as well as on agricultural and forest production (Landa *et al.*, 2008). Resilience has been a frequent subject of study of different disciplines and different systems (Lorenz, 2013). It originated in the medical sciences (Pfeiffer, 1929); however, the foundation of its definition lays in ecology (Holling, 1996). Resilience can be understood as a resistance to endure impacts or alterations of a certain magnitude, that can destabilize the system. It is mostly considered as a positive feature of the systems (Béné *et al.*, 2014) and as one of their intrinsic properties (Folke, 2006). Resilience is usually mistaken for sustainability, because the link between them is strong (Brand, 2009). However, resilience plays a key role in the agroecosystems, because it allows

them to absorb disturbances and to keep functioning, as well as to renew and reorganize themselves (Balvanera *et al.*, 2017).

Recent researches have proven that, traditionally, many farmers have strived to adapt and prepare to face climate change within their agroecosystems. The actions carried out by farmers include: reduction of loses using drought-resistant local varieties, polyculture, agroforestry, and timely weeding (Altieri and Nicholls, 2009).

The *milpa* is one of these agroecosystems. *Milpas* date back to pre-Hispanic times and are known as *Ich kool* in the Mayan language. They are very important agroecosystems, because they provide staple foods to the Mesoamerican territories (Velasco-Murguía *et al.*, 2021). In the Yucatan peninsula, corn (*Zea mays* L.) —in association with lima bean (*Phaseolus lunatus* L.), bean (*Phaseolus vulgaris* L.), and squash (*Cucurbita pepo* L.), as well as other crops— is still grown, using the "brush, knock down, and burn" system (Cuanalo-de la Cerda, 1999). The *milpa* is the core of all the productive and reproductive strategies used for the exploitation and integral management of the jungle (Santos-Fita *et al.*, 2013).

Achieving resilience in the agricultural sector —particularly in traditional agroecosystems— must doubtlessly be the main objective of the Mexican agricultural sector, in face of the uncertainty caused by climate change and other associated phenomena. The hypothesis of this study was that the *milpa* is a traditional agroecosystem whose survival has depended on indigenous agricultural practices and lore, which have allowed it to adapt and endure the extreme weather events caused by climate change. Therefore, the objective of this study was to prove that the *milpa* agroecosystem is resilient to extreme weather events, as a result of the indigenous agricultural practices and lore.

MATERIALS AND METHODS

The SCOPUS database was used to identify publications about the resilience of the *milpa* in the face of climate change. The terms used in the search were: "*milpa*", "resilience and milpa", and "*milpa* and climate change." The information collected from SCOPUS was not limited to a specific period; however, it only included scientific publications written in Spanish and English. In addition, a literature review about resilience of the *milpa* in the face of climate change was carried out using Google Scholar. This literature review was used to prepare this study and led to an interesting discussion about this subject.

RESULT AND DISCUSSION

Using the abovementioned search words, the SCOPUS database provided the following results: 1,853 publications included the word "*milpa*", 19 publications included the words "resilience and *milpa*", and 80 publications included the words "*milpa* and climate change". In conclusion, the *milpa* in the face of climate change has been the subject of very few research works.

Resilience of the Ich kool to climate change

The Mayans from the Yucatan peninsula call the *milpero Ichkoolij maak* (or *milpa* man). The *milpero* is the person who observes, reflects, takes care of, improves, and sows the seeds during the appropriate seasons, in order to obtain a good harvest.

The *milpa* is a plot that is used for one to three years (maximum), to grow a wide variety of plants and vegetables. Specifically, the main crops of the *milpa* are corn, bean, and squash, always associated with other crops (Figure 1), which provide food for the animals and family members, as well as household tools.

Modern industrial agriculture is based on artificial monoculture areas, which are exploited in order to provide benefits to humans, while the *milpa* involves the management of the jungle, avoiding the intensive use of soils and enabling the regeneration of the area and the recovery of its fertility (Figure 2).

Figure 1. A milpero and the wide variety of crops sown in the milpa. A: bitter cassava (*Manihot esculenta* Crantz); B: water yam (*Dioscorea alata* L.); C: watermelon (*Citrullus lanatus* (Thumb.); and D: summer squash (*Cucurbita pepo* L.).

Figure 2. The plants that remain after the brush, knock down, and burn system is carried out. Afterwards, the sowing takes place in the milpas of the Yucatan peninsula.

Currently, the fallow or resting period have been reduced, as a result of ejido or land ownership issues. The *milpa* has its own resilience to climate change: *milperos* observe the plants in their *milpas* to determine the changes in their own areas. In addition, they possess considerable lore about the appropriate soil types for the *milpa* and they carry out the best practices to guarantee a good harvest, despite the adverse weather conditions.

As a result of the changes in the weather, *milperos* have adopted certain new practices; for example, they now delay the burning date, to match the sowing date with the start of the rainy season (Castillo López and Torres Carral, 2022). Rain is fundamental for *milperos*; however, they are aware that the rain patterns have become unstable. Consequently, they resown as many times as needed to guarantee a harvest. The burnings are usually perceived as a negative practice. Nevertheless, they are essential to the Yucatan peninsula, which lacks enough soil; consequently, the burnings provide the plants with the required nutrients. Estrada-Medina and Álvarez-Rivera (2021) pointed out that burnings release a nutrient flux to the atmosphere and the soil (the latter as a consequence of the settlement of ashes).

The Mayan *milperos* use a great number of varieties selected according to the climate and the scarce rainfall (Barrera *et al*., 1977). In fact, they still grow and select the seeds of their own communities (Boege, 2009), seeking to find the best phenotypic and genotypic characteristics. The *milpero* understands that crops have adapted and were produced under hard environmental pressures caused by climate change. Although they are temporal crops, they can grow in unfavorable soils.

Another important characteristic of the *milpa* is the diversity of crops grown in the same space. These crops are essential in the diet of Mayan families; nevertheless, the loss of one of these crops would not impact food security, given the diversity of products available. Méndez (2015) pointed out that, in order to obtain staggered harvests, the *milpero* grows two corn varieties during the same year: one long-term (4 months) variety, known in Mayan as *Xnuuk nal* and one short term (7-8 weeks) variety, known in Mayan as *xmejen nal*. Other species, such as pulses, help to fertilize the soil; these crops include bean, lima bean, and jícama (*Pachyrhizus erosus*). Squashes and *X-tóop*' (*Cucurbita argyrosperma* Sin. C. Mixta.) and sweet potato (*Ipomoea batatas* (L.) Poir.) prevent the wind and hydric erosion of the soil and their wide soil coverage helps to control weeds.

In addition, *milperos* have noticed that weeds can help to protect crops from sunlight; consequently, they allow weeds to develop next to the crops. However, they do not allow them to grow excessively. When weeds threaten the growth of the crops, *milperos* prune them, leaving the weeds only next to the crops or extended along the ground (Figure 3).

In addition, the *milpa* provides extra supplies for the families, including: firewood for the kitchens; wild animals hunted for family consumption; and the sale of the production surplus.

The *milpero* lore regarding the resilience to climate change

The *milpa* is directly linked to the cosmovision and practices carried out by *milperos* and their families. The *milperos* are constantly aware of the weather. An excellent example of this phenomenon is the weather forecasting practices known as cabañuelas or *Xook k'iin*,

Figure 3. Practices carried out by milperos. A: protecting corn or other crops with weeds. B: covering plants and soil with weeds that have been pruned or pulled out.

which take place at the beginning of every year. In addition, Méndez (2015) describe the *milpa* as a system that can completely adapt to the current climate conditions, as a result of the great environmental lore of Mayan farmers, which is crucial to the potential mitigation, adaptation, and reversion of climate change.

The dynamism of the *milpa* allows the *milperos* to maintain food production over the years; consequently, the milpa has managed to survive to the present day.

The small community *milpas* are the cornerstone of family diets, as a result of the wide diversity of products that can be harvested every year from a small plot. The cosmovision and the practices inherited from our ancestors still influence the new generations, allowing the culture and resilience of the *milpa* to successfully survive. In this regard, Núñez (2022) reaffirmed that sowing the *milpa* is a living memory because, through the circularity of its work, it reconsiders, strengthens, and reformulates the meaning of language itself, the division of work, the social organization, the belief systems, the narratives, and even the rituals.

In their cosmovision, the pre-Hispanic peoples were very close to nature (Balvanera *et al*., 2017). The current Mayan communities still understand that they are not the owners of the mountains and the jungle and, consequently, they are fully aware that they should not damage them; otherwise, the guardians of the forests or *K-Yuum K'aax* will punish their actions through the *milpa*. The respect and devotion that the Mayans have for this god has allowed dismantled areas to recover, because the jungle is understood as a living being and, therefore, what was taken should be returned to its rightful owner and allowed to rest for a while in order to recover its vitality.

Consequently, the interest for understanding how societies coevolve along with their environment and how the power relationships work in the environment-society interaction has arisen (Balvanera *et al*., 2017).

For thousands of years, the milpa has been a teaching/learning center of the Mayan language and, at the same time, it has been the source of the agricultural lore developed

by the ancestors (Castillo López and Torres Carral, 2022). Resilience is the result of the empirical lore of Mayan farmers that observe the results of their practice, striving to improve the resilience of the *milpa*, through the accumulation and sharing of learning.

Climate change has impacted agriculture as a whole and certain traditional agroecosystems may have a higher resilience than others, because they have responded to the changing weather conditions with strategies aimed to face droughts, floods, and hurricanes, with the same resilience shown by indigenous and famer populations (Altieri, 2013). Hofstede (2014) pointed out that the ancestral lore of indigenous communities can help to adapt and develop resilience to climate change, because these communities have an accumulated experience that can be transformed into lore and practices against climate change and variability. The products obtained from traditional agriculture are exclusively used for family consumption: most of the harvests meet food necessities (Salazar-Barrientos *et al*., 2016). Unlike conventional agriculture, the *milpa* has enabled the survival of thousands of families that depend on this type of production systems, because they include a wide variety of nutritious products, that guarantee food security without using external supplies. Therefore, the value of the *milpa* must be acknowledged, regardless of the adverse conditions of the different types of traditional agriculture. In addition, the milpa is a very important part of the life of indigenous families.

Finally, the *milpa* should be reconceptualized and seen as an indigenous and famer strategy, aimed to achieve food sovereignty, environmental communion, and social and identity reproduction, as well as to face extreme weather events. In other words, the *milpa* requires an interdisciplinary, comprehensive, and biocultural approach.

CONCLUSIONS

The *milpas* of the Yucatan peninsula have managed to survive to the present day, because the Mayan communities have an excellent handling of natural resources and have accumulated vast lore about this traditional agroecosystem. Therefore, the resilience of the *milpa* is always linked to the resilience and evolution of the *milpero's* ideas, enabling a natural equilibrium. The *milpa* and the *milpero* would seem to be two different things; however, the *milpa* would not exist without the *milpero* and vice-versa. The *milpa* and the *milpero* are one and the same and they change together to achieve resilience in the face of climate change and to prevent production losses, implementing practices, using handling methods, and adapting different varieties of plants to their own regions, in order to give priority to food production and the preservation of seeds for the following year.

REFERENCES

Altieri, M. A. 2013. Construyendo resiliencia socio-ecológica en agroecosistemas: algunas consideraciones conceptuales y metodológicas. *Agroecología y resiliencia socioecológica: adaptándose al cambio climático*, 94-104.

Altieri, M. A., y Nicholls, C. I. 2009. Cambio climático y agricultura campesina: impactos y respuestas adaptativas. *LEISA revista de agroecología*, 24, 5-8.

Altieri, M. F., Fernando; Henao, Alejandro; Nicholls, Clara; León, Tomas; Vázquez, Luis; Zuluaga, Gloria 2012. Hacia una metodología para la identificación, diagnóstico y sistematización de sistemas agrícolas resilientes a eventos climáticos extremos. Documento preliminar de trabajo. *Red Iberoamericana de Agroecología Para el Desarrollo de Sistemas Agrícolas Resilientes al Cambio Climático*. 21p, 21.

Balvanera, P., Astier, M., Gurri, F. D., Yzermeño-Hernández, I. 2017. Resiliencia, vulnerabilidad y sustentabilidad de sistemas socioecológicos en México. *Revista Mexicana de Biodiversidad*, 88, 141-149.

Barrera, A., Gómez Pompa, A., y Vázquez Yanes, C. 1977. El manejo de las selvas por los mayas; sus implicaciones silvícolas y agrícolas. *Biótica*, 2, 47-61.

Béné, C., Newsham, A., Davies, M., Ulrichs, M., y Godfrey-Wood, R. 2014. Resilience, poverty and development. *Journal of international development*, 26, 598-623.

Boege, E. 2009. Centros de origen, pueblos indígenas y diversificación del maíz. *Ciencias*, 92.

Brand, F. 2009. Critical natural capital revisited: Ecological resilience and sustainable development. *Ecological economics*, 68, 605-612.

Castillo López, S., y Torres Carral, G. A. 2022. Milpa y saberes mayas en San Sebastián Yaxché, Peto, Yucatán. *Estudios de cultura maya*, 59, 171-189.

Cuanalo-De La Cerda, H. 1999. Las perspectivas de las unidades de produccion campesinas tradicionales en la peninsula de Yucatan: Un estudio de caso. *Agrociencia*, 33, 367-373.

Estrada-Medina, H., y Álvarez-Rivera, Ó. 2021. La milpa de roza, tumba y quema (RTQ) en el karst de Yucatán, desde el enfoque de seguridad edáfica. *Asociación Mexicana de Estudios sobre el Karst*, 109.

Folke, C. 2006. Resilience: The emergence of a perspective for social–ecological systems analyses. *Global environmental change*, 16, 253-267.

Hofstede, R. 2014. Adaptación al cambio climático basada en los conocimientos tradicionales. *Sabiduría*, 59.

Holling, C. S. 1996. Engineering resilience versus ecological resilience. *Engineering within ecological constraints*, 31, 32.

Landa, R., Magaña, V., y Neri, C. 2008. Agua y clima: elementos para la adaptación al cambio climático, Semarnat.

Lorenz, D. F. 2013. The diversity of resilience: contributions from a social science perspective. *Natural hazards*, 67, 7-24.

Méndez, R. M. 2015. La milpa maya yucateca en el siglo XVI: evidencias etnohistóricas y conjeturas. *Etnobiología*, 13, 1-25.

Núñez, M. N. 2022. La milpa y el maíz en la narrativa oral maya de Quintana Roo. 67.

Pfeiffer, K. 1929. Untersuchungen über die Resilenz der durch die Prothesen beanspruchten Gewebe und ihre Bedeutung für die Okklusion der Prothesen. Verlag nicht ermittelbar.

Salazar-Barrientos, L. D. L., Magaña-Magaña, M. Á., Aguilar-Jiménez, A. N., y Ricalde-Pérez, M. F. J. E. Y. R. A. 2016. Factores socioeconómicos asociados al aprovechamiento de la agrobiodiversidad de la milpa en Yucatán. 3, 391-400.

Santos-Fita, D., Naranjo Piñera, E. J., Baltazar, E. B., Estrada Lugo, E. I. J., Mariaca Méndez, R., y Macario Mendoza, P. A. 2013. La milpa comedero-trampa como una estrategia de cacería tradicional maya. *Estudios de Cultura Maya*, 42, 87-118.

Velasco-Murguía, A., Del Castillo, R. F., Rös, M., y Rivera-García, R. 2021. Successional pathways of post-milpa fallows in Oaxaca, Mexico. *Forest Ecology and Management*, 500.