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Vernacular Architecture in México: The Blue Corn Research Center in Michoacán

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Abstract

In Mexico, a large part of the population is still engaged in primary activities such as agriculture. That is why government and academic institutions have focused on encouraging the improvement and optimization of the farming of basic grains through research and technology. This work aimed to propose a building based on the Mexican vernacular architecture of Michoacán using local materials. The architectural project used the scientific method of analyzing socio-economic indicators, territory, and cultural conditions. As a result, we got a building that promotes the increase in the production of blue corn and solves part of the student lag in the rural area of Michoacán. The building contemplates open access for people of the surrounding towns through community use. Its design applies passive thermal control strategies. The project is a connection between local agricultural customs and the field of research.

Keywords: contemporary Mexican architecture, vernacular architecture, research center, blue corn institute, educational architecture

1. Introduction

Mexico is well known for its traditional food and culture; in the country, when we talk about corn, people connect the word with culture and gastronomic heritage. Corn is a cereal that has existed in the American continent since pre-Columbian times. Its consumption extends from the upper part of Mesoamerica to the Andean territory. For the Latin American population, corn is part of the region's identity. According to the research carried out by CIMMYT (2019) and published by the Government of Mexico in 2019, there are 220 types of maize in Latin America; 64 types are present in Mexico, and 59 are considered natives.

Nevertheless, what does corn have to do with vernacular architecture? Or what is the impact that corn cultivation has on the territory and landscape design? For its localization, corn is produced in rural areas and consumed in urban and rural areas of Mexico. For its usefulness, it is a grain with medicinal and nutritional value due to its versatility in livestock consumption and its use as a raw material for preparing processed foods. Its planting processing and application have generated a series on infrastructure in rural areas and industrial zones. In addition, the national agricultural policy has prioritized the harvest of local products for export but, above all, for own consumption. This policy applies to basic grains, the recovery of endangered species, and the care and preservation of protected areas. Corn is one of the products that are part of this agricultural incentive program and was chosen by the government because it is a grain that is part of the daily diet of the population throughout Mexico. Vernacular architecture is related to this research project because this architecture is in a rural area, and the characteristics of the complex must be a solution that includes local materials, adaptation to the environment, and integration into the community.

This work seeks to provide a spatial solution for a research center that will be in charge of studying, cultivating, and processing blue corn typical of the central zone of the Mexican Territory. The proposal aims to work as a training place for young settlers. In recent years, dropout rates have directly impacted the State of Michoacán. The second goal of the proposal is to design an educational building to teach, train and educate the local population in a vocational school that will become part of the national secondary educational system. This part of the building will reinforce educational services in the uncovered area of Michoacán.

Another aim is to propose a complex that takes the vernacular characteristics of Michoacán, uses local materials, and promotes the connection with the community through open spaces and services for the general population. The idea is to encourage and actively connect with the community, seeking a space to integrate services that can support the economic development of the locals and the rapprochement with both cultural and entrepreneurial activities. During the research development, good practices of Michoacán vernacular architecture were analyzed, retaking, and applied to the architectural proposal based on local materials, passive environmental control strategies, colors, and use of local vegetation, among others.

The study was qualitative work; the team followed the deductive process where the data review started from the current situation in Mexico, going through the site analysis and then reviewing the local characteristics of the natural and constructed environment to develop a suitable architectural proposal for the implementation of an educational building and research center dedicated to the study and production of blue corn which is predominant in the central Mexican area. (Figure 1)

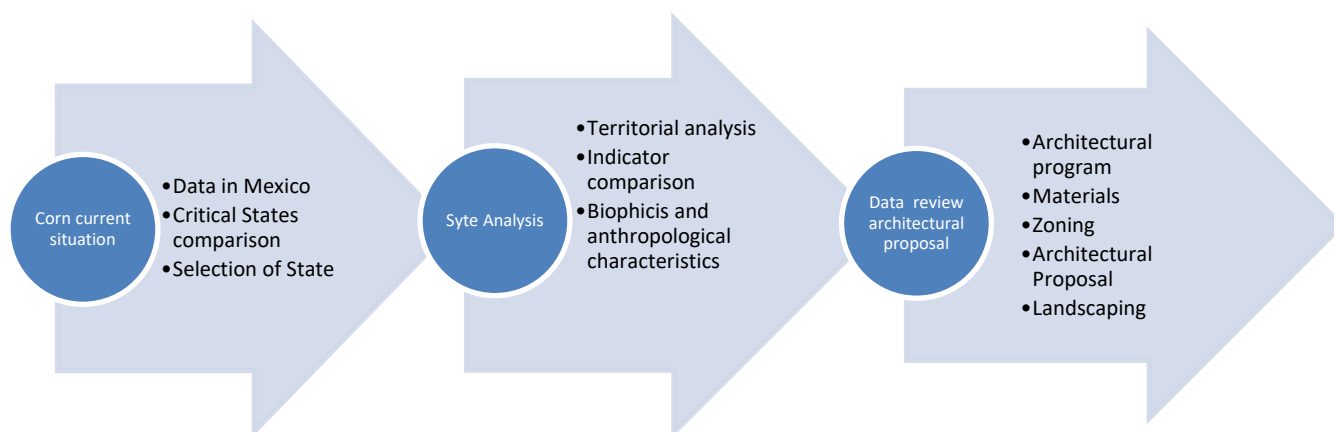


Figure 1. Process and work research phases (Godínez, 2023).

2. Overview

Corn is an essential food for the Mexican nation. However, it not only has a gastronomic value but also has a solid socio-cultural content. The consumption of this cereal has evolved, giving rise to the use of different types. (Massieu et al, 2002; Amen, 2021; Aziz Amen, 2022; Amen et al., 2023; Amen & Nia, 2020) Mexico is the eighth-largest producer of corn in the world. In 2017 it exported grain to 17 countries. The nation is in the tenth position with the highest corn exportation. (Alcantar, 2019) According to Elena Álvarez- Buylla, general director of the National Council of Science and Technology of Mexico (CONACYT), corn symbolizes resistance and autonomy for the country. Corn conservation and sustainable use are essential for the sovereignty and cultural diversity of the nation.

Mexico consumes more corn than it produces, depending on the corn imported from the USA (CIMMYT, 2019). Mexico is the country studied due to its great potential in corn production, with approximately 7.5 million hectares of area intended for cultivation, where almost two million people are involved (Arteaga, 2019; Khafizova, 2018). However, the technological deficiency of the field causes that of the 36 tons necessary to supply the country, which only produces 24 million tons; this data explains the need to grow corn. To reduce dependence on the exported product.

The government proposed a series of strategies to increase production and promote corn cultivation, especially blue corn. The federal government decided because, in the last 20 years, with the implementation of genetic manipulation of some grains, the production of blue corn has been declining due to factors such as urbanization, climate change, and the introduction of genetically modified corn. The Mexican government has worked to revive the production of the native species of corn, promoting sustainable agriculture practices and preserving traditional seed varieties by creating local cooperatives.

The blue corn research center project began to support national agricultural policy. The main guidelines to start the study were creating an architectural proposal integrating social, economic, and environmental factors. The investigation began by analyzing the use of the best practices of vernacular architecture and connected with a research center dedicated to the blue corn study. The goal was to propose an architectural solution that allows for optimizing the biophysics and intangibles characteristics of the site.

The research begins with a lecture on the Mexican territory. The team generated a map with two different layers, the first allowed us to explore the corn-producing states, and the second showed the types of corn produced. After the comparison, we released that white corn was the most produced in Mexico; however, there were zones with high potential to improve grain cultivation and distribution. The focus was on four more important producers: Sinaloa, Jalisco, Edomex, and Michoacán.

Michoacán was considered a state of potential intervention for occupying the number four position at a national level as a producer of corn. With one million nine hundred eleven thousand tons of corn produced yearly, Michoacán has registered a 42% increase in its production level and reduced production costs by 30% thanks to the flexibility of adopting new technologies in this agricultural production process. (INEGI, 2020) Michoacán is one of the states in Mexico where blue corn is traditionally grown and used in local cuisine. The blue corn from Michoacán is known for its unique flavor and nutritional benefits. Locals make various dishes such as tortillas, tamales, and atole. In Michoacán, several indigenous communities have cultivated blue corn for centuries, using traditional and sustainable agricultural practices.

Another determining factor for the definition of the research and the guidelines of the project were the data that revealed the lack of educational coverage in the different academic levels of Michoacán. The state has a significantly greater need for educational resources than other states. On the other hand, being the state with the most remarkable diversity of corn and considered one of the states that produce the most maize, it was considered an excellent candidate to receive educational and technological support in the study and cultivation of the grain. In Michoacán, the land has ideal conditions for growing corn without the need to use excess fertilizers or pesticides, so these conditions make the state a site of great potential for the type of architectural proposal to be studied.

2.1. Michoacán, territory, and relationship with blue corn

As stated by the anthropologist Miguel de León-Portilla, in Michoacán, corn is more than just a Mexican staple food. Since it is the basis of a worldview intertwined with the life and history of native communities, corn is the material and spiritual sustenance of a town that knows how to preserve its identity and its harmonious relationship with nature through the cultivation of corn. Moreover, currently, it is known that the state has approximately 135 thousand families dedicated to cultivating this cereal. (CIMMYT, 2019)

The first step was mapping the corn production in the Michoacán State (Figure 2). The reflection was about Pátzcuaro Lake's importance in the cultivation's development. The lecture on the territory gave some possible locations to develop the architectural proposal. The area of Lake of Pátzcuaro in Michoacán has a close relationship with corn since, in this region, it is considered the heart of the cultivation and tradition of corn in the country. Corn has been cultivated in this region for thousands of years and is regarded as a sacred food for the native people who reside on the shores of the lake. Different varieties of corn are grown, some of which are unique to the region and have been preserved over generations. These varieties have significant cultural and symbolic value to local communities.

The objective of the proposal is to create a bridge between local farmers, high school students, and the native villages; currently, around 2,000 families led by women in the Pátzcuaro Lake area are dedicated to the cultivation of blue corn; in this entire area, 22% of the territory is urban. 23.17% of the population of the rural area speaks the native languages of Mexico (INEGI, 2020). The residents of the zone do not have the necessary technological, theoretical, or economic resources to develop and improve their cultivation processes to enhance the biological benefits of blue corn. In addition, youth inhabitants in the area tend to drop out of school to return to work in the fields, either by family commitment or economic necessity.

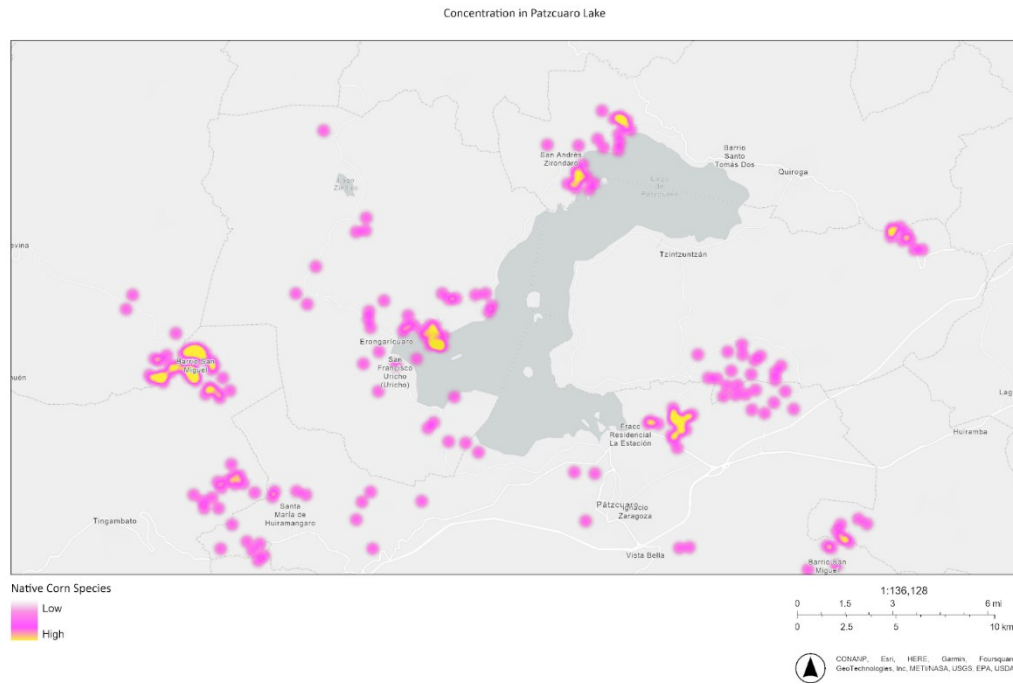


Figure 2. Corn cultivation concentration in Pátzcuaro Lake (Zapata, 2023).

The second step was to identify the different species of corn in the territory. The blue dots show the presence of blue corn in Michoacán. The corn cultivation process in the Lake Pátzcuaro area is traditional and deeply rooted in the native world. The communities practice sustainable agriculture, using ancestral techniques such as the milpa, which consists of growing corn, beans, and pumpkins on the same piece of land, taking advantage of the plant synergies and promoting biodiversity. (INEGI, 2020). Luis Gutiérrez Reyes, General Coordinator of the Mexican Society of Maize Science. "Michoacán has one of the greatest riches in varieties of corn, which is an invaluable genetic patrimony for food security and the conservation of agricultural diversity."

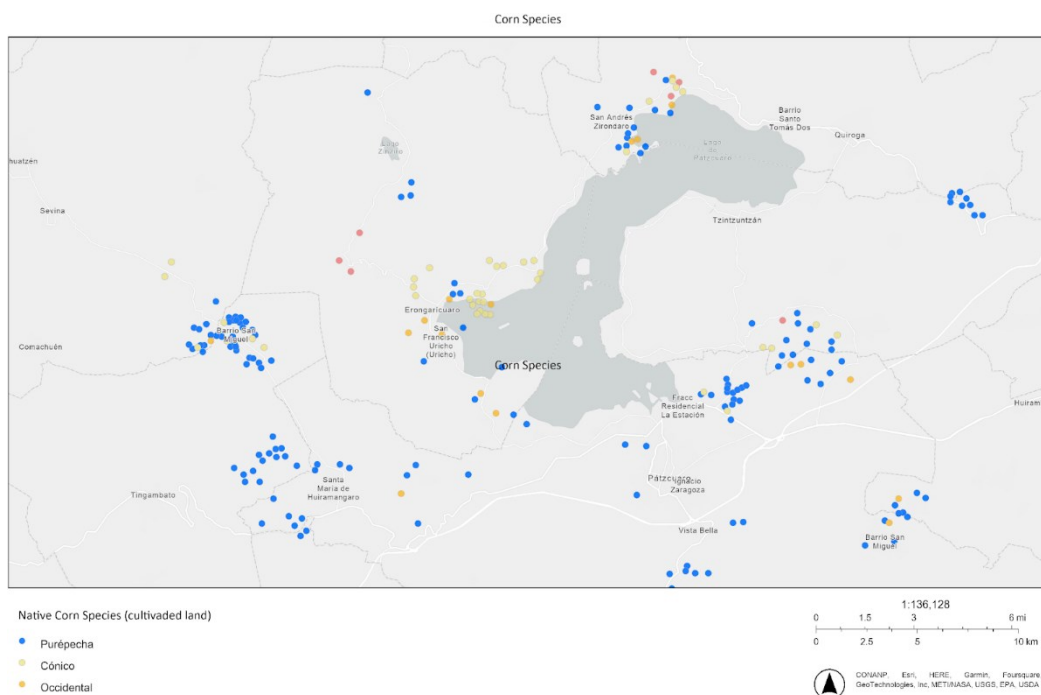


Figure 3. Types of corn cultivation in Pátzcuaro Lake (Zapata, 2023).

The overlapping of information layers, added to the statistical data analyzed, indicated that the two most suitable places for the location of the research center were Pátzcuaro and Erongaricuaró.

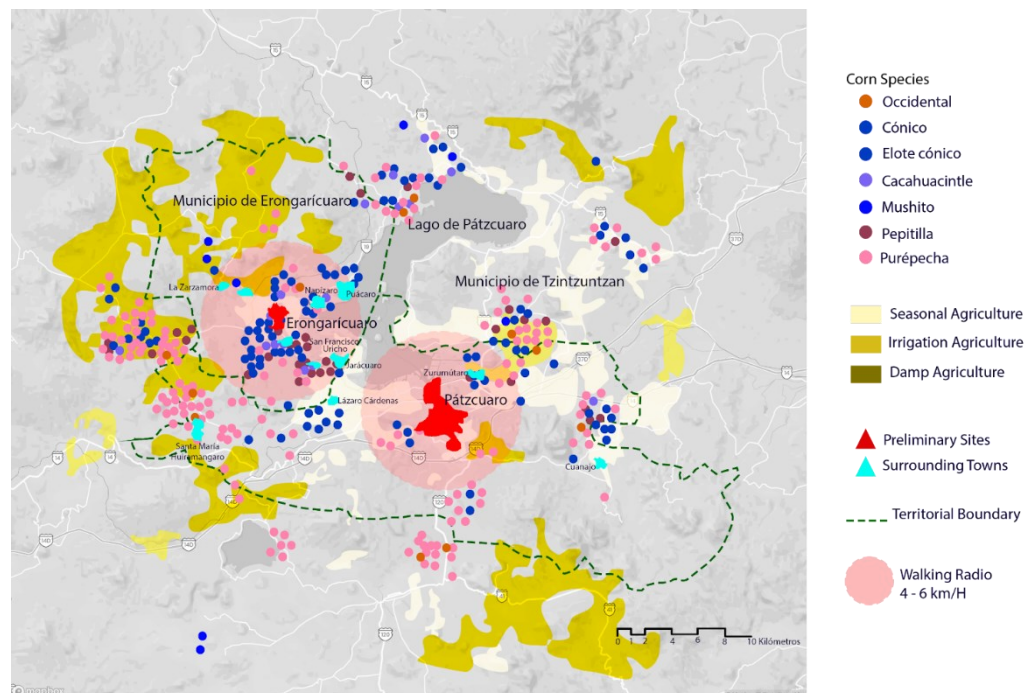


Figure 4. Types of corn cultivation in Pátzcuaro Lake (Godínez, Zapata, 2023).

Michoacán has a close relationship with corn. This connection is based on historical, cultural, and economic aspects. The state is recognized as one of the leading centers of origin and diversity of corn. (Artega, 2019)

2.2 Vernacular Architecture in Michoacán

Azevedo-Salomao describes vernacular architecture as a collective creation that, after a process, gives a result connected with a geographical and cultural space (Azevedo-Salomao, 2016, p.313)

Michoacán is also known for its rich cultural heritage and diverse architectural styles. Vernacular architecture refers to the traditional buildings and construction methods that have developed over time in a particular region, reflecting the local climate, materials, and cultural practices. The indigenous Purépecha culture influences the architectural styles existent in Michoacán. According to Francisco Javier López González, in Michoacán in the 16th century, houses with patios prevailed. There are in the towns of the lake area, four-sided roofs were popular, and the image of the edifications remembered the Asturian ones. (López, 1993, p. 92)

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López González also mentions that close to the Pátzcuaro Lake, there are three types of houses, the first one has a central patio with 1:1 proportion, the second type of house is more rectangular, and at the end has a space for the family pets, chickens, donkeys, and a small vegetal garden. The third typology is about a 1:3 proportion. (López, 1993, p.118) The exciting thing is that all the houses have corridors in the frontal façade, one or two patios, one of them used for domestic animals, and a space to store grains.

One notable example of vernacular architecture in Michoacán is the traditional Purépecha houses called "*trojes*." *Trojes* are circular or rectangular structures built with adobe or stone walls and thatched roofs made from local materials such as reeds or palm leaves. These houses are designed to withstand the hot climate and heavy rains. The *trojes* are in the rural areas where corn is cultivated.

Trojes are used in the Pátzcuaro Lake area because they are handy for the climate of the Sierra. The troje consists of three principal spaces: The porch at the front, which allows social and familiar activities; the indoor space used for praying and sleeping (some of them have an altar and storage) and the *tapanco*, which is a kind of attic, this place is used to store food and seeds. (Azevedo-Salomano, 2016, p.320). The main characteristic of the troje is the space's flexibility, which allows much variety when furnishing internally. They are based on stone. They have wooden columns on the front porch; generally, the entrance is in the middle.

The purépecha culture inhabitation is primarily outdoors. Indoors are essential, but daily and social life practices are developed in open spaces. The houses are planned to be in harmony with nature. Most of the social activities are set in the solar. The patio is an oversized area that commonly has cultivation. The deck is the heart of the house; everything is connected to it, allowing adequate ventilation. The materials used are organic, such as adobe (sun-dried brick) and wood. The community is actively involved in the edification process of trojes.

Another architectural feature in Michoacán is vibrant colors and decorative elements. The façade of many buildings are decorated with intricate murals, frescoes, or painted patterns, showcasing the regional artistic heritage. These elements can be seen in the colonial architecture of cities like Pátzcuaro and Morelia, where colorful buildings with ornate facades line the streets.

3. A contemporary concept with a traditional bases

The central concept for the project was to resume formal and functional aspects of the vernacular architecture of Michoacán. Among the most outstanding elements are the presence of outdoor spaces, an oversized patio surrounding the different rooms, the use of the harvesting place to support the economy, and integration with nature. *Trojes* was a big inspiration for developing the volumetric solution for the main building. The team decided not to use the typical squared solution or rectangular typology of projects but the rounded one because it would be more integrated with the site and allow a morphologically organic solution. The patio was the protagonist, but the buildings around will resemble the leaves of *totomochtli*. Totomochtli is dry, rough, and brittle leaves that wrap around the cob before harvest.

As mentioned before, the patio of trojes was the main inspiration for developing the morphological configuration of the architectural proposal. However, another vital part of the concept influenced the character of the typology of the buildings: the corn by itself. Furthermore, the corn was present in the native communities of Mesoamerica. It is also essential to mention that the ancestral book of the Mayas "Popol Vuh" says three crucial concepts in the indigenous worldview: renewal, creation, and the path of the heart. The heart is the central patio, the path, the corridors, the renewal of the educational area, and the creation was related to the research center.

The preliminary architectural program indicated four main zones that would become the four main volumes of the architectural complex. The evolution of the compositional diagram is graphically explained in Figure 6.

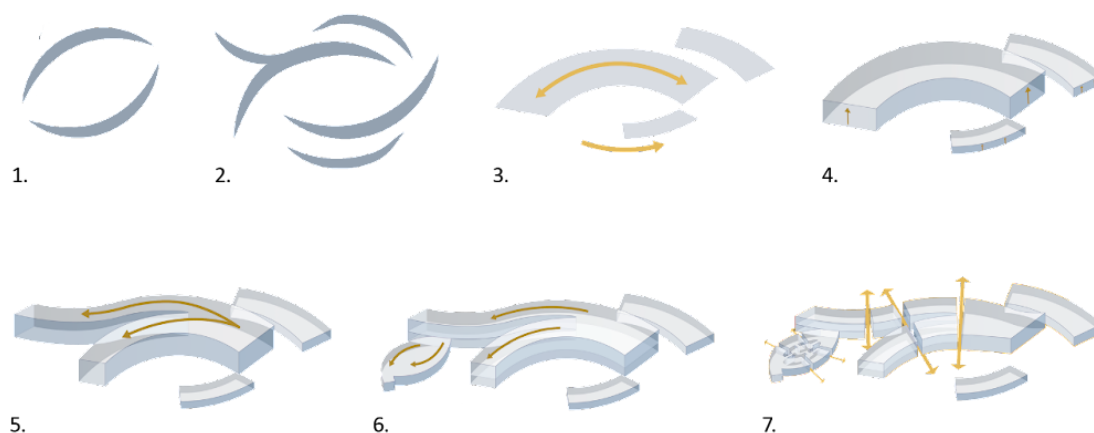


Figure 6. Types of corn cultivation in Pátzcuaro Lake (Godínez, Zapata, 2023).

The educational building takes on importance within the architectural complex since students have a leading role within the facilities; it is sought that the proposal can enhance their activities, help them in their learning, and that through the shape of the building, users can encourage their interest in research applied to agricultural activities. The main building has the highest hierarchy; the classrooms are located there.

4. Results

From the initial phase of the research, blue corn was identified as a predominant species within the central Mexican territory. The vital presence of blue corn in Michoacán was confirmed when the team developed the corn concentration mapping. (see Figure 3) Make a lecture on the territory and compare the production data of the different types of corn in Michoacán, revealing that blue corn is the agricultural product that most local families grow and sell in Michoacán. It represents one of the main economic activities for local families. That is why within the architectural program, priority was given to a research center for the study, development, and application of new technology and techniques for the cultivation of blue corn, connecting it to the vocational secondary to train young people in the cultivation, harvesting, and processing of the grain

A characteristic of the project is that the main building surrounds the central patio, where civic and academic activities occur in the open space. The round *trojes* houses inspired this open space in the Pátzcuaro Lake from Michoacán. The main characteristic of *trojes* is that the interior patio is present, and all the activities go around it. The morphological character of the proposal is organic, emulating the sinuous forms of nature. The totomothchtl inspired the branched structure of the buildings. The landscape design is developed with elliptical shapes; those forms create circulations that lead to the different points of the project, thus connecting the corridors where the complementary facilities, maintenance areas, green areas, and crops areas are located. The planting and the green places are essential to the project, making up 42% of the site.

The exterior columns found in the aisles are an abstraction of the shape of the leaves that cover the corn in its state before harvesting. The research center will have eight laboratories that will be used to study and develop blue corn varieties and promote and disseminate cultivation methods. The training will also be open to the inhabitants of the neighboring municipalities. As one of the main objectives was the link with the community, the architectural program included spaces and open areas for the residents of neighboring towns and an auditorium with a capacity for 380 users. Figure 7 shows the floor plan and wind circulation.

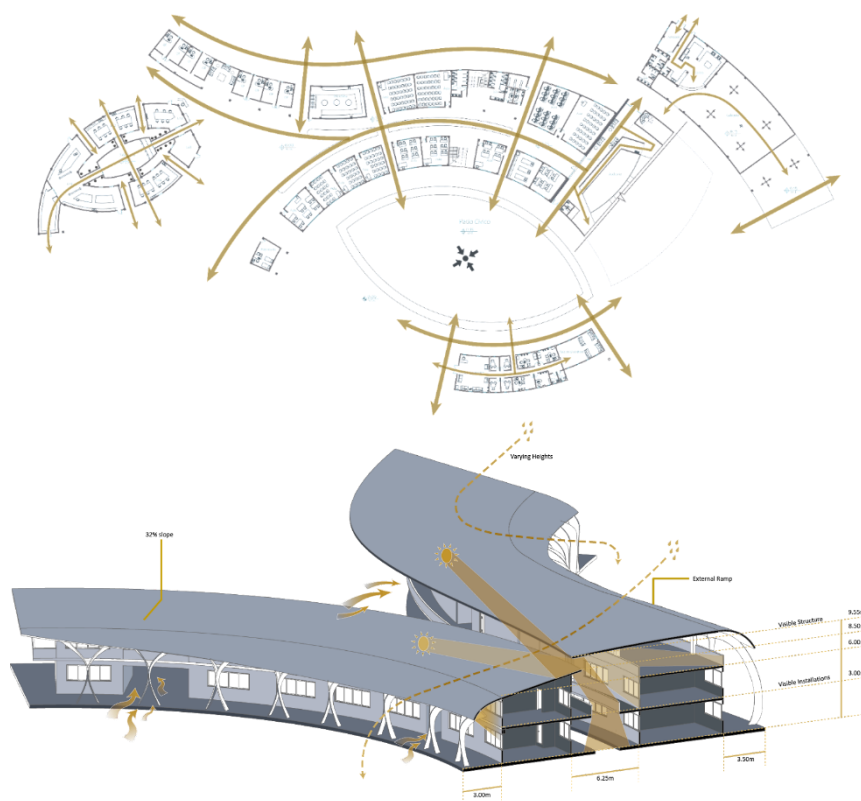


Figure 7. Circulation Diagram and scheme of sunlight and wind circulation. (Godínez, Zapata, Alvarez 2023).

The architectural program was defined according to the Mexican normative to build schools and educative centers.

Table 1. Architectural Program.

Space/room	Amount	Capability	Area (m ²)	Description
BUILDING A				
Classrooms	18	26	45m ²	1.5m ² per student for regular classrooms.
Auditorium	1	120	108m ²	
Workshops	4	15	40m ²	Gardening & Farming, Music, Woods, Arts
Storage	1	1	8m ²	Space allocated to store high school material for classes
Computer Lab	1	20	50m ²	Area for computers to facilitate access to technology.
Cleaning Room	1	1	2m ²	Area for storage of cleaning tools and cleaning personnel's belongings.
Bathrooms	2	14	18m ²	Exclusive space for student's needs
Sanitary Service (professors)	2	1	3.5m ²	Exclusive space for professor's needs
Recreational Area	1	35	80m ²	A semi-open flexible area equipped with non-fixed furniture allows the students to have an environment to do their homework or rest.
Civic Courtyard	1	360	440m ²	Open and roofed space for student recreation or school activities.
Science Lab	1	26	55m ²	Space for experimentation, designated for student use in their classes.
Multipurpose	2	26	60m ²	Flexible classrooms for school activities designed by teachers.
Place/room	Amount	Capability	Area (m ²)	Description
BUILDING B				
Break Room	1	18	36m ²	Rest area for researchers to provide them with a comfortable and optimal space for their work.
Sanitary Service	2	1	4m ²	Exclusive space for researchers' needs
Cold Chamber	1	3	15m ²	Considering a height of 2.4 meters, 36m ³ .
Laboratories	4	8	25m ²	Area for preserving samples and laboratory. Reagents to take care of the biological material.
Offices	3	10	25m ²	Considering 2.5m ² per person
Clean/White Room	1	2	10m ²	The area is assigned to cleaning and sterilizing equipment and personnel entering or leaving the laboratory.
Cafeteria	1	10	20m ²	Space for food consumption or rest for research personnel
Cleaning Room	1	1	2m ²	Area for storage of cleaning tools and cleaning personnel's belongings.
BUILDING B1				
Machine Room	1	1	4m ²	
Cistern	1	-	4.6m ²	
Security Booth	1	2	6m ²	
Counseling	1	2	4m ²	
Maintenance	1	5	2m ²	
Sports Area	1	-	420m ²	
Dress Room	2	16	45m ²	Superimposition of (concrete) bleachers on them
Bleachers	3	160	165m ²	
Parking Lot	1	30	300m ²	2m x 4m per space is considered in addition to the necessary circulation.
Place/room	Amount	Capability	Area (m ²)	Description
BUILDING C				
Cafeteria	1	380	570m ²	650m ² considering an esplanade with outdoor seating and tables. (Includes indoor tables, kitchen, outdoor tables, and sanitary service.
BUILDING D				
Nursing	1	10	27m ²	A space designed to safeguard the health of users. Whether they are part of the faculty, students, or researchers. The purpose of this is to provide immediate attention to urgent health cases. (Includes sanitary service, observation room, and medical office.
BUILDING E				
Administration	1	55		Administrative and managerial. Building of the study center.
Waiting Room		12	9.5m ²	This space is for waiting before meeting with management or teachers. This space fulfills the need for comfort and rest during the waiting time.
Secretary	1	1	3m ²	
Principal's Office	1	4	8m ²	Area for the bachelor's managers
Meeting Room	4	3	13m ²	Designated areas for groups of teachers
Professors Room	1	30	50m ²	
Sanitary Service	2	1	4m ²	Exclusive space for the needs of the administrative structure.
Social Worker/Psychologist	1	4	7.5m ²	Space designated for students' attention to promote their well-being and integral health.
		TOTAL=	1842 m²	

The priority of the Research Center is support to the study, cultivation, and improvement of conditions of properties of the blue corn grain. Focus on providing the native community with technological, academic, and economic

resources to develop and, in the future, commercialize the product of the fieldwork as an investment to preserve the cultural heritage of Erongarícuaro. The building comprises four laboratories with a capacity of approximately 4 to 10 occupants each, with the necessary equipment to encourage biotechnological research.

5. Conclusions

Blue corn is an essential part of the cultural and culinary heritage of Michoacán, and it continues to be valued for its nutritional and cultural significance. A corn research center in Erongarícuaro Michoacán would be relevant to the community due to its cultural, historical, and economic importance. Likewise, it would bring benefits such as boosting the local economy, promoting culture and identity, and developing sustainable agricultural practices.

In conclusion, a building where horizontality predominates was proposed. This configuration, combined with the rhythm in the change of heights, prioritizes cross ventilation within the enclosure and allows the facilities to be surrounded by green spaces. The first objective, which consisted of using local materials to emulate the vernacular architecture of Michoacán, was reached. This reinterpretation of architectural heritage corresponds to a current volumetric proposal supported by parametric design.

The priority of the Research Center is support to the study, cultivation, and improvement of conditions of properties of the blue corn grain. Focus on providing the native community with technological, academic, and economic resources to develop and, in the future, commercialize the product of the fieldwork as an investment to preserve the cultural heritage of Erongarícuaro. The building comprises four laboratories with a capacity of approximately 4 to 10 occupants each, with the necessary equipment to encourage biotechnological research.

The second objective consisted of including within the project space classrooms and infrastructure for vocational education, offering the inhabitants another option for training, modernization, and commercialization of blue corn, thus helping to reduce school dropouts currently suffered in Michoacán.

As previously mentioned, architecture responds to human needs and contextual conditions. The natural requirements of the environment cannot be omitted. It is crucial to consider the materiality of each zone, the microclimates, the local species in the site, and above all, the original cultures of our countries.

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Conflict of Interests

The authors declare no conflict of interest.

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