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México, Factor 3: Water Scarcity

Rainwater harvest and storage in the municipality Chemax municipality, for human consumption and their use in family orchards, located in a zone formerly known as “Puuc”; in order to improve it’s inhabitants food security and to preserve Mayan traditions

Historically, water has been scarce resource in the state of Yucatán, which is located in the southeast of the Mexican Republic.

This water shortage has existed since the very firsts settlements of the Mayan culture during the preclassic period, especially in the area formerly called “Puuc”, which has no water sources, moreover, since they have been going through a dry season that lasts approximately 6 months, the ancient Mayas used to recollect and store rainwater in massive tanks known as “chultunes”, derived from the Mayan words tsul and tun, which mean "dig" and “stone” respectively. **(Dahlin, B., & Litzinger, W., 1986)** According to the scientists Bill Ringle and Andrew Willis, each chultun had an approximate capacity of 10,000 gallons, equivalent to 37,854 liters. **(Herrero, H., 2012)**

According to the Census of Population and Housing 2010, there are 537,516 Mayan speakers just in the state of Yucatán. This numbers becomes smaller, as shown in the XII General Census of Population and Housing 2000, where 549,532 speakers were registered in the state. **(INEGI, 2012)** And so, as this language has been lost, we have also been losing certain Mayan customs and traditions.

Chemax municipality, whose meaning in Maya is “tree of the monkey”, is one of the municipalities belonging to the original Puuc region. It has 33,490 inhabitants, being the ninth largest mayan population. According to the National Council of Evaluation Policy of Social Development (CONEVAL) this is the third poorest municipality in the state, with 89% of residents living under the welfare line, which means that 29,806 people do not have a good quality of life. **(CONEVAL, 2011)**

A typical family is commonly formed between 4 and 5 members, from which, it is highly probable that none of them has completed elementary school, which would allow them to get a job in order to contribute with money to the home or help with the housework. Because it’s type of land is cambisol, which makes it extremely fertile, families grow mainly maize and beans, and in a minor proportion they grow hot pepper, tomato, jicama, among others. **(INEGI, 2017)** Houses are simple, with one bedroom on average, electrical service but, almost none of them has running water in their homes, most of them obtain it from one of the thirty one wells located in the municipality.

As stated in the Political Constitution of the Mexican Republic, article 4, “Everyone has the right to the access, disposition and sanitation of water for personal and domestic consumption, in a sufficient, safe, acceptable and affordable way”. In spite of being a right stated by the Constitution, so many communities are far from fully enjoying this basic need. **(Secretaría de Gobernación, 2014)**

As a solution to the water scarcity in this municipality and also to bring back a bit of traditions from their ancestors, I thought about regaining this long held Mayan practice of rainwater harvesting. This technique is cheap, feasible and also it can be adapted to the environmental and social needs of any community. The region has a high average precipitation range between May and October, which are the rainy months, since they have a warm subhumid weather with summer rains, reaching between 1200 and 1500 mm of precipitation, which means that for every square meter of land they can get 1500 liters per day. **(Dirección General Adjunta de Planeación Microrregional, 2005)**

For this community, the most efficient form of water harvesting is through a catchment box, also known in Spanish as aljibe, which is the successor of the chultun and, is defined as: "A large deposit, usually underground, to collect and store water, especially rainfall". **(RAE, 2001)**

The Conservation and sustainable Use of Soil and Water Component (COUSSA) is a program of national level implemented by the Ministry of Agriculture, Livestock, Rural Development, Fishing and Food (SAGARPA), which aims to contribute to the conservation, use and sustainable management of soil, water and vegetation used in agricultural production through the funding of services that enable people from rural localities to make works that allow them to take advantage responsibly of these natural resources. Among works this program supports, there is the construction of catchment boxes and according to the requirements and needs of the township of Chemax, this locality is a great candidate to be covered by the program. **(COUSSA, 2015)** The program absorbs around 90% of the works cost and the rest is paid by the municipality's inhabitants, either by the work made by its members or the payment of some materials used in the construction of the catchment box.

According to the Fact Sheet of Works and Practices COUSSA, the catchment box is a closed and waterproof structure, built on concrete, masonry or brick with different shapes and sizes depending on the conditions of the ground in which the catchment box will be built. A wing wall should be built, so that superficial filtrations are forced to enter into the humid chamber.

To install the catchment box, you need to dig until you find the true water outlets, ensuring that the entry of the box is in the lowest part of the land. It is recommended to build interceptor ditches to avoid the runoff. The boxes need to have a easy movable lid to make its cleaning easier. **(SAGARPA, 2015)** They do not require ventilation tubes, nevertheless they do require one for the leave of absence of stored volume and another for extraction and conduction of the water to the regularization or storage tank. In the dry box will be installed a control valve in order to regulate the water inside the catchment box.

As water is such a basic need, it has a lot of purposes such as personal cleaning, agricultural and industrial production, creating renewable energy, etc. Nevertheless, in this project I would like to use the recollected water to improve the water and food security of Chemax's inhabitants. In the last decades, the concept of food security has had different meanings, but now a days, the definition can be summed up to "Access by all people at all times to enough and appropriate food to provide the energy and nutrients needed to maintain an active and healthy life". **(Barrett, C., 2002)** On the other hand, water security is defined, by the United Nations, as "The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development". **(UN, 2013)** In order to see a visible improvement in this, the recollected water should be used of in two ways, for human consumption and for its use in a family orchard to growth organic vegetables.

Talking about the first option, the water needs to be disinfected prior to be suitable for human consumption. A sustainable, simple and low cost method is the solar disinfection of water. This kind of disinfection works because the pathogens and microorganisms are vulnerable to two effects caused by solar radiation: The first effect is the spectrum of ultraviolet light and, the second one is the increase of temperature in water caused by the heat. The joint action of this two effects make turns solar disinfection of water a foolproof tactic.

To carry out the disinfection, you need to put water into transparent containers, such as one liter plastic bottles and put them in the sun for about 6 hours before you consume it. However, if the day is really cloudy you will need to expose the bottles to solar light between 24 and 36 hours, on the other hand, if the water temperature is over 50°C, an hour of solar light is just enough to obtain water free of pathogens and microorganisms. **(Regula, M., & Wegelin, M., 2012)** The approximate cost of disinfection relies on the price of the bottle, which is around \$4.6 pesos, that is around 25 cents USD.

Regarding the second option, the access to good nutritional quality and in the adequate quantity determines the quality of life that a family has, especially when children, third age adults and pregnant women have the need to have a varied and complete diet.

You can start you family orchard in a small land extension and, as you become more familiar with the techniques and cares of the orchard you can start to make it bigger.

A family orchard constitutes a great alternative because the families can produce and consume low cost organic products and they can also have a balanced diet. This orchard can be established on small plots of land in places near to the house and are easy to maintain. When you are planing you family orchard, you need to identify what vegetable allow you to raise the nutrition level of foods, besides, they should be varied. It is recommended to start with the plants your family most consumes, such as: tomato, onion, hot pepper, broccoli, carrot, etc. In the next table will be presented some of the vegetable species which may grow in your orchard, as well as the distances that the plants need to be between themselves and its production:

Species	Production Unit	Fortnightly Family Need	Plants by Fortnight	Cycles by Fortnight	Distance between Plants (cm)
Tomato	kg	3	4	6	20 x 20
Bean	kg	1	15	6	15 x 15
Cucumber	kg	2	1	6	30 x 30
Cabbage	Piece	1	1	6	35 x 35
Beatroot	Piece	6	6	6	15 x 15
Cilantro	Bunch	2	40	3	7 x 1
Peas	kg	1	20	6	10 x 10
Onio	kg	2	12	10	10 x 10
Chard	Bunch	2	8 (one time)	26	25 x 25
Spinach	Bunch	2	6	5	15 x 15
Lettuce	Piece	2	2	6	25 x 25

In order to plant, you have to take into consideration that the seed must be sowed at a depth equivalent to 3 times the size of its diameter. After the seedlings have established, you must do a clearing, leaving only the bigger and bushier plants, afterwards, the pulled out plants from the clearing can be transplanted to the other places in which the germination failed, and thus optimize. **(SAGARPA, Not Defined)**

In the next image, you can see an example on how the plants can be distributed in the orchard:

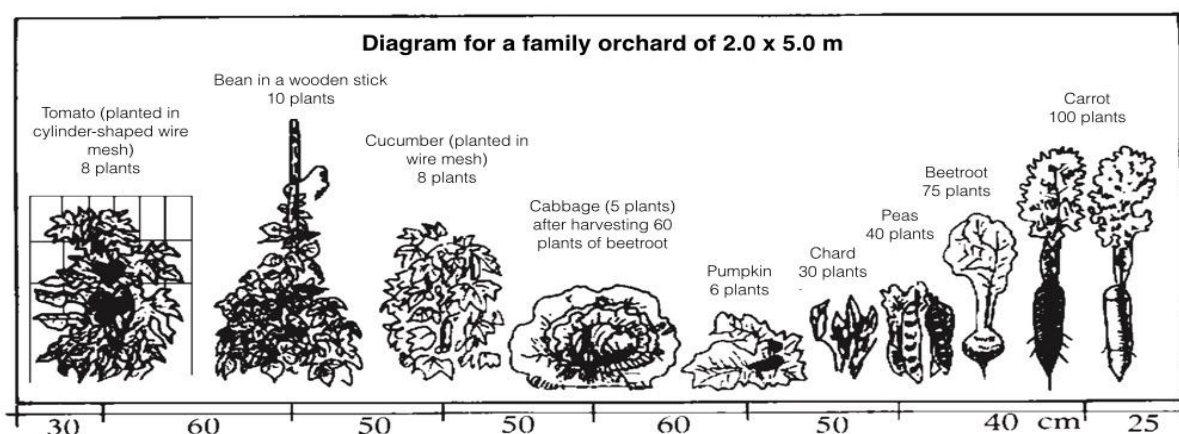


Diagram of an orchard. Retrieved from: <http://www.sagarpa.gob.mx/desarrolloRural/Documents/fichasaapt/El%20Huerto%20Familiar.pdf>

The basic basket is the set of about 80 articles vitally necessary to satisfy the basic needs of a Mexican, among which we can find pantry products and some services like electric transportation. Vegetables are part of this basket and its average price per month is \$379.52 pesos, that is around 20 USD, which would mean an average family spends annually about \$4554.21 pesos or 240 dollars in order to have food security. **(SEDECO, 2018)** This is a high price compared to what a family would spend each year in a family orchard. In the next table, you can see the annual price inverted by a household in a family orchard using as an example the diagram above is of \$487.80 pesos, which is equivalent to 25.89USD.

That means that if the inhabitants of Chemax apply this method in their daily lives they would get a better amount and quality of vegetables, key factor for a good nutrition, for a tenth of the price they would pay for the same products they can buy at any market. The money they are saving up can be used to buy other products or pay the bills, allowing them to improve their quality of life. The next table gives an approximate of costs:

Annual Cost of a Family Orchard		
Product	Price MXN	Price USD (equivalent to \$18.841 MXN)

200 tomato seeds	MX\$14.90	MX\$0.79
957 bean seeds	MX\$16.90	MX\$0.90
230 cucumber seeds	MX\$14.90	MX\$0.79
834 cabbage seeds	MX\$16.90	MX\$0.90
729 pumpkin seeds	MX\$16.90	MX\$0.90
213 chard seeds	MX\$14.90	MX\$0.79
434 pea seeds	MX\$29.80	MX\$1.58
1812 beetroot seeds	MX\$50.70	MX\$2.69
616 carrot seeds	MX\$16.90	MX\$0.90
10 meters of wire mesh	MX\$295.00	MX\$15.66
Total	MX\$487.80	MX\$25.89

For a plant to develop fully, it needs different nutrients, which are divided into macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium and sulfur) and micronutrients (iron, boron, manganese, molybdenum, magnesium, zinc, copper and chlorine) these are transported through water and absorbed by the root, also needing hydrogen, carbon and oxygen. Fortunately, many of these nutrients are found in soil and are abundant in the Yucatan Peninsula, others are found in rainwater and the rest can be added with a little compost, which is defined as: "An organic fertilizer that it is formed by the microbial degradation of materials arranged in layers and subjected to a decomposition process. "

The resultant vegetables from the family orchard would be of better quality, because the use of this kind of water makes them organic, as it does not have any kind of chemical like the ones used for water treatment that comes from water bodies, and the lack of pesticides used for their growth as the soil is fertile enough for them.

If both proposals were applied with the product of the water collected, the main diseases that affect this community could be counteracted. For example, according to the National Health and Nutrition Survey 2013: in the results by Federal Entity, 20% of children under 5 years old have had an acute diarrheal disease and an additional 30% are malnourished. **(Instituto Nacional de Salud Pública, 2013)** In addition to the above, food security would be improved and some of the customs of our ancestors would be preserved. Malnutrition is a factor that not only affects not only the physical appearance of an individual but it affects its health and makes people more likely to get sick faster and easily, in addition to that, they cannot recover as quickly as a healthy person because they don't have as much defenses as they should.

Moreover, the medical services that exist in the region are few compared to the amount of people that need them. To attend the whole population of Chemax there are only 5 health centers in the region, and they are normally overcrowded, besides the quality of attention that people receive there is not that good, so by providing a clean source of water, providing a better quality of food and improving the food insecurity of the region, people would have their immune system strengthen and as a consequence they wouldn't have to go as frequently to the doctor.

I think that this proposal has the capacity to help many people, and maybe, if it turns out, it can be implemented in more communities. Throughout my life I have been in a series of schools of different sizes, socioeconomic status, etcetera. However, something I have learned in all of them, is that Mexico is a wonderful country with marvelous people and history, and many times, we forget our customs and traditions that are of great value; as it is the planting of vegetables in our own backyard or an ancient technique for obtaining water. Currently, I am fortunate to have a good diet and access to drinking water, and after this research I realized that many people lack this, which makes no sense because they are essential for the overall development of a person. Unfortunately many people in our country need help, and I hope that with this project I can make a difference, in addition to encouraging more people to want to help and innovate.

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