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**Mexico: The development of a transgenic amaranth seed as a way to have a product able to eradicate malnutrition and help a local Mexican community in economic terms.**

**Problematic:**

Mexico has an enormous poverty problem. There are about 59.13 millions of poor people which represent 55.8% of the population (INEGI)(Instuto Nacional de Estadística y Geografía). This is presented in almost every state, some of them having a worse economic situation than others. The poorest states are: Chiapas with 74.7% of their people being poor, Guerrero with 69.7%, Puebla with 64.5% and Oaxaca with 61.9% (CONEVAL)(Consejo Nacional de Evaluación de la Política de Desarrollo Social).

Malnutrition is also a big problem in Mexico. It can be defined as a condition that is developed in the body when it doesn't get the right amounts of vitamins, minerals, proteins and other nutrients it needs to maintain health. Children are affected in many ways by this condition, for example it can reduce their physical and mental development during childhood. This affects their school performance often leading them to produce a lower income when they are economically active. There are many different types of this condition that depend on the lack of micronutrients in the body, the time they've been missing, and the age of the person. The most common known type is called "Marasmus". It is caused by the lack of protein and energy making people look really thin. This type of malnutrition is ranked in eighth place of the "Top 10 causes of death in low-income countries 2011" (World Health Organization). Unfortunately, Marasmus isn't the only type of malnutrition; there are deficiencies of vitamin A, iron, zinc and iodine:

Vitamin A: It weakens the immune system of people increasing their vulnerability to be affected by any disease. In all countries, an estimated of 163 million children suffer this deficiency (UNSCN)(United Nations System Standing Committee on Nutrition).

Iron: "Is the most prevalent form of malnutrition worldwide, affecting millions of people." (World Food Programme). Symptoms of this deficiency include: tiredness and lethargy. It also affects cognitive development.

Zinc: It affects the growth of children and weakens the immune system making the body vulnerable to diseases like diarrhea and pneumonia.

Iodine: It affects around 780 million people worldwide. The brain is the most affected organ in the human body because it cannot develop without the right amount of iodine. Its deficiency in pregnancy is causing 20 million babies each year to be mentally impaired. (UNICEF) (United Nations International Children's Emergency Fund).

So, according to these problematic, this paper has some research objectives:

- The creation of a genetically modified seed that has the nutritious properties to end the micronutrient deficiencies and protein-energy malnutrition in the world.
- The promotion of Mexican agriculture in order to increase the national production.
- The promotion of amaranth.
- To help a community of smallholder farmers from a bad economic situation.

If Mexican agriculture were promoted, people would start eating what their farmers produce. The income that farmers get will be higher making them able to live a better life and eventually buying higher quality seeds. Agriculture will become a strong economic support making the country's production higher. It could even change Mexico's situation in development terms, making it able to export food instead of importing it. Everyone would be able to eat healthier food alleviating malnutrition.

By creating a genetically modified seed that will be able to have the main micronutrients that the old seed lacks, having enough amounts of protein and energy in a way that people can reach it, malnutrition would be lowered and eventually eradicated of this planet. Amaranth is a seed that contains three of the four main micronutrients, a great amount of protein and energy making it a very nutritive seed. The only disadvantage that this seed has is that it lacks one of those micronutrients; but this can be changed by genetically modifying it.

Smallholder farmers are people who don't have the resources to increase their income. Just as the name says it, they own a small farm that isn't able to support a big harvest. By helping them, they are going to be able to move on and eventually get a better life.

### **Location:**

This project is focused on Santiago Textitlán, Oaxaca. This community was chosen based on the climate and economic situation. Oaxaca has a warm subtropical climate and an annual temperature of 22 and 31 °C. Its annual precipitation is around 1550mm with most of the rains presented between June and October. This state's economy depends on agriculture; but the main problem is that there are major issues such as climate changing and water scarcity that kill plantations.

The population is 3,315 habitants from which 1,941 of them are men and 1,713 of them are women. (INEGI) The community has 1,351 farmers with a total of 1,093ha to plant (INEGI). The average farm size would be of 0.809ha. A family there is composed of five people; the father, the mother and three kids (average). In Oaxaca, the minimal wage is \$4.61USD or \$61.38MXN per day (Rombiola); they have to feed a family with that amount of money. If they buy seeds, they are risking their seeds to die. A kilogram of corn seeds costs around \$4.88USD or \$65MXN; that's even more than what they earn. This state is classified as the fourth state with 61.9% of its people being poor and the third state with 23.3% of its people being extremely poor (CONEVAL). With the money they earn, they aren't able to buy seeds.

One of the objectives is to promote Mexican agriculture in order to increase the national production. Many people in Oaxaca are wishing for a seed that is able to survive more than others. And with this seed they can have a solution.

### **Product:**

Amaranth:

Mexico is not the only country that harvests amaranth; Peru, India, Guatemala and many other countries produce it. “Amaranth” is the most common name for one of the eighty different types of the seed “amaranthus” that comes from the Amaranthacea family. Even though there are many different types, only three of them are currently cultivated:

➤ *Amaranthus Cruentus:*

Common known as the “Purple Amaranth”, is being cultivated in Guatemala and in some states in Mexico. It can grow up to 2 meters, which makes it one of the tallest types; sometimes it is used to make tortillas in Mexico.

➤ *Amaranthus Caudatus:*

Commonly known as the “Love Lies Bleeding” because of its intense red color; this type is only cultivated in Peru. It is almost as tall as the purple amaranth, but it’s used in a different way because of its medical purposes. It can even be used as an astringent, anthelmintic or a diuretic.

➤ *Amaranthus Hipochondriacus:*

This is the type of amaranth that is used in this project; commonly known as the “Prince’s Feather”. It’s being cultivated in Puebla, Mexico, planted and eaten since ancient times. Aztecs are an example of a civilization that ate amaranth. This type doesn’t grow as big as the other two main types, but it is able to reach 1.2 meters, the perfect size for a smallholder farmer. It has many uses but the most common one among Mexicans is the “Alegria” (a sweetened bar made with this seed). It’s also used as a medical resource for treating diarrhea.

### **Proposal:**

The amaranth is an incredible seed in many ways. It contains a great amount of proteins, it is a great source of energy and it has many nutrients such as fiber, calcium, zinc, iron and vitamins A, B and C. But that’s not all this seed offers; it has some benefits such as:

- Surviving in times of water scarcity for days and when there are floods; it’s able to resist from 300 to 2,000mm per year.
- Growing in a wide temperature range; from 14 to 31 °C.
- Growing fast (from 150 to 180 days).

- It's really cheap; the average value of the seed is  $\$0.98USD$  or  $\$13MXN$  each kg while maize is  $\$4.88USD$  or  $\$65MXN$ .
- The leaves are edible and contain the same nutrients as the amaranth itself.

Amaranth is an amazing seed, but it has a big disadvantage; it's still missing one of the four micronutrients malnutrition is based on, iodine. That's where this proposal starts.

There is a worldwide company named "Monsanto" who genetically changes seeds to make them better; these are common known as transgenic seeds. Monsanto will develop a new type of amaranth seed that will have these four micronutrients: vitamin A, zinc, iron and iodine.

Based on the price of other transgenic seeds, we can speculate the price that the transgenic amaranth seed will have.

Table 1: Price comparison between normal and genetically modified seeds:

Seeds price/kg	Maize	Soybean	Cotton
Normal seed's price (The Organic Center)	$\$1.73USD$ , $\$23.08MXN$	$\$0.33USD$ , $\$4.40MXN$	$\$2.33USD$ , $\$31.09MXN$
Transgenic seed's price (The Organic Center)	$\$2.93USD$ , $\$39.09MXN$	$\$1.82USD$ , $\$24.28MXN$	$\$13.77USD$ , $\$183.71MXN$
The seed's value increases:	169.36% 1.6936 times	551.5% 5.515 times	590.98% 5.9098 times

As we see in table 1, the average increasing value raises 437.28% or 4.3728 times. Based on that, the new amaranth's seed value will be  $\$4.28USD$  or  $\$57.1MXN$ .

The government is going to support this proposal with subvention just as the president Enrique Peña Nieto (2012-2018) declared in "The National Development Plan" In Article V.I.4., Objective 4.10., Pages 141-142, Strategy 4.10.1. "To support the production and income of farmers, little agricultural producers and fishers of the poorest zones by creating alternatives to make them part of the economy in a more efficient way" (Nieto). This way, farmers are able to buy seeds with a little help from the government; but not for free because this is supposed to be a hand-up, not a hand-out.

Farmers can eat the amaranth's leaves while harvesting is in progresses; which are as nutritive as the amaranth itself.

The average farm size in Santiago Textitlán is of  $0.809ha$  and  $4kg$  of amaranth seeds are needed for each  $ha$ ; so the average farm would need  $3.236kg$ . This will cost  $\$13.85USD$  or  $\$185.47MXN$ . An average farmer earns  $\$4.61USD$  or  $\$61.38MXN$  making him/her able to buy a third part of it. The government will start sub venting 75% of the price.

The government is going to invest:

- For each farmer \$10.38USD or \$139MXN
- For all farmers \$14,033.59USD or \$187,924.79MXN

Each farmer is going to pay \$3.46USD or \$46.33MXN.

By the time the plantations are finally giving the product, the modified amaranth would be recognized and demanded by many people. The economy on Santiago Textitlán will grow incredibly fast.

Table 2: Comparative on products.

	Seed's Price	Production/ha	Production's price/ kg	Average's farmer income every 165 days
Amaranth	\$0.98USD or \$13MXN	2-3 tons	\$5.27USD or \$70MXN	\$13,175USD or \$176,427.35MXN
Transgenic Amaranth	\$4.28USD or \$57.1MXN	2-3 tons	\$23.01USD or \$308.13MXN	\$57,525USD or \$770,321.30MXN

As we see in table 2, the transgenic seed's price increased 437.28% but also the income, making the product profitable. Each farmer will spend \$3.46USD or \$46.33MXN and he is going to earn \$57,525USD or \$770,321.30MXN each 165 days.

The government is only going to sub vent the first production; after the amaranth is sold the farmers are going to be able to buy more seeds without any further help.

Private companies are also going to be interested in this new product. An example would be any company that produces bread because amaranth can be used as flour to create a new type of bread. Amaranth is going to be at everyone's reach in Mexico, but if any international company decides to create a new product with it, it's going to be profitable too.

### **Conclusion:**

People need to start opening their eyes to reality; life is not the same for all of us. There are many humans around the world suffering day after day but most people prefer not to think about them. Every day spent without helping someone in need, is a lost day; there are more people suffering than living a life at ease. Even us, the youth of society can help in some way.

People don't give the importance they should to agriculture. Most of them don't realize that they are eating what farmers are producing. If we are able to make everyone understand the importance it has, many people will benefit from it due to the impact agriculture has on economy. This would be a way to help farmers in Santiago Textitlán in many ways. They are finally going to be able to succeed in life and alleviate malnutrition in all Mexico. My project is also going to make people think about agriculture and maybe promoting it.

This project really showed me that poverty and malnutrition are bigger problems than what I thought. There are many people surviving day by day while many of us are doing nothing to help

them. I think that this consciousness should be created in us, the youth for we are the future of this world. That way we can try our best to suppress these problems.

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