CRISTIAN ZAVALA ESPINOSA [speaking Spanish]: To describe maize is to describe a whole world. Maize has so many shapes, textures, and colors...even smells. Cuisine in Mexico is based on maize. You can see it in any market, small town, or village. Maize is everywhere. We can’t escape it, and neither can you.

[Cristian Zavala Espinosa; Germplasm Bank Coordinator]

NARRATOR: Maize is all over the world. It’s in many of our foods, it feeds our livestock, and it even provides energy as biofuels. But today, this crop faces an uncertain future in our fast-changing world. Why is maize vulnerable and what can we do to protect it?

ZAVALA ESPINOSA [speaking Spanish]: My name is Cristian Zavala. I like doing this work because, in a way, we maintain the diversity of maize found around the world.

NARRATOR: Located just outside of Mexico City, the International Maize and Wheat Improvement Center, or CIMMYT, protects the diversity of maize by storing seeds from more than 28,000 different native varieties — the largest collection in the world.

There are tens of thousands of native maize varieties, but today, farmers grow many fewer varieties. So what happened to the diversity of maize?

ZAVALA ESPINOSA [speaking Spanish]: The culture of maize in Mexico has existed since before there were history books. In fact, Mexicans were created from maize according to some cultures, such as the Maya and the Mexica.

NARRATOR: About 10,000 years ago, Indigenous farmers began cultivating a native grass called teosinte. Through many generations of selective breeding, teosinte evolved into the crop we know today as maize. Growing maize in diverse environments resulted in thousands of distinct native varieties, each well suited to different conditions.

But over the last century, crop breeders have used a handful of the most productive of these — the ones that grow the fastest and produce the most food per acre — to develop modern varieties that could be grown at large scales. Many scientists think that growing so few varieties of maize could come at a cost.

ZAVALA ESPINOSA [speaking Spanish]: We are currently losing many of the native varieties that have developed over the last 10,000 years. The danger is that we don’t know what we are losing.

NARRATOR: A diversity of traits within a species is a powerful defense against changes in the environment. And each maize variety has different traits; one variety might be more resistant to a new disease, while another variety might grow better in drought conditions or extreme heat.
So scientists want to preserve as many varieties of maize as possible in case these traits are needed. But how do you preserve thousands of native maize varieties? This is where seed banks come in. When the seed bank at CIMMYT receives new maize samples from farmers, Cristian and his team begin by checking the cobs for diseases.

ZAVALA ESPINOSA [speaking Spanish]: Next, germination tests are carried out to ensure that the seed is viable for medium- and long-term conservation.

NARRATOR: Technicians take a random sample of kernels and put them in ideal growing conditions to see how many develop into healthy sprouts. Next, they take kernels from those cobs and sort them into envelopes that are vacuum sealed and stored in vaults, which are kept at low temperatures and constant humidity.

ZAVALA ESPINOSA [speaking Spanish]: Finally, the extra seed is shelled and stored in a compound that we call “bulk,” which is basically mixing all the extra seed and making it available for distribution worldwide.

NARRATOR: Storing and maintaining all these maize varieties is a lot of work, but it’s really just the beginning. Once this diversity is preserved, how can it be used to improve maize agriculture in a changing world? To solve this problem, scientists turn to genetics.

[Sarah Hearne, Maize Geneticist]

SARAH HEARNE: My name is Sarah Hearne, and I try to identify characteristics. Things that will help, in the future, develop varieties that are more tolerant to drought stress, to heat stress, to some of the pests and diseases that are starting to emerge as climates shift.

NARRATOR: As growing conditions change, scientists want to identify the DNA sequences associated with traits that will help maize thrive.

HEARNE: So about 10 years ago, we took samples of every single one of those varieties, and we grew them out in very large greenhouses that we have here. And at the seedling stage, we chopped off the leaves and we dried those leaves. And then from that, we extract the DNA.

NARRATOR: Sarah and her team compared the DNA of different varieties and identified locations in the genome where the DNA was different.

Different versions of a segment of DNA are called alleles. These alleles often differ by just one nucleotide — one letter of DNA. For example, one allele might have an “A”, while an alternative allele has a “T” at the same position.

HEARNE: So this is where things get really exciting. We calculate what is called an allele frequency.

NARRATOR: An allele frequency is a measure of how common a particular allele is in a given variety of maize.
HEARNE: So in a hot, dry environment, I have a very high frequency of a particular allele. And when I look at the cooler, wetter environments, I have different alleles which are present in high frequency.

NARRATOR: Alleles found at higher frequencies in the hot, dry environments may be associated with traits that protect those plants from heat and drought, even if we don’t know exactly how those alleles work yet.

HEARNE: The most important thing is, is there a difference in productivity when I have this allele, or I don’t have it.

NARRATOR: To test this idea, Sarah and her colleagues selectively bred these promising alleles into modern varieties.

[on-screen bar graph showing modern variety of maize produced under drought stress compared to modern variety plus novel genetic variation]

HEARNE: And we’ve got some lovely data which shows some really quite big boosts in productivity under things like drought stress when we start to incorporate this novel genetic variation.

NARRATOR: Seed banks like the one at CIMMYT are a vital resource for global agriculture, and they wouldn’t be possible without the Indigenous farmers who have been cultivating native varieties of maize for thousands of years.

ZAVALA ESPINOSA [speaking Spanish]: I think it’s knowledge that’s been passed down from generation to generation. They are the real guardians and the real owners of all this diversity.

NARRATOR: Scientists are finding new ways that the incredible diversity of maize, created and maintained by Indigenous farmers, and secured in seed banks, can ensure a future for maize that’s both productive and resilient against emerging threats like climate change. If their work is successful, maize will keep powering humanity for a long time to come.