Yosef Mizrahi
Israel is quite famous for taking fruit trees and converting them to orchards in the desert. For example, we did that with mango, we did that with avocado, we did it with citrus. However, in the last decade we are running into a severe problem with water shortages and increasing prices of water, to the point that farmers in the desert were bankrupt, and in these days they started to uproot their orchards. We had a strange idea, some kind of crazy idea. What we did in the past, and now this is not working any more, is to turn the desert into orchards. Why not take desert plants and convert them into crops?

NARRATOR
What had seemed a good idea for decades, turned out to be a big mistake - growing fruit trees in the desert. Fruit trees require a lot more water than desert plants, but in spite of all the knowledge and energy spent on clever irrigation systems, they've never really proved a success. Meanwhile desertification goes on all over the world, at the cost of farming areas.

04.05 (Mizrahi in car) But is there an alternative? The Israeli agronomist Yosef Mizrahi thinks there is. He is looking at the potential of cultivating desert plants, such as cacti. Cacti are not native to Israel but they take well to its soil and climate.

Yosef Mizrahi
Opuntia Ficus Indica is a cactus that was brought to Europe by the Spaniards after finding the Americas, and it is spread all over the Mediterranean as a semi-wild plant. You can find them along the road with many kind of fruits, different colours, different taste and different size of spines. It is up to us to convert it into a crop, to select the proper one that the farmer will be able to grow and market.

You can see another one here, a white one. And here you can see a beautiful colour of a red Ficus Indica and I ask you, would it not be nice to have an ice cream and a cold drink made of this beautiful tasty cactus?

You're invited this afternoon to have it in an ice cream parlour here in Beersheva.

NARRATOR
Opuntia Ficus Indica, or 'nopal' in Spanish, is the most common cactus in the world. In its native Mexico, it is used extensively by the indigenous people, as food for instance.

Woman
My daughter has a book with cacti recipes. This is it, it has over 300 recipes for salads, desserts – yes, desserts and beverages, also soups.

NARRATOR
Alejandro Casas is a Mexican ethnobotanist. He's studied the plant use of the local population, and the way they've farmed the land through the centuries. When modern industrial materials arrived the use of plants diminished in Mexico, as elsewhere. Important cactus species such as nopal are nowadays only used for their fruits and leaves - and sometimes as building materials. In the past everything was used, including the parasites that lived on the cacti.
Alejandro Casas
Another way people used cacti is this, the production of the dye carmine (crimson). This was already done in pre-hispanic times, but its height was in the 16th and 17th centuries, when it was traded all over the world. Oaxaca was the main production and trade centre, and all the richness of this city goes back to the production of carmine red.

NARRATOR
Nopal grows very well in Israel, and its fruits are now being harvested by nomads in the desert. But can they also be made profitable for a modern Israeli farmer?

Yosef Mizrahi
The cacti that you see in Israel they do produce fruits from 15 July to 5 August. When farmers try to make a living of it they run into a problem, that if you sell fruits only one month of the year you cannot make a living. So we were looking for techniques, how we can force the plants to flower whenever we want to. Luckily enough we developed a technique that we can now produce fruits eleven months of the year, and farmers adopting this technique can make a living. The secret is very simple - it is heavy fertilization at a proper time, and then the cactus will reflower and produce the fruits at the time you want to.

This was a very interesting finding, opposite to what we know from plant physiology. Usually when you heavily fertilize a plant it will avoid producing flowers and will grow very strong. I have no idea why the cactus is so different but I suspect that the generalizations that were made in text books are not 100% correct. Maybe other plants follow the same rule, but we have to test it. We don’t know.

NARRATOR
Nopal fruit is already for sale in many grocery shops as ‘cactus pear’. It’s also used to flavour juice and tea. But Israel faces huge competition from Nopal producers in other countries. So Mizrahi has had to come up with new ideas. He looked all over the world for other desert crops, though none have proved as successful as Nopal.

Yosef Mizrahi
Seventeen years ago we introduced to this research station many fruit plants, among them this cactus that was introduced from Mexico. It was growing and growing and growing and growing and nothing happened for 17 years. Only this year, only one cactus out of 30 started to flower and produce flower buds. But no fruits were produced from this plant.

This means that because of the unpredictability of this cactus we cannot use it as a crop. We have to know its reproductive biology to know how to regulate it to produce fruits at the will of the farmer, otherwise it will stay like this with no use.

Alejandro Casas
Cacti are able to survive in harsh and unpredictable conditions, but this is no guarantee of their reliability as a fruit crop. Just as the amount of rainfall varies from one year to the next, as does the presence of suitable pollinators, so these factors directly affect the productivity of the cacti plants.
NARRATOR
Alejandro Casas is working in the Tehuacan Valley in Central Mexico. This valley is also the cradle of Mexican corn farming - one of the world's most important staple crops.

But unlike corn, none of the hundreds of cacti species in the valley have ever been cultivated, even though they were all once used by the local population.

Alejandro Casas
This corncob is about 2000 years old. In caves like this one, the archaeologist Richard McNeish found evidence that corn was already in use over 6500 years ago. In the layers beneath the floor of the caves he found that the amount of corn increased with time, which is a sign that corn was apparently under cultivation. This evidence was sustained by the changes in size and appearance. This cob is bigger than the other one and that also is a sign of cultivation.

In the same layers he also found traces of other plants, amongst them also cacti, but they did not increase in quantity. So it is debatable as to whether these plants were cultivated.

NARRATOR
Could it be that cacti were once cultivated but that knowledge about how, has been lost over time? Casas consulted historical sources, written down by the scientists that came to Mexico in the wake of the Spanish conquerors.

Alejandro Casas
In these historical sources we find information on different forms of the uses of cacti. This codex for instance describes the use of columnar cacti as torches to illuminate rooms. This practice can still be found in some indigenous communities, although very few.

The information on uses of cacti is rather exhaustive, but the information on cultivation is practically absent. This could mean that the Spanish researchers were not interested in the subject or that it did not happen at all.

NARRATOR
Finally Casas decided to look at the plants themselves, to solve the mystery of cacti cultivation. He analysed the genetic material of the flower buds and came to a surprising discovery. Many cacti species had indeed been cultivated but in a primitive way.

Normally when a piece of land is being cultivated, to grow corn for instance, most cacti are removed. Only the best variants are tolerated because of what they produce. But by weeding out the unwanted cacti, the gene-pool is reduced and thus made poorer. This is the oldest form of cultivation and is known as 'in situ management' because no plants are removed to elsewhere.

In the farm settlements, however, Casas found genetic enrichment of the wild cactus population. Here useful species were removed and taken to the villages and planted in the gardens. Only a few cacti species are suitable for this 'real' form of cultivation. They are the ones that flower often in a farmer’s life, so he can see for himself that these plants are worth cultivating.
Alejandro Casas
There are cacti that can easily be cultivated. Those are the ones that can be multiplied by cuttings, or that germinate easily. But others cannot be multiplied that way at all, and they usually grow very slowly.

NARRATOR
Mizrahi was confronted by a number of obstacles in his quest to grow cacti.

Yosef Mizrahi
Our major problem in our research programme is that we are scientists that have no land and no orchards to grow these plants that you have to grow for many years. So we are approaching farmers and we tell them ‘fellows, I have something interesting for you to grow’, and then they ask what it is all about and I tell them ‘this is a plant that the indigenous people of America eat for thousands of years. So they ask, “Who is going to buy it?”, “what is the volume in the world market?”, “what is the price?” And I tell them that nobody ever tried to sell it. They tell me, “Give me a break, you and your stupid fruits!” Luckily enough we have been able to find some farmers with an adventurous spirit, and they were ready to risk their time and start this from the very beginning.

But it works the other way round as well: I was approached by a farmer and he tells me, I heard you were growing crazy cacti, can you get me some opuntia to grow as a fence around my orchard, so people don’t walk in and out. I told him, ”Fellow, I have a much better thing to offer you”. It is what we call today ‘koubo’, it is a columnar cactus, with spines this big. He grew them. This is now a fence, and for me it is a selection ground for new clones to come, and we both have the benefit.

NARRATOR
Cereus Peruvianus, a cactus species from the coastal deserts of South America, was another success for Mizrahi. The first and only commercial plantation of this cactus - renamed koubo for commercial reasons - can be found in Israel. Koubo is fast-growing and plentiful. Its fruits can be harvested all year round, which makes it particularly valuable. But most of all koubo can do without water for a very long time.

Arnon Ronen
Even in Israel there are 4 or 5 months that we are not irrigating at all. In Israel that is a most important issue, because there is no water in this country, almost no drinking water. The crop yield is not very high, but it is reasonable: 25 ton per hectare (?)

Yosef Mizrahi
When developing a new fruit for the market, it has not only have to be beautiful and tasty, but it also has to have the characteristic that you can send it from the producer to the consumer without any problems.

Fruit cracking is a natural way for this fruit to spread its seeds in nature, and once you have it as a new fruit crop, this is a major problem that we have to solve. This problem is known in other fruits, but the way that people solve it is by avoiding irrigation before the ripening will start. And once you avoid irrigation there is inhibition of growth and the fruit will not crack.
However with cacti this is not possible because if you avoid irrigation the plant will still keep on growing because of the water saving characteristic that this plant has. So we had to develop totally different ways to overcome this problem: we are trying to spray with natural plant hormones that will force the skin to grow and become stronger and avoid the skin cracking. And we hope to try this on a commercial basis this year for the first time to see if we can ease the problem with the koubo

NARRATOR
And, not without importance, how do they taste?

Yosef Mizrahi: Now I want to offer you to taste some of the clones of this new fruit that we develop. Tell me what do you feel?

Interviewer: it is sweet

Yosef Mizrahi: it is sweet, okay, now try this one and tell me what do you feel?

Interviewer: it is acidic, I like it more.

Yosef Mizrahi: that is what we found that Europeans like acidic fruits, sour fruits, more than the sweet ones. And I think that 90 % of the people will react this way, if they are of Asian origin they will go for the sweet, and now we have to find our target market. If this is Europe we will have to offer them sour fruits, if it is Asia we have to offer them sweet fruits.

NARRATOR
But the effort will be well rewarded. Latest figures for sales of cactus fruit show sales soaring across the world. Nopal is king of the cacti fruit and is immensely popular in Australia, the Americas – as well as some European countries. Hundreds of thousands of tons of the fruit are sold annually. Nopal is a successful crop not only because of its fruits, but because other parts of the plant can be eaten and used to feed cattle. The UN Food & Agriculture Organisation has also recognised that the plants can help fight desertification all over the world.

The second most popular cactus is the vine cactus – known in Asia and Australia as Dragon Fruit – and referred to throughout Latin America as Pitaya.

And now Mizrahi’s particular speciality, Koubo, is making a splash across the globe. Last year close on 30 tons was sold – a figure that is expected to double this year.

Yosef Mizrahi
“I found whenever you are talking about the upper class, they have an interest in experiencing new things, in experimenting with new things, new fruits, new tastes, new odours, new smells, they are very interested in experiencing them. Once they have tasted them other people will follow. We saw it in my lifetime – when avocado first came into the market place everybody looked at it – a green fruit, it looks like butter, it tastes like butter, who needs it? And the kiwi fruit – it was a brown one with green flesh – who was going to use it? The fact was they became major crops in the world, and I am sure that sooner or later these desert crops will also become major fruits in the world market. It takes time”.
Meanwhile Mizrahi is working on 6 other desert crops, two of which originate from Mexico. But is Mexico also reaping the benefits?

Alejandro Casas
Mexico has about 60 columnar cacti species that produce edible fruit. It is a form of subsistence over here. We have the right soil, the animals that pollinate and an enormous array of variants that can all be developed into crops. So Mexico should play a major role in the commercialisation of this new fruit.

Yosef Mizrahi
In Israel we are trying to grow this new fruit under different conditions at different locations. For example this location has the hottest temperatures in Israel. In summer time the average is 40 centigrade and it can go up to 47 degrees centigrade. Under this conditions plants suffer to the point that you can see the tissue becomes liquid and under this conditions they cannot be productive.

However, we did find some variants that do grow here and they did not show this kind of damage, and we think with the proper breeding programme we can come to variants that can be productive under these conditions. If we succeed it has two advantages: number one we can produce food under extreme conditions with a minimum amount of water, and on top of that we don't have to use any pesticides since the pests cannot survive under these extreme desert conditions. Maybe the desert will be the best place to grow clean food with no damage to the environment.