Walter Goldstein: These are the things we're trying to do. Enhance the nutritional value and the yield. Strengthen the cross incompatibility so it won't be pollinated by GMOs. And we've discovered in these ancient races of corn that many of them grew on very poor soils, and they seemed to have the ability to work together with microbes in order to get nitrogen even from the air. And that's very significant to be able to bring that into modern corn and see what that can do in order to reduce the terrible amounts of fertilizer that we're using and are polluting the water in the Gulf of Mexico and our drinking water and so on.

Cooley Ludtke: That's Walter Goldstein. He's the founder of the Mandaamin Institute in Wisconsin and has been breeding organic corn for more than 30 years.

John Swain: We first met Walter back in 2000. At that time, he was Research Director at the Michael Fields Agricultural Institute. When we turned our attention to seeds, Walter was one of the first people we wanted to talk to.

Cooley Ludtke: In preparing for the interview, we came across a presentation Walter gave in 2016 called *The American Story of Corn.* We liked it so much that we asked Walter if we could share excerpts from it here on the podcast — and that's what this episode is all about.

John Swain: In this podcast, Walter traces the history of corn, the role of Indigenous people in its development, and how today's plant breeding still benefits from this partnership between humans and plants**.**

Cooley Ludtke: Thank you for listening to the Farms for Tomorrow Podcast**.** I'm Cooley Ludtke.

John Swain: And I'm John Swain.

Cooley Ludtke: Let's get into it.

[01:42]

Part 1: Corn and Its Indigenous Origins | Length: 3:08

Walter Goldstein: Corn: it's really the cereal crop of our North American civilization. And it has really deep roots. It's a wonderful thing and it's something that we rely on, but there's a certain kind of erosion that's going on and we're trying to do something different.

And I should say, I, I get along with a little help from my friends who help me out in many different ways by providing land or helping me to run our organization, which is called the Mandaamin Institute; Mandaamin, meaning corn or corn spirit in some of the Algonquian languages.

Some of you may know that the people who lived here when the whites came were Algonquians and the Ojibwe up north, the Potawatomi down in the south, the Fox and the Sauk in the southwestern portion of the state; they were all Algonquians, and they more or less spoke a very similar language to the Miami.

And you had the Ho-Chunk, who were more of a Sioux-speaking or like the Lakota-speaking nation. And they lived around Green Bay and Appleton in that area. Now we have the Oneida who were pushed in from the northeast.

But the native people were the ones that made the corn. And I think it’s worthwhile for a moment just to think about how it was done because it was a wonderful, wonderful, wonderful occurrence. You had these grasses, and they didn't have cobs. They didn't have a cob; something beautiful upon which you have naked seed. In the axils of the leaves, they did have female flowers, and they did make seeds, but they were hard. They had a hard seed case on them. They looked like little stones. And they were stacked one on top of the other in little columns. And so, these tiny little seeds would be there all around the plant without any sort of central cob that would hold the seed together. And if you would brush up

against those plants, those seeds would scatter. And like a wild plant, the plant would renew itself.

Well, somehow the cob came into being and that cob came into being as a very, very directed activity. And how it was made was rather unusual and amazing. And scientists fight over how it was made, and they can hardly believe that it was made, because once you made a cob, the seed would no longer be spreading itself around and the wild plant status was over. You came into a new phase where people and plant were together.

And that's one thing I want to say about this whole activity of making plants, of the plants that we eat, is that actually they're part human and they're part plant. They have to do with our desires, our needs and the creative activity of the plant kingdom. And somehow between the two, between people and between plants, a partnership is made. And that partnership has gradually become so productive that we have this amazing, it seems like a pun to say amazing, but we have this amazing partnership and this amazingly productive plant.

[04:50]

Part 2: Corn as an Ancestor | Length: 1:01

The corn is very much connected with the spirituality of native people, and how they believe it's the most holy crop, and part of it is that it's connected with people. It's connected with people in a very deep way. And it's also connected with the dead that the native people in many of the different tribes, those who were agriculturalists have this conviction that the dead actually live in the corn, that actually they are the ones who grow the corn. And so, corn is their relatives. And that's a very profound thought and experience.

I visited the Hopi as some of my corn was developed by the Hopi and then I took it further and began to recognize how incredibly profound corn is for those tribes, and this living in a feeling that the corn is actually their relative, the way that they treat it in the field, the purpose it actually has in

the family structure of the Hopi, it's an incredibly significant and important crop.

[05:51]

Part 3: The Anatomy of Corn | Length: 2:04
And when you go around the country and you fly over the Midwest, and you see all these fields where this one plant, despite all the bad soil, despite all the chemicals, despite the abuse that modern farming has brought about, that this one plant is so tough and so able to take it and so able to continue to evolve that it's the most fantastic thing.

I think you probably all know that the corn plant has a tassel on the top, which has male flowers and produces pollen, whereas in the axils of the leaves, it has a female set of flowers in a little organized cob. And they produce silks. And each silk comes out very demurely, comes out of those leaves. And the tassel on the top releases its pollen and it drifts down. And once a pollen grain lands on one of those silks, it germinates and grows inside the silk down to a little egg that's in that cob in the axil of the plant. Well, that's what was made. That’s what was created by the native people.

And that cob is actually something very special. It's a side branch. A whole side branch. If you can imagine, a side branch that has become condensed and held back. And the tassel that was on that side branch became femalized. In other words, all the male flowers changed their sex into female flowers. And you'll notice whenever you buy corn in the store and you strip off the leaves, have you ever noticed that there's a little stalk beneath the cob and the leaves are attached around that? And that's actually the leaves on that branch. It's all become shortened and shortened.

And the tassel has changed its sexuality from being a male inflorescence to being a female inflorescence. You can see the process of the tassel with all its branches condensing into a cob of corn.

[07:55]

Part 4: The Diversity of Corn | Length: 1:23
And so, I'd like us to look at some corn. Grab a corn of your choice. There's different ears here, many different colors. We have yellow corn. We have black corn. Black corn. So red, that's so red it's almost black. And some are so blue, they're almost black. Some are red. Some are yellow. Some are white just like the races of humanity.

And this is a crop that's been more genetically engineered than any other crop. And it can take it. And this is from the Amazon. This is one of the very primitive corns. They're just absolutely gorgeous with especially high nutritional value. This is one of our white corns that we're converting so that it cannot be pollinated by GMO corn. This is sweet corn. How many of you have seen sweet corn before? Yes. I mean, you've all seen sweet corn, but I mean really the seed and so on.

So anyway, for those of you who have corn, you have something in your hands that has a history and is connected, this very special partnership between people and plant is incarnated in that corn and where is it going to go?

So, I'd like you just for a moment to feel into that corn. Just what is this corn? What's associated with it? You know, what is your nature, dear corn?

[09:18]

Part 5: The Breeder's Intuition | Length: 3:37
A most amazing thing, my colleagues and I, we spend months in the winter time sorting out what corn we're going to be working with, sorting seed, looking at the seed, deciding which of them have the quality that we want, deciding on the basis of their feel, looking at their notes of how they did during the summer, and deciding actually, what do we keep to bring forward.

And as we do that, you know, you can get a kind of a feeling for where is corn? Where is this plant? It's not just genetic machinery. In fact, our culture thinks about corn as just being a sort of a genetic machine, and they treat it in the abstract.

But when you live with it and work with it and really want to do it justice, you begin to realize, you begin to live with this living body. It's actually more of a body than a set of genes and machinery. It's actually a living body. And you begin to sense how that body is at different times of the year, that living body.

And at this phase, once you start to grow the corn and you feel the difference between now and before, well the corn, it's there in the seed, but it's kind of like it's outside, it's outside the seed. It's like in suspended animation at this time of the year. The body is in suspended animation. It's like the Beatles song. The inside is out, and your outside is in, but your inside is out. Now you're out, it's out. It's not quite in. Even though it's in the seed.

And so, you have this feeling of working for months with this somewhat disembodied being. And then you plant it and up it comes. You can actually get a sense for when it comes up, how awake is this plant? And if you work with the plants for a while, you begin to sense that they're sensing. These plants are actually sensing.

You can look at their form, whether it's a kind of a dull plant or it's a plant that's more in sync with its environment and more awake to its environment. And to what extent can this plant actually sense its environment? That's important. And then you see it’s inside is out, it's outside is in. And now the outside is actually in. It's in what it's experienced from the outside.

And then you begin to notice that there's never any one point where the plant is, you know, you can catch it all at once because it's constantly

changing. So when you say, well, what is corn? Well, you say, oh, it's a seed. Well, no, it's actually not in, but it's in, in this dynamic. But there's never one point where you can catch the whole plant until it dies. And there you have the whole plant in front of you, but it's dead. It's kind of a dead image of what it was.

And so actually, what do you say? Well, Bente says, “childhood is a verb,” but corn is a verb, too. And so, you have this well, how do I get a relationship to this verb, you know, to this becoming? And so, the thing is, is that as a breeder, you have a chance to participate in the becoming, you actually have a chance of guiding it and working with it and being in partnership with the becoming and where does it go? And that's what we're trying to do at the Mandaamin Institute.

So, the Mandaamin Institute, we're trying to guide it, and work with it because it's creative and new things come about as you work with it. And particularly, I think as you start to work with it as a whole being as a body, an evolving body. And it has so many gifts that we can enhance. Only people can do that with them. The plant gives the gifts. But we can use our senses and our part in order to move it forward and move to something that it’s never been before, to enhance it to a different level.

[12:55]

Part 6: Breeding for a Better Future | Length: 1:45
These are the things we're trying to do. Enhance the nutritional value and the yield. Strengthen the cross incompatibility so it won't be pollinated by GMOs. And we've discovered in these ancient races of corn that many of them grew on very poor soils, and they seemed to have the ability to work together with microbes in order to get nitrogen even from the air. And that's very significant to be able to bring that into modern corn and see what that can do in order to reduce the terrible amounts of fertilizer that we're using and are polluting the water in the Gulf of Mexico and in our drinking water and so on.

One of the things that farmers confront us with and we come to the realization very quickly is that, “Fine Walter, you want to increase the nutritional value. We never thought about that before. Or we don't think too much about that. And you want to increase its efficiency in terms of fertilizer use so you don't need so much fertilizer. That may be of economic value. But we think about money, and we want to have the same yield.” And so, a lot of our effort has been, okay we have these wonderful things we can do with corn, but it has to yield the same for the farmers.
And so, we struggle. And we grow corn on different farms, including the Zinniker Farm and our farm and Janet Gamble's farm and other farms in the area and across the country. And we try to get a handle on, well, how are we doing? Do we have varieties that actually will produce hybrids because the farmers predominantly want hybrids? I'd say 90% of the organic farmers want hybrids. They don't want open pollinated. We produce that as well, but they mostly want hybrids.

[14:40]

Part 7: Competing with Big Ag | Length: 1:02
Well, how can we compete? And at this point we're actually competing with Monsanto and Pioneer and Syngenta and BASF and all the other companies that are producing the seed. And the wonderful thing is, we seem to be able to get to the point where we can compete.

If you're an organic farmer and you want to grow a hybrid you go to several different companies. Those companies get their seed that they use from a broker firm. The broker firm gets it from the big companies. And the organic farmer doesn't know which company has produced the varieties that they're using, but they're probably mostly Syngenta or Pioneer or Monsanto or BASF or Dow. So, they're mostly the big agrochemical firms that do the breeding.

Those corn varieties are very good at yielding and they're very good at standing, but their quality is very poor. But they can yield like crazy and

they're reliable. And we have to be able to pull off the same sort of performance.

[15:42]

Part 8: Hybrids, Inbreds, and Open-Pollinated Varieties | Length: 2:04
What is a hybrid and what is an open pollinated? An open pollinated would be if I give you a variety and you grow it year after year after year on your farm, and you keep back your seed, it more or less looks the same. There's a lot of variation. Some plants are this tall, some are this tall, and the ear maybe varies in height, but it more or less looks the same. And you can keep that variety.

A hybrid is made by crossing two different things that are very diverse, and usually when you cross them together, you get an extra yield. And that's why the farmers want to grow the hybrids, because they get maybe a third to half more yield when they grow them. And that makes a big difference to them, especially under stress conditions. And believe me, we're having more stress conditions. And the hybrids really do help push the plant. The hybrid vigor helps to push the plant through the stress. The plant doesn't experience the stress probably as much, and the extra vigor makes a difference.

Every hybrid has a has an inbred parent, and the inbred is produced by crossing a plant eight times for eight generations to itself, and as it does it, it becomes more and more clear what that plant is like. It becomes more and more fixed in its characteristics. You know, people have this issue too, when they become too inbred, they become very fixed in their characteristics, and they become weaker. And so it is with corn. When you inbreed it, it becomes weaker and shorter, but it becomes very clear as to what the characteristics are of that plant.

And when you have an open pollinated, it's very hard to know what you will get. If you cross two different open pollinated varieties, each one of them is still in flux and in change.

So, part of the whole thing with making the inbreds is you have something that you know and you can trust. The other part of it is the whole commercial side of it.

[17:46]

Part 9: Restoring Integrity to Corn | Length: 2:30
Corn is the biggest seed crop of the country. It is now the most grown cereal crop in the whole world in terms of production. It just out produces. It's grown now in Europe, in places it never was grown before or hardly grown before. And it's very high value. And that's why the big companies are into producing it big time.

And so how can we develop something that's more true to the nature of corn and bred in line with what corn actually is and form it in such a way that it doesn't become some sort of pawn of money interests. So those are some of the challenges that we have.

With the inbreds that we develop they have extra carotene in them. And that carotene is very important. It's an antioxidant. It's very important for human health, particularly for eye health. If you don't have enough of it, there's a tendency to go blind, to have problems with your eyes.

But we also develop white corn. And that's because people like to eat tortillas and all sorts of other corn products with white corn. And also for Africa, we know that people in Africa like to eat white corn. So, we want to make sure there is white corn for people in Africa.

You can see the effects of the high carotene corn when we feed it. And it's also very high in protein quality. So, we can feed a diet that has a lot of that corn in it that we will get very, very orange eggs. And once you start getting eggs like that, you really don't want to go to other eggs. And those sorts of eggs would be very, very valuable for human nutrition. And the birds also tend to accumulate it in their fat so that when we open them up, they look like they've been spray painted with orange paint. You can

see how orange some of our corn can get. And you can see that we can really select for that high carotene content. You can see the skin on our chickens. We had a rooster that wasn't enabled to eat the corn because the other roosters would bully him and keep him away from the corn, and he did not have this kind of skin at all. He was just totally pale. So, we know that it really is the corn that can produce that orange coloration, which is so important also in the developing world for preventing blindness and helping people.

We have tried to capture this fantastic nutritional value that's available in some of these Indian corns. Corns like this will often have up to 14% protein.

[20:16]

Part 10: Keeping Corn Clean: Cross Incompatibility | Length: 2:25
One of the objectives we also have is to keep our corn from being crossed with GMO corn. And there are these natural genes that occur in corn and in particular they occur in wild corn, in teosinte, but they also occur in sweet corn and popcorn from Mexico. And what's happened is that for generations and generations, people have selected their sweet corn so that it won't get outcrossed by their neighbor's corn, because if it does, it loses its sweetness. Or if it does, if it's popcorn, it loses its ability to pop.

And so, they accumulated these genes that were naturally there in the wild corn. And they allow the plant to recognize when the pollen comes in from the outside, whether it has those genes in it or not. And if it doesn't have those genes in it, that pollen can't grow that little tube and fertilize the egg in the cob. It's called cross incompatibility.

So, what will happen, and this is how we test the corn, we have rows of normal corn which has its tassel on and we take the tassel off the plants that we think has this gene. And if it allows itself to be pollinated at all,

then it doesn't have the genes. But if it has the genes in it, it will stop the pollination. It won't allow itself to be pollinated.

And you can see it can be very strong. In 2014 we had 39 different inbreds or hybrids. And we tested them in this way in rows, different rows, and out of them 35 no pollinations at all. Totally. It was like, wow, this is so strong. Six had a few kernels, four had a few whole ears that were pollinated, so we knew we didn't have complete control. But our effort now is to try to get this into all of our corn. We're now backcrossing the trait into our corn so that all of our corn can keep the GMOs out. And that's one of the major things we hope to achieve. Also, sweet corn. We're backcrossing it into the sweet corn so that people will have sweet corn that won't be allowed to be contaminated by any other corn, which is useful for farmers. Even if they don't grow GMOs, the sweet corn will be sweeter if no other corn can cross it.

[22:41]

Cooley Ludtke: Those were excerpts from Walter Goldstein's 2016 presentation *The American Story of Corn*. If you'd like to hear more stories like this, check in with us at farmsfortomorrow.org**.** You can also find previews and highlights on our Instagram page. Thanks for listening.

END OF TRANSCRIPT