NEAL'S ADVENTURES-III
THE PLANT BREEDER

Written by
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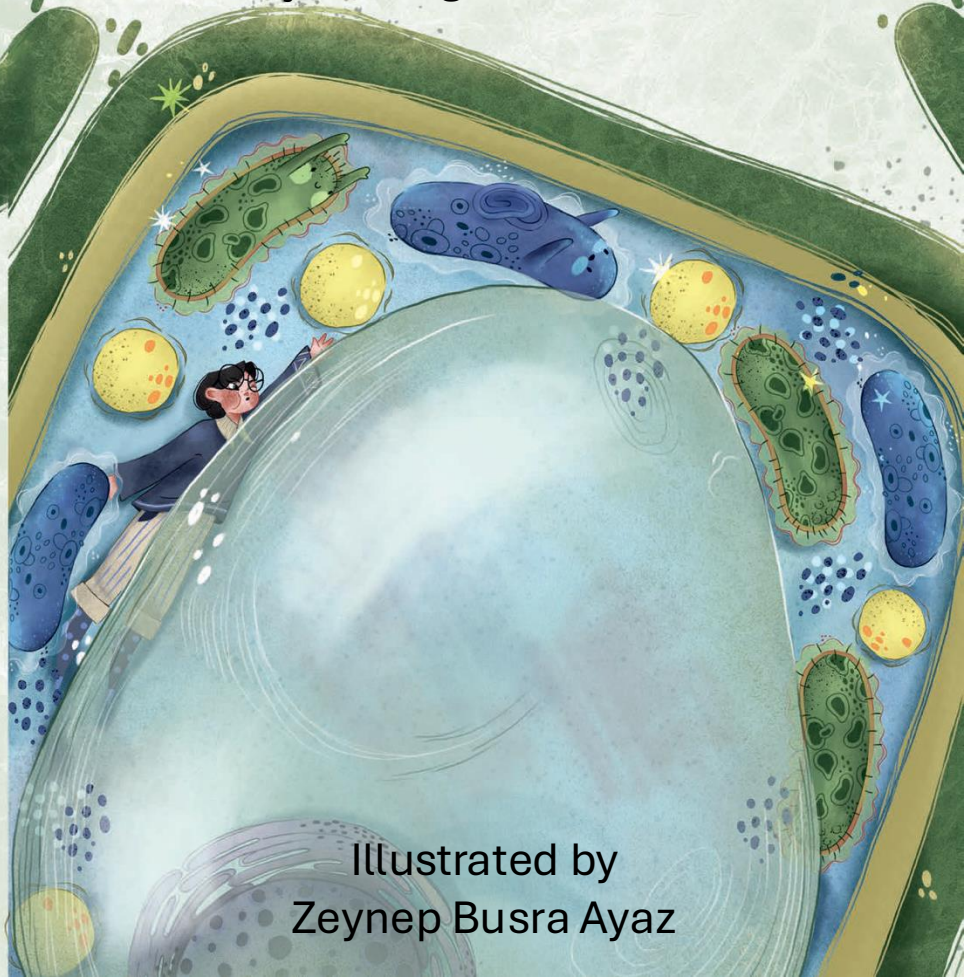
Neal has a new friend -- a plant! But one day, it looks sick. To learn more about his plant, Neal dives into a big book about plants -- and then into the plant itself.
He journeys through the roots and stem to the leaves, encountering unexpected challenges and some frightening obstacles along the way. But he surprises even himself when his curiosity wins out over fear every time.



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Dear Children,

We live in a world with other living organisms that we can see with our eyes, like animals, plants, and fungi and microscopic organisms like bacteria.

Plants provide us with food, medicine and clean air. They make our world a more beautiful place to live.

As a sign of our gratitude, this work is dedicated to plants. It offers an adventure in the world of plants. In this adventure, everything might sound new for you. Don't give up reading; be courageous enough to explore this new world. You might read the whole work or the certain parts again and again to get familiar with the heroes of this world. In the end, you'll feel part of it.

Seckin & Esra

In his last adventure, The Quest for Iron, Neal had spent months living inside a plant, waiting for a dandelion seed to fly him home. During that time, he had helped the stressed plant to find iron-rich patches in the soil and learned about how plants cope with various stresses by talking daily with the nucleus. When dandelion season finally arrived, Neal said goodbye to his friends, Nucleus, Chlo, and Mito, and spent the evening on a dandelion flowerhead that was going to seed. The next morning, the dandelion seed Neal was sitting on took off, and he rotated its stem just as Nucleus had instructed and soon found himself back at home.

Neal opened his eyes and saw that he was perched on top of a leaf. He was watching the sunrise. Suddenly the serenity was shattered by a deep, unsettling sound—like the sweep of a giant broom against the earth, echoing ominously.

"What could that be?" Neal whispered to himself. The plant beneath him trembled, the vibration growing stronger with each passing moment. He leaned over the edge of the leaf and looked down. Below, a legion of earthworms was coiling around the plant's stem. They were scraping against the stem, creating that eerie sound and leaving behind trails of smoldering ash.

Suddenly, the sunlight dimmed. Neal looked up, expecting to see a cloud covering the sun. Instead, there were shadows. These shadows descended from the sky, releasing the sunlight and revealing themselves as birds. Each bird was carrying shiny grey stones in their beaks. As the birds swooped low, they released the stones. Under the rain of stones, the earthworms quickly vanished into the soil.
Neal opened his eyes. He was at home in his bed. “It was a dream” he murmured, relieved and disappointed at the same time. And then he realized: “I am home! I did it!”
Neal jumped out of bed. Racing to the kitchen, he found his mother preparing breakfast. He hugged her tightly.

“Good morning, Mum! How are you today?” Neal’s face was very close to his mum, scanning her face for any sign that she knew what he’d been through.

“Good morning, sweetie!” she replied, her tone as calm and familiar as ever. Nothing was out of ordinary. Mum was unaware of what Neal had passed through.

“Either I had a dream or a real adventure,” he thought. He had to hurry to school, so he had to postpone thinking about what had happened. Glancing at his plant in the living room, he noticed something.

“Mum, my plant is green again!”

The fertilizer was working and the plant, its leaves all yellow when he had left home, was again a beautiful green, as he has hoped.

Neal went to the school. He had no problem adapting to real life. He met his friends, played basketball during gym, and tried to stay focused during science class. But his mind kept wandering back to plants.

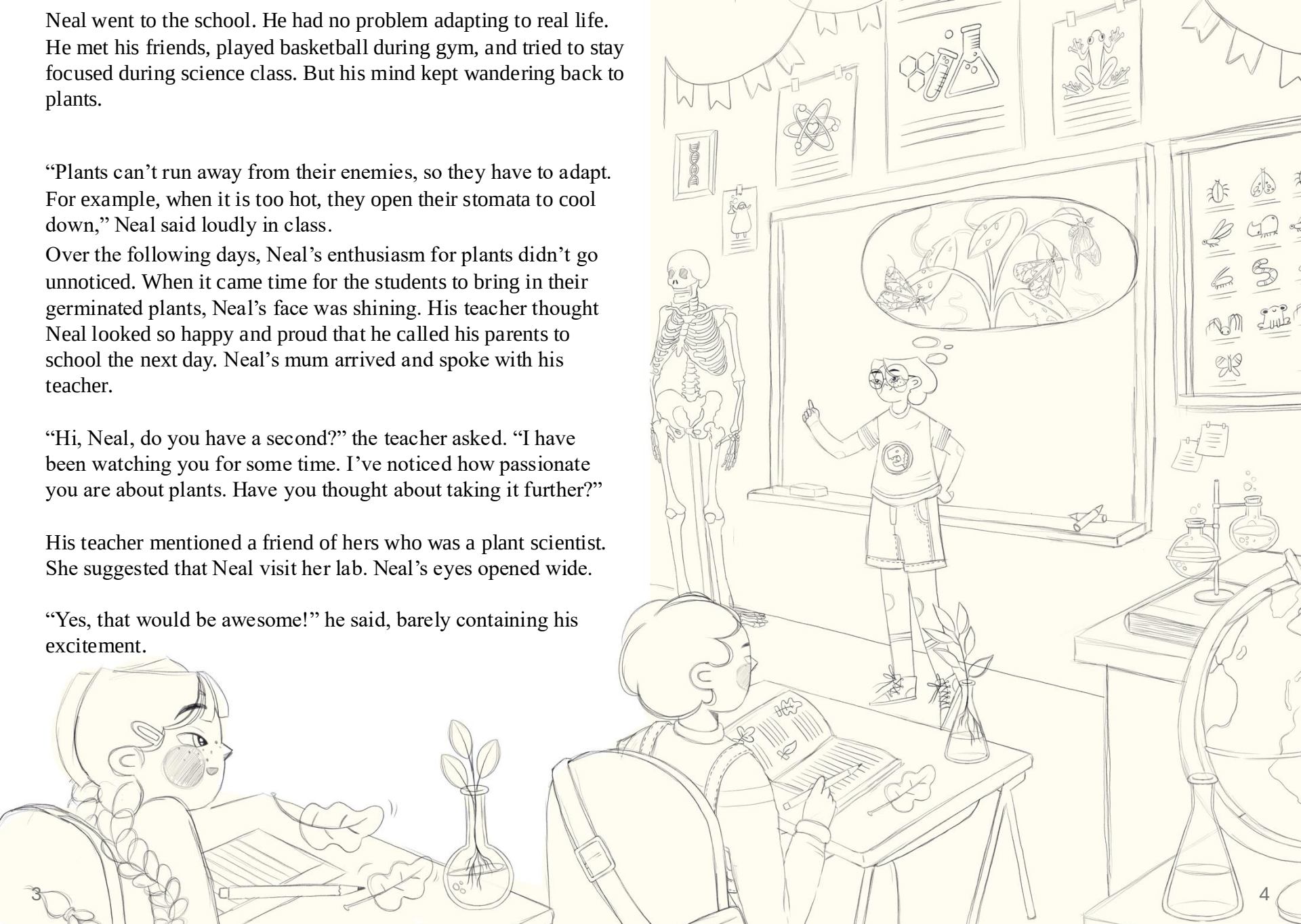
“Plants can’t run away from their enemies, so they have to adapt. For example, when it is too hot, they open their stomata to cool down,” Neal said loudly in class.

Over the following days, Neal’s enthusiasm for plants didn’t go unnoticed. When it came time for the students to bring in their germinated plants, Neal’s face was shining. His teacher thought Neal looked so happy and proud that he called his parents to school the next day. Neal’s mum arrived and spoke with his teacher.

“Hi, Neal, do you have a second?” the teacher asked. “I have been watching you for some time. I’ve noticed how passionate you are about plants. Have you thought about taking it further?”

His teacher mentioned a friend of hers who was a plant scientist. She suggested that Neal visit her lab. Neal’s eyes opened wide.

“Yes, that would be awesome!” he said, barely containing his excitement.



The next week, Neal's father left Neal in front of the Professor's office. He knocked on the door and entered.

"Hello, Professor."

"Hi, Neal! Come on in. I was waiting for you!"

They started to chat. The professor was surprised by how much Neal knew – not just memorized facts but a deep understanding of plant anatomy and stress responses. She could hardly believe her ears when Neal casually mentioned his "journey" inside a plant and his time-traveling. "Maybe it was a dream," the professor said with a smile, though clearly astonished by Neal's vivid story.

The professor talked about her research area and the basic concepts involved.

"I am a **plant breeder**. I work on improving crops," the professor explained.

"Improving crops?" Neal questioned. This sounded promising to Neal. "So, is there a way to make plants better at dealing with stress?"

The professor then explained the basics of plant breeding.

"Yes, we first decide which traits to improve. Do we want to have bigger fruits? Do we want to have plants asking for less water and be more drought tolerant?" she explained.
"Then, we go around the world and collect as many crop-related plants -- cultivated or wild -- as possible. We assess the ones with the largest fruits or those growing with the least water. Once we find those plants, we **cross** them with the current crop varieties and select improved offspring.

Neal absorbed every word. "It sounds so simple and powerful," he said.

"Yes, provided that you have some crop-related plants with the needed traits." The professor's expression dimmed when she talked about the limits of this approach. "Let's go to the lab. My student will show you how to cross two plants!

The professor brought Neal to her research lab. Researchers were surprised to see a child visiting the lab. Neal asked what they were working on with insightful questions.

Another research group worked under the same professor in another lab section. Neal noticed they were busier and more tense, as if a problem had no solution. Neal soon learned from them that a virus outbreak was wiping out the corn.

“Millions may suffer if the disease spreads,” the professor said. She had the exact same look Neal had noticed when she mentioned the shortcomings of the breeding approach.

“Professor, I guess you collected corn varieties worldwide, but none were found to be resistant to the disease. Right?”

The professor shook her head.

“For such cases, we usually look for the resistance trait in the relatives of the crop. For example, if a tomato gets a disease and modern tomatoes fail, we return to the wild to find **plant relatives** of tomatoes. We usually find some that can then be crossed with our modern variety. However, there are very few wild relatives for corn.”

The professor was explaining in detail, as if she was trying to get something off her chest.

“I sent some of my students to New Mexico to search for the wild relatives of corn. But with rapid urbanization, most of these wild relatives have disappeared in the last few decades. So, I’m not really hopeful.”

Neal asked his mother to return him to the professor the next day. Neal asked about the details of the problem. The professor handed Neal a big book called “Corn Breeding.”

Neal had an idea that struck him as soon as he heard about the missing relatives of corn. He read the book in the following days to develop his idea before he sharing it with the professor.

Finally, Neal returned to the professor with his plan.

“Professor,” Neal said, “I know we need to find corn’s wild relatives that are tolerant to the viral outbreak, but much of the **biodiversity** for corn and its relatives has been lost. But what if I could travel back to when they still existed and collect some seeds?”

The professor lifted her head from the computer. She smiled and walked around the room.

“This kind of thing may happen in children’s books, Neal, but in real life, we cannot travel in time,” she said.

“Who’s to say we are not in a children’s book?” asked Neal.

Professor took a moment of silence, looking at Neal’s face.

Neal continued, “I do not know if it was just a dream and whether I could do it again, but I did enter a plant and came back without being hurt. Let me help you. Give me a chance!”

The professor was hopeless. The virus was spreading, and 99 percent of all the corn cultivated in the world was susceptible to that virus. There might be no chance to withstand this virus. Corn was used in many industries, including food for humans, feed for livestock, and fuel. If corn were wiped out, it would devastate the world economy.

The professor smiled.

“Look, Neal, I cannot believe what you told me,” she said. “But I will give you the best response I can, in the most detailed way. I do not know why I’m taking your offer seriously, though. Maybe we don’t have any better alternative for now.”

Neal was relieved and listened to the professor carefully, took notes, and asked follow-up questions to avoid missing crucial points that would help him collect the seeds of plant relatives of corn from the past.

After Neal said good night to his family at home that evening, he went to his bedroom much earlier than usual.

“Was it all a dream?” he asked himself. He noticed he was rather worried and feeling anxious. Would it be possible to bring something from the past to the future? Last time, he found a way to come back, but it was far from smooth. Could he take the risk again? He noticed he was losing control with the thinking process. He tried to calm himself down.

"Innnnn, ouuut..., innnnn, ouuut...”

Once calmed, he went to the kitchen to find a large sack. He tested it by pushing it in and out. It was durable. He went back to his bedroom and tied the sack to his waist. He grabbed a pen and drew a big dandelion on the Corn Breeding book cover. The book cover included a drawing of southern Mexico, the **domestication** center of corn. He started reading the book and fell asleep whispering his wish: “I need to find **ancestors** of corn.”

Neal opened his eyes to an unfamiliar landscape.

“Yes! I did it again!” He checked that the sack was still tied to his waist.

Neal felt very proud of himself that the “bringing the sack” had worked. Suddenly, with a tight face, he looked around for the dandelion. Did the “drawing the dandelion” fail? He stood up and ran back and forth. He pushed through some bushes and saw a large area without much vegetation. Over this land, he noticed a huge piece of dandelion fluff. It was drifting slowly and silently.

“Oh, good! It’s here!” he cried.

He fetched the dandelion seed and hid it in a safe place.

Neal remembered his first trip to the plant world. He had possessed an adventurous soul at that time. He wanted to explore and discover the world of plants. This time, however, it was instead a serious sense of responsibility that motivated him. He felt that he should focus on his task. Still, before starting the task, he took a moment to enjoy the sunrise. He thought his trips to the plant world had been magical, but so were the colors during sunrise and sunset. They also felt out of this world.

A moment later, Neal took his eyes off the sunrise and tried to concentrate on his task. He should have been in southern Mexico, probably 10,000 years ago. Corn was everywhere in the world from where Neal came. But back then, there was no corn, only its ancestors. And they grew only around Mexico.

The first inhabitants of this land decided to take care of corn ancestors. These plants started to be cultivated in **human settlements.** In the hands of the early plant breeders, as time passed the corn ancestors started to look less and less similar to the wild plants and more and more similar to modern corn.

The professor had told Neal not to travel too far into the past. She had said that if Neal ventured back to prehistoric times, the wild plants would differ too drastically from modern corn, and such a difference might not allow crossing. They had settled on 10,000 years as an ideal time period to find enough biodiversity. At that time, human intervention likely would not have begun, and plants were not so different from modern corn as to prevent crossbreeding.

Neal started looking around for the corn ancestor. The professor had given him a picture of **teosinte**, the closest living relative of corn, and described how it should be the exact look of the corn ancestor. Unlike modern corn, with its one tall main stem, the corn ancestor had many branches and was shorter and bushy. While today's corn has delicious yellow kernels on its **cob**, its ancestor had just a few kernels. Each kernel was encased by a tough shell like a walnut.

The first inhabitants of this area took care of this wild plant, sowing its seeds in their camps and looking at the **progeny** for the plants with the biggest seeds. Early **breeders** likely selected for traits that gradually changed the plant over time. At some point, some lucky breeders may have seen corn varieties without the tough shell covering the kernels. Ears whose kernels no longer fell to the ground at maturity would also have been valuable. The early plant breeders would have sown those improved seeds.

Despite corn changed dramatically, wild relatives of corn would not have changed much in the last 10,000 years. However, wild relatives of corn went extinct either naturally or by urbanization. As a result, Neal had to travel to the past to bring back those lost plants to screen for potential virus resistance in them.

Not far away from where he started, Neal found the plant he was looking for. It was exactly as the professor had described it. He started collecting two or three seeds per plant. Some plants had already scattered their seeds; Neal collected those from the soil. Collecting from one area was easy, but the professor had urged him to collect samples from a diverse area. As the area of sampling expanded, so would biodiversity, increasing the chance of finding a virus-resistant trait.

"It will take days to collect like this," Neal thought. "I have to improve my technique!".

With a new idea in mind, he returned to where he had hidden the dandelion.

A moment later, Neal was flying in the air on his dandelion seed

“Harvest time!” he shouted, as he descended to the sea of corn ancestors that he had spotted from above.

Skillfully maneuvering the dandelion fluff, he moved between different regions where the corn ancestors were spread. Neal quickly got used to collecting seeds while on the dandelion. This saved him an immense amount of time. He filled his sack and even his pockets with seeds.

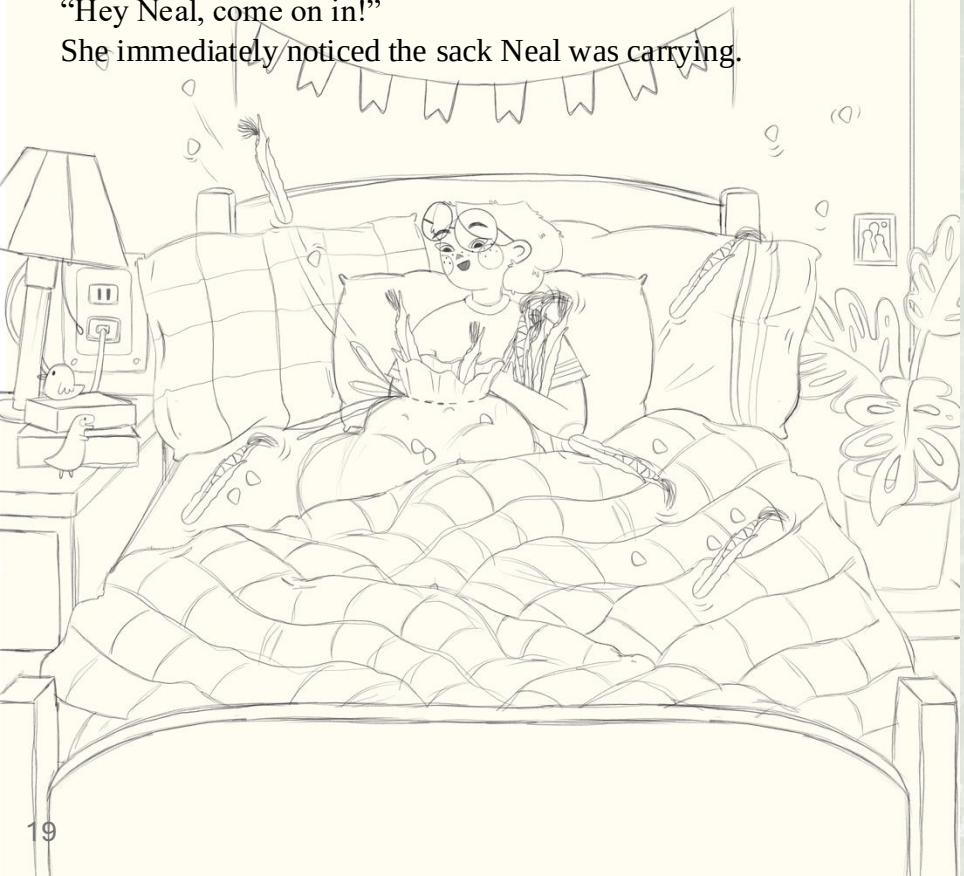
Being in Mexico 10,000 years ago was an unbelievable opportunity to explore big questions, such as how early humans first settled. But Neal was focused on his mission. After some time, “Mission accomplished!” he said, mimicking the voice of his favorite video game.

Now, he just needed to return. He hoped he would be able to transport the seeds he collected back to the future. He slowly started turning the dandelion seed. Some kernels fell from his pockets and even from the sack as it ballooned out from his waist. Neal was angry with himself. Why hadn’t he tied the sack more tightly? As on his other time travel adventures, the world spun around and Neal lost consciousness.

Neal opened his eyes.

“I am in bed!”

He checked the sack at his belly and felt the hard kernels.
“It worked. It worked!”
Neal was excited. It was the weekend, though, and he had time to calm down. He secured the sack in his wardrobe. He carefully collected the kernels that had spilled and put them back into the sack. After his successful journey, he went outside to play with his friends, pretending nothing unusual had happened.
On Monday, Neal knocked on the professor’s door.
“Hey Neal, come on in!”
She immediately noticed the sack Neal was carrying.



“Here it is, professor, the lost seeds of the past!” Neal had thought for a long time about what to say about the seeds. He was very proud and excited but didn’t want to sound like he was bragging.

The professor opened the sack and inspected the kernels. She was really surprised.

“How did you find these?” she asked. “Just a moment.”

The professor left Neal in her office. She handed the sack to her lab technician and asked him to check their seed stocks to see if any seed had disappeared. She also wanted the technician to screen the seeds in this sack for virus resistance. She was about to leave the lab but turned to the technician again: “Please prioritize screening these seeds.”

When the professor returned to her office, she explained to Neal that they would now germinate each seed and deliberately apply increasing concentrations of the virus to the germinating plants. She would inform Neal in a few months, she said, about whether any of the seeds he had collected produced a virus-tolerant plant. Once they found such a plant, they would collect seeds from the tolerant ones and repeat the experiment to confirm tolerance.

“What will happen if a tolerant variety is found?” asked Neal.
The professor smiled widely.

“We would then cross it with modern corn and test the offspring for the virus resistance trait. If it is confirmed, we would continuously cross this new variety with the modern one for a few generations to ensure we retain both the superior traits of the modern variety and the virus resistance.”

Back home, Neal felt relieved. This journey had been both easy and rewarding. Not only had he learned about plant breeding, but he had also become one of the breeders by helping to collect breeding material. He hoped some of the seeds he brought would show virus resistance.

He thought he had earned the professor's respect, which could help Neal learn more from her. Neal still had many questions about plant breeding.

“How is it possible for an ancient plant to have a resistance against a virus that just recently appeared?” Neal asked.

The professor explained, “Unlike crops, plants in the wild have been exposed to various diseases, so a group of plants in a wide area may have developed diverse resistance mechanisms. Although the virus is new, viruses tend to share certain properties. So, resistance developed against an ancient virus can also be handy against a new one.”

That made sense to Neal.

“Ah, I see. Ok. How did we lose that resistance when we started cultivating plants?”

“Not all wild plants had resistance to all viruses,” she said. “Early cultivation practices did not screen plants for virus resistance as we do now. They probably selected plants with larger and tastier fruits, higher yields, and other useful traits, and started to cultivate and reproduce only a subset of selected plants. A lot of useful properties for present and future challenges were left behind in the wild relatives.”

“I see,” said Neal. “But I still do not understand one thing,” he continued. “When I collected the seeds, I noticed they were inedible due to their hard seed covers. Why did the first breeders show any interest in the corn ancestor? Did they somehow guess that the hard covers would disappear during breeding?”

The professor thought for a moment.

“We don’t know exactly what happened back then. We only have guesses,” she replied. “Humans may have taken care of the corn ancestor to prepare clothes or baskets using its fiber. They probably selected plants with larger cobs and more kernels, and only maybe later for those without a thick cover and edible.”

She smiled and said, “Another possibility is that the first humans ate the ancestor of the corn after roasting kernels over a fire.”
“Popcorn!” Neal exclaimed.

Learning how much corn had changed in the hands of breeders made Neal curious about the history of other fruits. He had always enjoyed eating fruits and wondered how their flavors had changed over time. While learning about the fruits, he noticed that his appetite was increasing. He reflected for a moment on himself. A couple of weeks ago, he was sharply focused on a task to help the world. Now he was thinking of the taste of the fruits. How much he had relaxed!

Neal's father noticed the light was still on in Neal's room. He quietly slid in. Neal was wearing a napkin tucked around his neck, smiling in his dream as if he was not prepared for sleep but for a big feast.

"What a strange kid!"

Father chuckled and fondly patted Neal's head. An open book lay on the ground. Neal must have fallen asleep while reading. Father picked the book, "Watermelon Breeding," and saw a picture of huge and appetizing watermelons that made his mouth water. Father gently placed the book on Neal's desk, kissed his forehead, and left the room. As he closed the door behind himself, he made a note to remind Neal to take better care of his books and to stop drawing dandelions on the book covers.

Glossary

Ancestors: Early plants from which current species have evolved over time. Almost every crop we consume today has been domesticated. They had ancestors that might have been very dissimilar to today's crops. They had been selected by humans and gradually changed.
Natural variation: The variety of different traits in one species.
Breeding: The process of selecting plants or animals with specific traits and helping them reproduce to pass on those traits. For example, early plant breeders selected corn with more kernels and less tough coverings, improving the crop over time.
Cross: When two different plants are combined to create a new plant that has traits from both.
Domestication: The process of changing wild plants or animals over time to make them more useful for humans. For example, wild corn was domesticated by early people who selected plants with more kernels and softer coverings. Any domestication decreases natural variation for that crop. This may be good because plants gain the best traits in daily life, but it also has the disadvantage that some traits that can be valuable in emergencies such as a viral outbreak can be lost.
Human settlements: Places where people live and grow crops or raise animals.
Plant Breeder: A scientist who improves plants by selecting and crossing them to create better varieties. For example, a plant breeder might create a new type of tomato that is bigger and tastes better.
Stomata: Small openings on the surface of plant leaves that allow air and water to move in and out.
Stress: A factor that causes harm to plants and slows down their growth, e.g., heat, drought, toxic substances, or viruses.
Traits: Characteristics of plants such as color, size, or disease resistance.
Variety: A type of plant that is different from others in certain ways. For example, a green apple is a different variety of apple than the red apple, but red and green apples are also divided into many varieties such as Fuji, Granny Smith, etc. Almost all corn cultivated is of a single variety.
Viral outbreak: When a virus spreads quickly and affects many plants or animals. An example is banana bunchy top virus, which destroyed all bananas in Australia in 1920.
Wild relatives: Plants that are related to crops but still grow in the wild and haven't been changed (domesticated) by humans. They have much more natural variation than today's crops and may still able to fertilize/cross with them.