

SEIEI TOYAMA

In everyone's lifetime," wrote Seiei Toyama, "there is a fateful moment that determines one's life." For Toyama, who died in 2004 at the age of ninety-seven, that moment was meeting Akio Kikuchi, professor of horticulture at Kyoto University. It was Professor Kikuchi, he says, who "helped me put my feet on China's desert." In fact, "everything I did began with Professor Kikuchi."

Seiei Toyama's long productive life began on December 14, 1906, in Yamanashi Prefecture, near Mount Fuji. He was the third of seven children of Shodoh Toyama, a Pure Land Buddhist priest, and Fusae Toyama, a homemaker. The family lived in a Buddhist temple and their circumstances were humble, so much so that, for elementary school, Toyama was sent to live with his maternal grandparents in Yokosuka City in Kanagawa Prefecture—a day's journey from home in those days. Toyama says he actually "grew up" there, under the strict guidance of his grandfather, a pharmacist who specialized in Chinese medicines. When he finished elementary school, he returned home to wait his turn to attend junior high school. Meanwhile, he was sent to study in a small village school. There, he came under the spell of a local teacher who introduced him to plant life and the joy of growing things. This was the beginning of his fascination with agriculture, he said.

Through much thrift, Toyama's family managed to send him to Hikawa Junior High School, some distance away in Yamanashi Prefecture. Boarding in the nearby town of Katsunome, he found himself in an area famous for its *koshu* grapes, which by legend had traveled to Japan across the Silk Road along with Buddhism. Everywhere around him there were vineyards, some of them run by the families of his schoolmates. Toyama began joining his friends picking grapes at harvest time. He noticed that grapes darkened as they ripened and—since he also ate grapes as he picked them—that those close to the main branch were sweeter. The local grapes ripened and were shipped in October, but Toyama noticed that those still remaining on the vines after harvesting and chilled by the November frosts were sweetest of all. Only the local people ever got to taste them.

Grapes fascinated him. "If I study grapes," he thought, "that will be interesting." There were two great centers for the study of fruit horticulture in Japan: Tokyo University and Kyoto University. Toyama set his sights on Kyoto.

For high school, Toyama's family sent him to the city of Sendai in northeast Japan, where the young Toyama lived in a dormitory and studied at Sendai Number Two High School. This led to his first meeting with Professor Kikuchi. Toyama was an avid sportsman in kendo, judo, boating, and rugby, as well as mountaineering. While in Kyoto for an intra-high school sports competition, he and the other athletes visited alumni of the high school to solicit donations to pay for their trip. It happened that Kikuchi had also attended Sendai Number Two High School. Toyama boldly approached him. Kikuchi made a donation and then asked, "What will you do after high school?"

Flustered, Toyama answered, "I want to do agriculture."

Kikuchi replied, “If you want to do agriculture, come to Kyoto University and I will train you.”

“*Hai*, yes,” said Toyama.

Later, having passed the entrance examination, Toyama enrolled at Kyoto University and presented himself to Professor Kikuchi. At this point, said Toyama, “my life changed dramatically.” Kikuchi Sensei told him, “The sun never rests, even a day.” In agriculture, too, “there is no rest. Do you understand that? We must work like the sun.”

Kikuchi himself was renowned for his work ethic. Toyama vowed to follow his lead. For the next three years, Toyama said, he did not rest a single day. Weekdays were filled with lectures and experiments and work in the laboratory and on the university’s experimental farm. On Sundays and holidays, he combed the nearby mountains and woodlands collecting wild plants to transplant in the university test fields and for his own study of plant life cycles. In three years, he collected eight thousand pages worth of samples!

These studies led to Toyama’s first breakthrough in the study of plant ecology. The *manjushage* plant (also called *higan-bana*, the cluster amaryllis) had long been thought to be two separate plants: one with beautiful red lily-like blooms in the autumn and another with thick green leaves in the spring. By transplanting *manjushage* bulbs to the test field, Toyama discerned that the two plants were actually two stages in the life cycle of a single plant. This was the first of several similar discoveries. As Kikuchi Sensei’s research assistant, Toyama assisted in the creation of a subtropical botanical garden on the island of Oshima in Wakayama Prefecture and scoured the countryside in search of the “index plant” for tangerines. Traveling in remote places, lodging in cheap country inns and with local farmers, and “walking everywhere” to ferret out shrines and temples where the oldest trees were protected, he discovered the joy of “learning from nature.”

When Toyama graduated from Kyoto University in 1934, Professor Kikuchi asked him to stay on as his research assistant. He did so for another year and a half until, one day, his mentor asked him, “Would you like to go to China?” Kikuchi Sensei explained that the roots of horticulture in Japan lay in China; even Japan’s knowledge of Western horticulture had come through China, as had many plants themselves. We must study there, he said. Toyama was only too eager to do so.

Kikuchi arranged funding for Toyama’s fieldwork in China through the Boxer Rebellion Indemnity Fund, money provided by the government of China as an indemnity for attacks on foreigners during the Boxer Rebellion of 1900. Many young Japanese had been sent to China under this program to study the arts and culture, but Toyama was the first agriculturalist. He departed from Japan for the first time in his life aboard the *Chojomaru* in September 1935.

By this time, relations between Japan and China had worsened since the time of the Boxers. In a few short decades, the last imperial dynasty of China had fallen and been replaced by a weak republican government and, in many regions, rule by warlords. Among China’s nationalists, a violent power struggle over the future of the country was taking shape. In this weakened state, China became easy prey for Japan, whose empire-minded militarists were on the rise and gaining at the expense of Japan’s civilian politicians and democrats. Japan already enjoyed special privileges along the China coast through the notorious treaty port system. In 1931, its forces invaded Manchuria and created the Japanese-sponsored state of Manchuguo in 1932. The following year, Japan occupied Jehol (or Chengde; Rehe, in Japanese) Province bordering Manchuria and, two years later, forced China to recognize its virtual occupation of eastern Hebei

and Chahar provinces. By then, its imperial armies were poised to seize more of China—and would soon do so.

Meanwhile, Toyama settled in Beijing near the Forbidden City and embarked in intense study of Chinese—attending classes during the day at the American Chinese High School (where he remembers being taught by a certain Mr. Wittfogel) and working with tutors at night. For three months, he did nothing else. When he could speak the language, he began to study Chinese farming techniques and surveyed the local markets and farms to learn what vegetables, fruits, and flowers were growing and how they were being distributed. He made meticulous records of everything and took glass-plate photographs of his most interesting finds. From the environs of Beijing, Toyama eventually traveled “all over China” and, in the summer of 1938, made his way to Inner Mongolia. It was a rough trip punctuated by a bandit attack during which he saved his money and possibly his life by taking out his Buddhist beads and chanting like a monk.

Traveling along the route of the old Silk Road, Toyama arrived in Ningxia Province (today, Ningxia Hui Autonomous Region). Years later, he remembered seeing the desert and its “vast open spaces” of sand for the first time. He was speechless. He reached down to touch the sand and later wrote that it felt warm and rough, like burlap. What surprised him were the large numbers of Chinese farmers growing grapes, peaches, and pears as well as vegetables and fields full of poppies. Seeing this, he realized that, if properly irrigated, sand was “an ideal medium in which to grow crops.” It was a eureka moment. He was immediately possessed by the idea of sand and the possibility that, in China, sand agriculture might succeed on a vast scale.

In the meantime, however, Toyama returned to Beijing. There, a visiting Japanese scholar whom Toyama respected advised him privately that the time had come for him to marry. Taking this advice to heart, Toyama slipped home to Japan where he proposed marriage to Hideko Yokoyama, the sister of one of his friends. Although she said no the first time, ever-persistent Toyama won a yes when he tried again. He and Hideko were married in Kyoto, after which Toyama paid his respects to Kikuchi Sensei and returned with his bride to Beijing.

For several months thereafter, Toyama’s work proceeded without incident, but in July the deteriorating relations between Japan and China finally caught up with him. While Toyama was on a field trip to study chestnut trees early that month, hostilities broke out between Japanese and Chinese soldiers over the Marco Polo Bridge Incident of July 7. As a Japanese national, Toyama came under suspicion and was forcibly detained for one week by members of Jiang Jieshi’s [Chiang Kai-shek’s] army. (His makeshift jail was a small restaurant. Toyama slept on a tabletop.) When the Japanese foreign minister issued a protection order for him, Chinese officials intervened and he was released and taken to an inn. While there, he was approached by a Japanese woman, the wife of a fellow Chinese agriculturalist and a friend of his. Fearing for her life, she pleaded with him to take her back to Japan. But Toyama, in a panic himself, fled during the night without her and, hidden under the seat of a car without food and water for two days, made his way to Tianjin. (Toyama was wracked with bitter memories over this betrayal until, many years later, he serendipitously met the woman again and had the opportunity to apologize and was forgiven). In Tianjin, Toyama was greeted by Oniwa Tadashi, an old friend from elementary school who was serving as an occupation police officer. Tadashi served the starving Toyama a bowl of tempura and rice, and then a second one. It was “like meeting Buddha in Hell,” said Toyama.

From Tianjin, Toyama took a military train to Beijing where he rejoined his wife. Almost immediately, the Japanese embassy ordered all Japanese expatriates into the embassy building. As the Marco Polo Bridge crisis quickly expanded into full-scale war, the Japanese foreign

minister ordered Japanese civilians to evacuate China quickly. Toyama and Hideko jumped on a train and sped to Japanese-occupied Tianjin, where in October 1937 they boarded a ship home. By this time, Japan had launched an all-out invasion of China. Toyama would not return for forty-three years.

Only a day after his return from China, Toyama paid his respects to Professor Kikuchi who told him, "I've already decided where you will go next." A vocational horticulture school in Ikeda, Osaka, was in urgent need of a teacher (having just fired one). "You go there tomorrow," said Kikuchi. Feeling lucky just to be alive, Toyama set out for Osaka and, just a few days later, began to teach.

The horticulture school was in the process of transferring to a new site. Its students were rowdy and academically mixed. Among its other shortcomings, as Toyama soon discerned, was that no one but himself was actually qualified to teach horticulture. During the next four years, he played a key role in getting the new school off the ground, building its facilities and its teaching staff and carrying a great deal of the core-teaching load himself. The project flourished and the school eventually became the Osaka Prefectural School of Horticulture.

On December 8, 1941, the very day that Japan's imperial forces attacked the United States at Pearl Harbor and the Philippine Islands, Toyama received a postcard from Kikuchi Sensei with this message: "Go to Tottori Agricultural College tomorrow!" To Toyama, "what Kikuchi Sensei says is equivalent to what the emperor says." Ever loyal and grateful to his mentor, he obeyed. Tottori, a coastal prefecture facing the Sea of Japan, possessed a geographical feature that fascinated Toyama but that was rare in Japan: a desert-like habitat. It is there during the next four decades that he would explore the remarkable agricultural potential of sand.

The Tottori sand dunes, Toyama wrote, are "tiny compared with the world's major deserts." (In fact, with an average annual rainfall of two thousand millimeters, they are not technically a desert. But they are most certainly barren sand.) The dunes stretch only sixteen kilometers along the prefecture's coast and are, on average, two kilometers wide. They are one of three concentrations of dunes in Japan, and the largest. The sand at Tottori is coarse and resembles "cotton," said Toyama, unlike the silk-like sand of some other deserts. As he was to discover, the coarseness of Tottori sand made it permeable, easing the flow of oxygen, water, and nutrients to plant roots—thus making it an ideal medium for irrigated agriculture.

When Toyama began teaching at Tottori Agricultural College, he met Professor Masaru Hara, who had been an instructor of forestry at the school since 1923. In the intervening years, Hara had experimented with planting trees in the dunes. By constructing a large artificial dune on the seaside of the Koyama section of the Tottori dunes, he had created a stable wind-protected enclave on the landward side, where a nascent forest of Japanese black pine trees was well under way by the time Toyama arrived. It was from Professor Hara that Toyama borrowed twenty hectares of duneland in the Koyama section to begin his own experiments in transforming the desert into arable land, just as he had witnessed farmers doing along the Silk Road in western China. Aside from his own scientific curiosity, the war raging outside Japan lent urgency to his project. There were severe food shortages. Indeed, these shortages would continue until well after the war. "Every bit of land that could be cultivated had to be tamed," he wrote.

In 1942, on the land borrowed from Professor Hara, Toyama began planting bulbous plants, asparagus, and melons in small plots. "I filled old gasoline cans with water from a shallow, hand-dug hole and carried them slung from a pole, coolie-fashion, to my fields," he later wrote. "It worked, and my crops thrived."

At war's end, Toyama was able to expand his research into the larger Hamasaki section of the dunes. The Hamasaki dunes had been used as a military training base during the war and, in 1946, were still being used as a firing range by occupying American forces. Toyama set up his field headquarters in an abandoned, dilapidated army barracks and, "shovel and hoe in hand," set to work. Local farmers were skeptical. "We've tried for generations to cultivate the dunes," they said, "yet we've always failed. Now a college professor comes and announces that he's going to farm the dunes." Working alone at first but soon enlisting help from his students and colleagues, Toyama bicycled to the dunes every morning and spent his days "endlessly digging and carrying sand in straw buckets." In the immediate postwar years, food was rationed; to feed his coworkers, Toyama bought rice on the black market by bartering away his wife's finest kimonos. He worked obsessively. "Nothing could keep me away from the dunes," he said.

A boon for Toyama and his coresearchers was the presence of a spring on the research site. From this oasis, as he called it, 1,200 cubic meters of fresh, cool water bubbled up daily. "Thanks to the spring, we have never wanted for irrigation water," he said. As is customary throughout Japan, Toyama built a small Shinto shrine at the site to honor the water god.

In 1953, Toyama began introducing mechanized irrigation to his dunes. The primitive overhead-nozzle system he installed (courtesy of an Asahi science grant) was a great improvement over improvised watering cans. However, the equipment was not portable and covered only a small section of Toyama's dune farm. When the Japanese government implemented a law in 1953 designed to stimulate agricultural productivity in Japan's under-cultivated sandy coastal areas, Toyama was quick to apply for funds. A grant of 2.4 million yen from the Ministry of Education permitted him to import a portable sprinkler system from the United States. "The 'swish, swish, swish' of artificial rain was music to our ears," he wrote. "The shower of water cooled the air, and our wilted crops revived before our eyes." On his 4.5 hectares of irrigated fields, Toyama began raising summer crops such as Chinese yams, peanuts, and tulips. When a local company began manufacturing a similar but cheaper sprinkler system of Toyama's own design, he began introducing the technology to local farmers. They resisted at first, in part because they were obliged to pay for a portion of the sprinkler-delivered water. But in time, Toyama was able to demonstrate the benefits; by using mechanized irrigation, farmers could shift from low-priced crops, such as sweet potatoes, squash, and mulberry trees, to more profitable cash crops, such as Chinese yams, watermelon, strawberries, asparagus, and tobacco.

Meanwhile, Toyama experimented with other innovations. He and his team invented a plowing machine that could create furrows up to a meter deep. Deep planting (of gourds, melons, and yams, for example) promoted healthier roots by enhancing their capacity to absorb water and nutrients; deep under a protective cover of sand, they were also less susceptible to heat and drought. One of the most onerous aspects of Toyama's project was leveling the dunes by hand. In 1957, Toyama was able to expand his experimental farm considerably when a junior colleague of his at the college leveled a seven-hectare section of dune hills with a bulldozer. All of this activity culminated in 1958 with the inauguration of the Sand Dune Research Institute. The institute was recognized officially by the Japanese Ministry of Education as an affiliate of Tottori University. (In 1949, Tottori Agricultural College became the College of Agriculture and Forestry, one of five colleges that made up the newly established university.) The institute was also the headquarters for the Sand Dune Research Society of Japan, which Toyama founded in 1954. The Sand Dune Research Institute at Tottori would be Toyama's base for the rest of his career. He served as its formal director from 1965 until his retirement.

Working tirelessly at the institute, Toyama studied the special properties of sand and arid-land habitats. Plants grown in sand not only develop healthy roots, he learned, but respond well to controlled irrigation. Since sand itself does not absorb water or nutrients, virtually all of the water and nutrients introduced to the sand can be absorbed directly by the roots. Toyama studied exactly how much water was needed to irrigate each centimeter-depth of sand. “Through experimentation,” he wrote, “we learned that one millimeter of water would penetrate exactly one centimeter into the sand. Thus, a plant whose roots went down 45 centimeters would require 45 millimeters of water. More than that and the excess water will seep into the ground below the roots, a waste.” By dissolving organic fertilizer in the irrigation water, Toyama could fertilize and irrigate at the same time, delivering a precise amount of both water and nutrients to the roots in a sort of sand-based hydroponics. “Fruits and vegetables grown in sand tasted better,” he concluded. “Root crops looked better.” (Toyama published his early findings on dune farming in his doctoral thesis of 1962, a best seller in the field of horticulture: *A Study on the Adaptation of Crops to a Sand Dune Environment*.)

At the Sand Dune Research Institute, Toyama devoted himself to discovering which plants, exactly, could be most improved through sand farming. Chinese yams, for example.

“Before the war,” wrote Toyama, “not even the locals were willing to eat sand-grown yams.” Moreover, cultivating them was arduous from first to last. Yet, these tuber vegetables seemed ideal for sand farming. Beginning in 1950, Toyama began applying his sand-irrigation techniques and was soon harvesting mild-tasting, perfectly shaped yams. To extract them from the ground, he loosened the sand around each one with a high-pressure water hose, making extraction of the long, thin plants easy. (In the past, farmers had to dig a meter deep into the sand around each yam, to the very tip, so that the tuber could be removed gently from the earth.) By the mid-1990s, Toyama was happy to report that Chinese yams flourished “in two hundred hectares of dunes” and were a staple of the Tottori tourist trade and “in demand all over Japan.” They still are.

Through similar applications of his techniques, Toyama identified several other plants with commercial potential whose botanical characteristics lent themselves to dune farming. The techniques developed for Chinese yams, for example, applied equally well to the *manguchi daikan*, a large white radish of exceptional length. Scallions, beloved by the Japanese pickled in vinegar, grew perfectly in the sand. Toyama’s dune gardens yielded scallions that were “small, white, glassy, and satisfyingly crunchy,” he said. Tobacco was yet another crop suited to dune farming, he discovered—after the Japanese government urged him to study it. For one thing, its fine roots require lots of ventilation; for another, by carefully controlling the flow of nitrogen to the roots, farmers can enhance the quality of the plant’s all-important leaves. Tobacco is notorious for depleting the soil, but in dune farming, where nutrients are delivered via fertilizer-enriched irrigation water, this is not an issue. Finally, tobacco grown in sand has lower nicotine content than tobacco grown in soil.

Flowers were another commercial crop that Toyama and his Tottori colleagues adapted to dune farming. Beginning in the 1950s, Toyama took a special interest in tulips, which the Dutch had developed into a major national industry by cultivating former coastal sand dunes. Sand provided the perfect environment for their long delicate roots, and Toyama’s plowing and mechanization techniques made tulip production cost effective. He found that tulips grown in the dunes produced “earlier buds and more beautiful flowers than those grown in soil.” Indeed, his tulip fields were often inundated with visitors when the flowers bloomed in mid-spring. Today, tulip growing is a principal industry in several Tottori towns.

A hallmark of Toyama's work at the Sand Dune Research Institute was collaboration with farmers and also with local companies and government. When he established the Sand Dune Research Society of Japan based at the institute in 1954, he made a point of opening the society to farming households and to professionals and amateurs alike, indeed to "people who are simply interested in dunes." The society fostered cooperation across the sectors of scholarship, business, and government and published an influential journal. Toyama learned that the Chinese government was an early subscriber and that Mao Zedong himself was among its readers. Another measure of Toyama's influence and of the importance of his research at Tottori University was the training of a new generation of scholars who carried on his work at Tottori and elsewhere across Japan and later in China. His own son, Masao Toyama, took up the cause of desert agriculture and became Toyama's protégé and successor at the institute, which in 1990 became the Arid Land Research Center. But as early as 1967, another of his protégés, Itsuo Wakisaka, an assistant professor in horticulture at Tottori University, was appointed director of a new dune experimental station at the Ichinada Hokudai Dunes of Ishikawa Prefecture, which, like Tottori, possesses a long coastline facing the Sea of Japan.

In compliance with university rules, Toyama retired formally from Tottori University in March 1972. (Having long since internalized his honored mentor's work ethic, however, he never stopped working and continued to report daily to the institute—where a photograph of his mentor Professor Akio Kikuchi hangs prominently on the wall.) By this time, about 80 percent of Japan's dunes had been developed. Now, said Toyama, "we had more time to direct our attention outside Japan, to the world's deserts."

Funding from the Pure Land Buddhist lay organization Rissho Kosei-kai in 1976 led to the institute's first major international undertaking in Iran. Led by Toyama's son Masao, Tottori-based researchers surveyed the possibilities there and established an experiment station. Iran's vast deserts combined with major new irrigation infrastructure made the country an ideal site to apply and test Toyama's findings in Tottori. The project was hindered by political instability, however, and in 1979 was completely overtaken by the Iranian Revolution, which ousted the shah (Mohammad Reza Shah Pahlavi) and brought a self-consciously Islamic government to power under the Ayatollah Khomeini. The Tottori team was forced to abandon the project. In the wake of this setback, Masao Toyama launched a new project in Baja California, Mexico—a region with a habitat much like Tottori's but with much less rain. Working with a team from Tottori and several other Japanese universities, Masao Toyama and his coworkers successfully introduced new techniques for growing muskmelons, bok choy, and a vast range of fruits and vegetables in a project that lasted until 1987. By this time, Seiei Toyama himself had launched new work in yet another of the world's deserts, one close to his heart, in China.

Indeed, throughout his many years in Tottori, Toyama had never forgotten his youthful sojourn in China and his first encounters with the Chinese deserts. He longed to return. But Japan's brutal assault on China in the 1930s and the horrible long war that followed had created a bitter rift between the two countries—a rift reinforced by the triumph of Mao Zedong's revolutionary communist movement in 1949 and the establishment of the People's Republic of China. In the years since, Japan had stood with its postwar occupier the United States and its Cold War allies in refusing to recognize the new regime. Relations remained frozen for more than twenty years.

As a Buddhist, and also as a witness to the Japanese onslaught in 1937, Toyama believed that his country owed a generous debt to China. Yet China had received nothing by way of reparations for Japan's invasion. He now hoped, he said, to contribute his own expert

knowledge—and also his sweat and labor—for the development of China’s deserts as “one person’s endeavor to make amends.”

Toyama gained hope when President Richard Nixon of the United States visited the People’s Republic of China in February 1972, sensing that Japan would soon follow. In fact, Premier Kakuei Tanaka made an official visit to Beijing the following September and diplomatic relations were reestablished. But for Toyama, seven years passed before an opportunity arose to revisit China’s deserts. When he was invited to join a Western China Scientific Inquiry Tour in 1979, he leaped at the chance. He was seventy-three.

In a tour that included the great deserts of inner China—the Gobi, the Taklimakan, the Tengger—and several desert cities and towns, Toyama observed closely how local farmers had adapted to the desert habitat over the centuries and marveled at the untapped possibilities. In Xi’an, Shaanxi Province, capital city of several great dynasties and the eastern terminus of the old Silk Road, he witnessed the region’s famous walled-in farms, irrigated by ancient canals and wells. In Turpan, in the Xinjiang Uygur Autonomous Region at the edge of the vast Taklimakan Desert, he saw “vast fields of wheat and rapeseed” and old willow trees demarcating one farm from the next, “a sure sign water was plentiful.” In Turpan, he learned, farmers had been growing grapes for centuries and drying them in hot brick sheds to make raisins.

Hotan, on the western fringe of the Taklimakan Desert in the Kunlun Mountain foothills, had long been a silk-producing center where farmers specialized in mulberry trees and also grew cotton and a wide range of fruits and nuts—most of them originally from the Middle East and introduced to China through the Silk Road. The Hotan River that skirts the western edge of the Taklimakan Desert made all of this possible—the desert itself, Toyama noted, was completely barren.

In other sites along the way, Toyama observed the positive results of more recent efforts to green the desert. In Zhongwei, along the Yellow River bordering the Tengger Desert, he found the whole city covered with poplar trees, a result of Mao Zedong’s call to “Green Our Homeland” with groves of trees planted strategically to control drifting sands in regions bordering the desert. And in the town of Shihezi, north of Urumqi in the Xinjiang Uygur Autonomous Region, he witnessed the remarkable work of People’s Liberation Army general Wang Zhen who, following 1949, had turned his troops to building reservoirs and establishing farms and factories in the once-barren locale. When Toyama visited in 1979, Shihezi’s agricultural communes were irrigated by eight reservoirs and covered some 3,300 square kilometers growing wheat, sugar beets, cotton, and corn. These farms, in turn, provided the food and raw produce to support livestock, cotton spinning, sugar refining, and food processing. Seeing this, Toyama said, “I was reassured that my own dreams of greening [China] were indeed possible.”

Everywhere he went, Toyama saw potential. Everywhere he went, he took note of untapped or under-tapped water sources for irrigation—noting the deep snow atop the Tianshan Mountains, the ponds of water in the otherwise barren Gansu Corridor, and the mighty Yellow River itself that traversed the adjacent Kubuqi, Mu Us, Tengger, and Gobi deserts. And everywhere he went, he saw work to be done. In Lanzhou, he said, it occurred to him that the Japanese vine known as kudzu could be used to anchor the drifting sand along the banks of the Yellow River. In Turpan, where grapes had been grown for more than two thousand years, he said, “I could see that no effort was being made to improve viticulture, the quality of the grapes, or the regularity of the harvest. What a waste . . . !”

Five years later in 1984, Toyama returned to China as head of the Japan Cooperation Corps for the Development of China's Deserts, a new organization he had founded. "The Chinese government had heard of my achievements in dune farming," he said, "and believed in my genuine interest in greening the Chinese deserts." His hosts were the China-Japan Friendship Association and the Chinese Academy of Sciences. Traveling with Professor Tomahisa Yano, the current director of the Tottori Sand Dune Research Institute, Toyama visited two desert research stations affiliated with the Academy of Sciences: the Shapotou extension post of the Lanzhou Desert Research Facility and, two thousand kilometers across the desert by train, the Bioagronomic Desert Research Station at Urumqi. He and Professor Yano found themselves in good company among the Chinese researchers, but Toyama concluded that these research centers were too focused on basic research—at Urumqi, for example, on the sandy soil's hydrogen-ion concentration and acidity. "As a result," he observed, "little headway has been made in applied research on what to grow and how."

By the end of his trip, Toyama had clarified his goals for China. In the next four years, as his trips to China became more frequent and as the Japan Cooperation Corps became increasingly active, he focused on two new concerns: modernizing desert viticulture and controlling the drifting sands of the Tengger with kudzu. Although he now began to move widely through the region—making return visits to Lanzhou, Huhehot, Baotou, and Zhongwei—the Shapotou Experimental Station became his working base in China.

The research station at Shapotou had been founded in the early years of the People's Republic to plant trees and grasses along the region's all-important railway lines and, by the 1980s, was a major site for desert research. It rests near the banks of the Yellow River at the very edge of the Tengger Desert. From the station's viewing platform, Toyama wrote, "one can see across the Tengger Desert to the Yellow River, and beyond to more desert and hills." The climate is dry and very hot, reaching degrees in the high forties Celsius. Aside from the research station itself, an enclave of modern civilization, the place was primitive when Toyama began working there in 1986. Families in a nearby village lived crowded into small brick houses that they lighted with oil lamps; there was no electricity beyond the station. Apart from some terraced fields and wheat farms along the river bank, little was growing. To Toyama, the local apples grown on a state farm seemed stunted. He noted that the farmers did not know how to prune the trees properly.

Grapes had been grown in the region since ancient times, with little change in methods of propagation. Here and in other grape-growing areas that he had observed (such as Turpan), farmers grew grapes on poles and hedges and, during the frigid winters, arranged the vines in coils to be buried in the ground. This was not only laborious but also injured the plants, which were often damaged when farmers dug them from the ground and uncoiled them in the spring. Toyama introduced a new system in which the grapevines were trained along one-meter-high wire trellises strung along rows of concrete pillars. In Toyama's system, in the winter time, the vines were buried, uncoiled, in long trenches parallel to the vines—making the springtime re-hanging easier and safer for the plants.

Funded by a ten-million-yen gift from the Rissho Kosei-kai Fund for Peace, which also donated a bulldozer, a jeep, and over one thousand agricultural implements, Toyama introduced the new-style vineyard to Shapotou in 1987, planting a few hectares of recently reclaimed desert land near the station. Two years later, the vines were flourishing and full of grape clusters. Toyama's grapes were sweet, with a sugar content of 30 percent (as compared to 18 percent in Japan). He attributed this to the long hours of intense daily sunlight in the region and the extreme

temperature shifts between day and night. On return visits in subsequent years, Toyama witnessed the project grow and thrive. He described it as the “first attempt to modernize techniques and improve the quality of [Chinese desert] grapes” in two thousand years.

A signal aspect of this project and others was collaboration between Chinese horticulturists at the station and Japanese experts (such as his son Masao and others from Tottori University). Also fostering his work was the China-Japan Friendship Association—whose honorary chair was his friend and fellow “desert greener” General Wang Zhan of Shihezi—and his sponsors at the Chinese Academy of Sciences.

As his Shapotou viticulture prospered, Toyama simultaneously tackled the more fundamental problem of using plants to tame the desert and mitigate its harmful impact on China’s farmers, especially through the giant Yellow River.

The Yellow River rises in China’s west Qinghai Province and wends its way for five thousand kilometers toward the sea at the Gulf of Bohai. In its middle reaches, it traverses a vast range of desert, famously absorbing untold tons of yellow silt called loess as it moves downstream. By constantly raising the level of the river, loess has been the cause of century-upon-century of catastrophe as the Yellow River overflows its banks (and even changes course), destroying homes, farms, and lives on a colossal scale. In China, Toyama heard that the Yellow River had flooded two thousand times in the past three thousand years! Indeed, diking the capricious river and containing its damage had preoccupied Chinese rulers for centuries. Toyama personally witnessed its destructive force in 1936 in Shandong Province. “I remember vividly,” he wrote later, “the long line of refugees who had lost both their homes and their crops. The starving farmers sold their children one at a time.”

Although Chinese farmers attributed fertility to the river’s yearly deposits of loess, Toyama disagreed. He pointed out that the clay-like loess hardened the soil and drew salt to the surface; moreover, loess bore few nutrients. For these reasons, Toyama became obsessed with controlling loess.

Erosion was the problem. Rainwater in the desert regions lifted loess from the earth’s dry surface and carried it into the river. Plants along the riverbanks were the obvious solution. Their roots would anchor the dry soil and soak up the rainwater, capturing it before it flowed into the river with its load of topsoil. Chinese researchers at Shapotou had already experimented with grasses and with some stands of poplar trees. But Toyama believed something more ambitious was needed, indeed a carpet of greenery along the entire length of the river. And he believed that one plant was superior to others in its potential to succeed. This was kudzu.

The kudzu vine, as Toyama explained to his Chinese counterparts, has deep penetrating roots, which create “a powerful underground net a meter and a half deep” that captures and holds water and stabilizes the soil; it also provides a tenacious and hardy ground cover. Hence, it can serve as a powerful check on erosion. Once established, kudzu “readily proliferates.” Its leaves, moreover, can be used as fodder for livestock, and the Japanese have long valued its starchy tuber to make flour. Toyama had studied irrigation and flood control projects in the United States and knew from a U.S. Department of Agriculture study that kudzu had been introduced as an erosion brake by the Tennessee Valley Authority in its mammoth seven-state rural development scheme of the 1930s. (For the project, five tons of kudzu seed were shipped from Japan to the United States.) Calling again upon the generosity of the Rissho Kosei-kai, in 1986 Toyama began to introduce Japanese kudzu to China. He would use it, he told a Chinese colleague, “to harness the great loess plateau.”

Having made such a bold promise, Toyama realized how hard it would be to deliver on. To begin with, he would need a huge quantity of seeds. He took his idea to Reverend Nikkyo Niwano, founder and president of Rissho Kosei-kai, who shared with him nostalgic memories of chewing kudzu root as a boy. “Kudzu to green the deserts,” he said, “that’s an excellent idea.” Reverend Niwano put his organization at Toyama’s disposal. All over Japan, members of its youth groups began to collect seeds. An article in the *Asahi Shimbun* newspaper introduced Toyama’s idea to readers and, meanwhile, Toyama himself did what he could to stir up interest all over Japan. In a period of four months ending in February 1987, he received a ton of kudzu seed. “The packages kept coming and coming,” he said. “By our estimates, more than two hundred thousand people must have helped.” Rissho Kosei-kai volunteers alone collected 550 kilograms of seed.

This was only the beginning. The seeds now had to be dried and removed from their pods, washed and dried again (to remove parasitic insects), and prepared for shipping. For this arduous work, Toyama once again turned to volunteers. To separate the seeds from the pods, Toyama said, “volunteers at Rissho Kosei-kai’s Shimana branch spread the pods on straw matting and trampled them with their bare feet to knock out the seeds.” The seeds were then weighed, dried, sorted, and finally packed in five-kilogram cloth sacks. “Making the special sacks, sewing them shut, packing the sacks in cartons—volunteers did all this.”

When Toyama returned to China with his seeds in February 1987, the head of the Forest Experimental Station in Lanzhou showed him a Chinese-variety kudzu plant that he had transplanted from a nearby mountain—this after Toyama had regaled him about kudzu a year before. Toyama took this as a sign that he was being taken seriously. He then moved on to Shapotou with his Japanese seeds and, with his colleagues there, sowed some of them in an experimental field. He was embarrassed to find, however, that some of the seeds were infested with weevils and had to delay the inauguration of the project. In April, he returned to China with fresh seeds and these, along with the uncontaminated remainder of the first batch, were now planted in thousands of pots to germinate. In a ceremony marking the opening of the project with a ritual planting, Toyama spoke of the many volunteers who had made it possible and of his hope that these efforts would enhance Sino-Japanese friendship and understanding.

Toyama was back in Shapotou again in August to check on the seedlings, and again in November for the long-awaited moment when they would be transplanted onto the banks of the Yellow River. By this time, the new vines had grown to lengths of two meters. With a delegation from Japan and the staff of the research station working side-by-side, it took two days to transplant three thousand vines. Upon inspection the next morning, all the vines were gone, “not a vine, not a root” remained, said Toyama. Sheep herded by neighboring nomads had eaten them all. Toyama said he yelled at the sheep but realized that the mistake had been his. “I had expected plans made on paper to work in the field without considering such features of reality as the sheep. Nature and agriculture were always full of the unexpected.”

After this, the research station’s transplanted kudzu vines were protected with a fence. The plants now thrived, Toyama said, “growing quickly to lengths of ten, twenty, or thirty meters.” In the end, Toyama recognized the local sheep as a potential blessing. He knew that in the United States and parts of Japan, kudzu was considered a nuisance because it grew so aggressively (blanketing trees, road signs, and telephone poles) without a natural predator. Sheep and goats would hold kudzu in check. He said, “I would not mind at all if kudzu covered China’s deserts as a weed. That would only mean my project was a success.”

In the early 1990s, Toyama turned his attention to trees. To begin with, he needed wood to make his kudzu-protecting fences. But trees were also a key component of his vision for the greening of China. The poplar had been Mao Zedong's tree of choice for his Great Wall of Greenery and, by 1990, great rows of it were to be seen everywhere in China, lining highways, town-and-village streets, and rural pathways. Toyama also favored the poplar. It was hardy and grew quickly—so quickly that it could be harvested in ten years. Toyama and his colleagues from the Tottori Sand Dune Research Institute identified a site in the Mu Us Desert northeast of Shapotou. There were swamps and marshes in the area that favored the forestation project. Toyama's plan was to plant two hundred thousand saplings a year over a period of four years; after ten years, one half of the trees would be harvested, the rest left standing to build a permanent forest.

But how to accomplish this large task? Building upon the popular support for his kudzu campaign, in 1991 Toyama founded the Japan Association for Greening the Deserts to support desert forestation projects and to organize trips to forestation sites by experts and volunteers. When the association solicited volunteers to make field trips to China to plant trees—at their own expense—the response was much stronger than Toyama had dared to hope. The first Cooperation Corps for Greening China's Deserts left for the Mu Us site in July 1991, shovels in hand. They were a diverse lot, made up of office workers, civil servants, high school and university students, and homemakers. The youngest was sixteen, the oldest sixty—not counting Toyama himself who was now eighty-five. Bad weather delayed the volunteers so that they had only half a day to plant saplings. Toyama put them to work, calling out orders in his customary gruff fashion. "Plant them straight!" he barked. Although the pioneer group planted only two hundred saplings, others followed in September and October and added 120,000 more.

After that, Toyama's tree-planting volunteers began arriving on a regular basis, as the spirit of "green volunteerism" spread through Japan. The volunteers represented a cross section of Japanese society: civic-minded youth groups; delegations from major universities such as Waseda University and Osaka University of Arts; elementary and high school students volunteering with their parents; major companies; and labor unions. While these groups planted trees in China, other volunteers grew poplar saplings, which were always in short supply. Still others donated money and equipment, such as the Kurashiki Lions Club, which, according to Toyama, "donated saws, hatchets, and sickles."

As the poplar forest blossomed in the Mu Us, Toyama and his volunteers launched another forestation project in the not-too-distant city of Baotou. Here, the concept was a seventy-three-kilometer-long, one-hundred-meter-wide windbreak of five hundred thousand trees to protect the industrial city of 1.5 million from damaging winds from the Yinshan mountain range. In March and April 1992, some one hundred Japanese volunteers launched the project with a gala tree-planting event attended by five thousand local citizens. Two years later, the windbreak was complete.

Another China-Japan tree-planting project launched in 1992 bore great symbolic meaning. An area some thirty kilometers north of Beijing called Shunyi was being developed as an aquatic park. Sun Pinghua, chair of the China-Japan Friendship Association, proposed that space be set aside there for a Peace Forest and invited Toyama to join the project. Land was donated by the China Forestation Fund Association, and Sun suggested that the area be forested with dawn redwood trees (*Metasequoia glyptostroboides*). This suggestion inspired Toyama. The dawn redwood had been prolific in Japan in prehistoric times but was thought to be extinct, until 1943 when some live specimens were found in China. Subsequently, the redwoods were propagated in

the United States and Japan, including in the Fukiage Garden of the Imperial Palace. The emperor himself, in his guide to the gardens, called the dawn redwoods a symbol of Chinese, Japanese, and American friendship. The first two thousand saplings were planted by Toyama-led volunteers in 1992.

In 1993, Seiei Toyama shifted his base of operations in China from Shapotou to Engebei in the Kubuqi Desert, about four hours' drive across the Yellow River from Baotou. The vineyard in Shapotou was "growing strong," he said, and the Chinese government had suggested that Engebei might be another good site for grape cultivation. The Inner Mongolia University in Huhehot operated a livestock-breeding research station in Engebei, known for its kashmir goats and a local cashmere industry. Poplar planting had already begun there, and there was a dormitory for housing Cooperation Corps volunteers. Toyama was appointed a general instructor there, and it became the headquarters of Project Green Hope. Aside from introducing viticulture, Toyama hoped to develop the Engebei station as a training center for desert reclamation and to create a model reclamation site there. At Engebei, he hoped to "gather young people from all over the world to participate in greening the world's deserts and to learn horticulture." To succeed in this, Toyama said, one could not rely solely on knowledge gained in London or Paris or other such places. One must "come to the desert itself."

Seiei Toyama, in his work clothes, sun helmet, and high rain boots, cigarette in hand, became a familiar sight in Engebei, his second home in his later years. He lived to see its transformation into an oasis of millions of trees and bushes, and of vineyards and vegetable gardens and fruit orchards bearing apples, pears, and cherries—all teeming with wildlife. By 2001, the Engebei Desert Development Model Zone covered nearly eleven thousand hectares; it had a tree-survival rate of 85 percent. Toyama returned there as long as he was able. People there called him the Grand Old Man and erected a bronze statue of him, with an inscription that reads, "Mr. Toyama looked on desert control as the path to world peace. At the age of ninety he still worked diligently and unswervingly. His spirit has earned our respect. . . ."

By 2003, some 335 teams of Toyama's volunteers—nearly seven thousand people—had traveled to China to help green the desert, and many more were doing the same thing with independent environmental groups that were inspired by his example. Indeed, today some thirty Japanese nongovernmental organizations plant trees in China.

Seiei Toyama dreamed of a "new law of interdependence and coexistence" to replace "the old concept of survival of the fittest." He believed that for people to understand each other they needed to "sweat together." Planting trees in the desert was his way of bringing this about. After all, he said, "We all share equally in the life of the planet."

James R. Rush

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The quotations from Seiei Toyama appearing in this essay are taken from my interview with Mr. Toyama in Tottori City, Japan, on September 4, 2003 (which occurred with the valued assistance of Toshimitsu Ishida, Hiroshi Takeda, and Asuncion Benitez-Rush), and from the two books by Seiei Toyama and Masao Toyama listed below. Passages from the first, published in Japanese, were translated for me by Kumiko Gahan and I gratefully acknowledge her assistance. Further

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