expensive that at least this helps you whittle it down."

Breeders around the world are already using the Nigerian team's data to check their plants for resistance to cassava mosaic disease. The viruses underlying the blight, which are spread by whiteflies, stop roots from growing. The viruses have already marched through Africa, causing famines in the 1920s and 1990s. In 2015, a severe strain appeared in Cambodia.

Farmers in Thailand, South America and the Pacific Islands — where cassava is highly susceptible to the viruses that cause mosaic disease — are hoping to mix resistant alleles from Africa into their crops through conventional breeding. One such cross between a Colombian plant and a Nigerian variety has been aided by the markers identified by the Next Generation Cassava Breeding project researchers, and is currently growing in test plots near the IITA.

SOWING SOLUTIONS

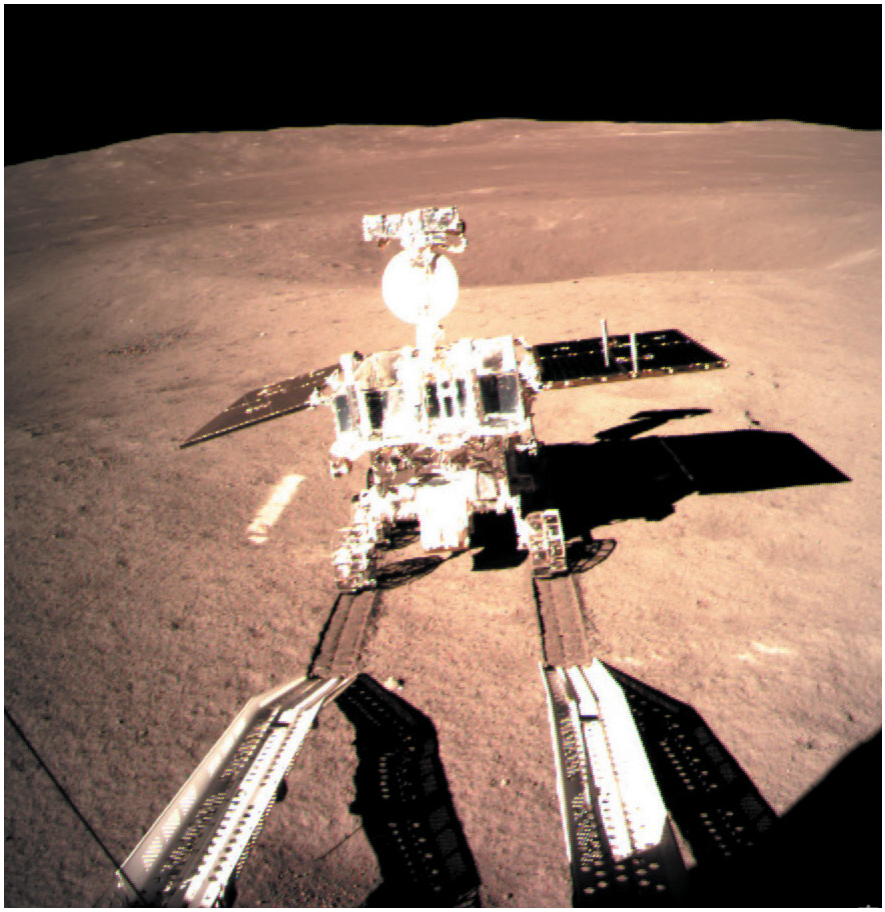
In 2020, the scientists will select varieties from their current top eight, and distribute them across Nigeria. They're also talking to colleagues in Thailand, Laos, Brazil, Uganda and Tanzania about shipping varieties there. And the team is trying to find ways to address issues that stop farmers from adopting new products.

When Nigerian farmers are asked why they don't grow more cassava varieties, they often reply that they don't have enough plants to do so. Cassava is propagated by sowing pieces of the stalk from a mature plant, rather than seeds. Each clipping sprouts a clone of its parent, and so years can pass before a field is filled with the same variety. And the genetic backbone of a variety degrades over time when cassava is cultivated this way, because clones acquire mutations; the latter can lead to 'mutational meltdown' (P. Ramu *et al. Nature Genet.* **49**, 959–963; 2017).

In 2016, IITA geneticist Elohor Mercy Diebiru-Ojo and her colleagues developed a work-around: the first semi-hydroponic system for growing cassava. In her lab, slim shoots of cassava grow under fluorescent lights in transparent plastic boxes filled with watery soil. Every two weeks, the team cuts the saplings at nodes where they branch, and repots the snippets. Within 2 months, they can produce 100 plants from a single parent.

Lifting a box of seedlings grown using the method, Diebiru-Ojo says some farmers she knows have told her they're willing to pay for such premium plants. She hopes that this will foster the growth of businesses that sell high-quality cassava shoots to farmers, so that the same plants are not cloned for too many generations. "When this project ends," she says, "I want the system to keep going."

If new varieties fail to take root, viruses will eventually have their way. Staring out at his field of cassava, Egesi says, "I'm really excited to see that none of these show any signs of disease." He adds, "the minute the government approves of them, we must get them out to people." ■



XINHUA/ZUMA WIRE/UNIVERSITY APPLIED PHYSICS LABORATORY/SOUTHWEST RESEARCH INSTITUTE

The Yutu2 rover was deployed on the lunar surface on 3 January.

SPACE

China explores Moon's dark side

Chang'e-4 could send back clues about how parts of the Moon became pockmarked by asteroids.

BY DAVIDE CASTELVECCHI

A Chinese probe has become the first to touch down on the far side of the Moon, 60 years after an orbiter gave humans their first glimpse of the region.

Chang'e-4 landed inside the Von Kármán Crater at 10:26 China local time on 3 January, and sent back its first images. Twelve hours later, the mission's 140-kilogram Yutu2 rover drove down a ramp and onto the lunar terrain.

As the Moon's far side is permanently hidden from Earth, the news of Chang'e-4's successful landing was relayed by a spacecraft called Queqiao. It has been circling around a gravitationally stable point about 60,000 kilometres beyond the Moon since it launched in May.

The far-side landing location also meant that, during the final phases of the approach, Chang'e-4 was on its own, and could not be operated remotely. Starting from an altitude of 15 kilometres, the probe used a rocket booster to brake and briefly hover. Meanwhile, an on-board camera and a laser ranging system scanned the terrain to avoid boulders.

"The landing was a huge technical and scientific success," says Brad Tucker, an astrophysicist at the Australian National University in Canberra.

Chang'e-4 launched on 8 December, and entered a highly elongated lunar orbit

4 days later. It then manoeuvred itself into a lower orbit.

Mission management chose to land the probe inside the relatively flat, 186-kilometre-wide Von Kármán Crater, which sits inside the much larger South Pole–Aitken Basin. The basin — which is more than 2,500 kilometres wide — is thought to be the oldest of the Moon's large, deep, impact basins, and it is the only such feature on the orb's far side. Studying the basin has long been a top priority for Solar System researchers.

The basin is thought to have formed when a large asteroid hit the Moon towards the beginning of the Late Heavy Bombardment period, around 3.8 billion years ago. An accurate dating of the basin's formation could reveal whether this epoch of battering — which must have affected Earth as well as the Moon — stretched over hundreds of millions of years or was concentrated in a relatively brief time.

UNEXPLORED TERRITORY

After the successful Moon landings in the 1970s, some began to take a "been there, done that" view of the Moon, says Jeffrey Taylor, a lunar scientist at the University of Hawai'i in Honolulu. But China's venture to the far side shows otherwise, he says. "We have not done it all or gone everywhere on the Moon." Still, solving the mysteries of lunar history will require collecting samples and returning them to Earth for analysis, he adds.

Because the Moon's rotation around its axis is precisely synchronized with its orbit owing to 'tidal locking', humans had no idea what the far side of the Moon looked like until the Soviet Union's Luna 3 probe sent back the first shots of it in 1959. Luna 3 revealed a region pockmarked by many more craters than the near side — and almost devoid of the 'maria', or seas of solidified lava, which dominate the familiar near side. (Apollo 11 landed on one such mare, the Sea of Tranquillity.)

"We have not done it all or gone everywhere on the Moon."

In the following decades, other probes followed up with detailed topographical and gravimetric mapping of the full lunar surface, but no craft has landed on the far side until now. (A NASA probe crash-landed on the far side in 1962.) Studying the region from up close could provide clues to why it is so different.

HISTORIC STEP

"The Chang'e-4 mission is an historic step in the Chinese lunar exploration programme and in international scientific exploration of the Moon," says Jim Head, a planetary scientist at Brown University in Providence, Rhode Island, and a veteran of NASA's Apollo programme. The mission will open up the 'Luna Incognita' — the unknown Moon — to surface exploration for the first time, he says.

Chang'e-4 and its six-wheeled rover carry instruments that will do a range of experiments, including a study of the radiation environment of the lunar surface; deep scans with a ground-penetrating radar; and analyses of the geology of the surface with an imaging spectrometer. It will also conduct radio measurements of the early Universe. These measurements are difficult to capture from Earth because low-frequency radiation is mostly blocked by its atmosphere. Because the far side never faces Earth, it is an ideal place to collect these types of data, says Tucker. Astronomers have long talked about doing these kinds of experiments on the Moon. "China went ahead and did it," he says. Chang'e 4 also carries a small, climate-controlled environment with potato and *Arabidopsis* seeds and silkworm cocoons.

Chang'e-4 and its rover were originally built as a back-up to the previous lunar mission, Chang'e-3, which went successfully in 2013. China's next Moon trip, Chang'e-5, will aim to return a sample of lunar rock to Earth, and is due to launch later this year. ■