Desert soilization is an approach, through mechanical manipulation, of endowing the surface layer of desert sand with the eco-mechanical attributes and water retaining capacity of soil to become a favorable habitat for plant growth. Since 2016, desert soilization has been successfully conducted in various deserts, desertified land and islands, with a total area of 1,130 hectares. Liu et al. published a commentary in The Innovation (https://doi.org/10.1016/j.xinn.2022.100237) which attributed the success of desert soilization to “shallow groundwater”, and then questioned the principle, practice and innovation of desert soilization. We decided to refute. Our desert soilization research adheres to scientific principles and facts, as is with the following refutation.

First, the 3 photos used by Liu et al. as evidence of “shallow groundwater” are inauthentic. They provided a low-resolution photo (their Figure 1B) with “natural reeds” and claimed them to be growing near our experimental site. However, our repeated field investigation has confirmed that no reed is found within at least 1 km around the site in their Figure 1A. We would like to ask them, When and where was the photo taken? Can they provide the original photo? Meanwhile, they claimed that their Figure 1C is our “failed case” in Minqin County. We immediately sent our staff there for confirmation. The fact is that the plot in their Figure 1C is an unsoilized desert site. We would like to ask them, Is there a soilized desert site? When and under what conditions was soilization done? Is there a contrast between the soilized and unsoilized areas? They also claimed that their Figure 1A “is a mosaic from Google Earth Pro images of June to August 2021.” However, we did not find such a mosaic from Google Earth Pro where “natural shrubs grow well in the surrounding interdune fields”, nor any similar image of the same site in the same period as their Figure 1A from other sources. The satellite images we obtained from other sources (Figures 1A and 1B) and aerial photo (Figure 1C) show that the desert surrounding our experimental site is barren. We wonder whether their Figure 1A has undergone any processing. We hope they provide the original image and source to the public.

Second, their conjecture of the groundwater depth in our experimental site in the Ulan Buh Desert at “about only 20 cm” or “usually less than 1 m” based on photos, is inconsistent with the facts. It is common sense that groundwater conditions should be obtained by geological survey rather than judged by photos. The fact is that the site in the Ulan Buh Desert is not located in an area with the so-called “shallow groundwater”. Figure 1D is a groundwater depth map from local authorities, which shows that our site is located in an area with the groundwater depth greater than 10 m. According to our geological survey data, the groundwater depth is greater than 15 m at the lowest position, which is completely different from their assumption of “about only 20 cm” or “usually less than 1 m” (the water in Figure H of Reference 1 resulted from watering for collecting sample plant roots). The desert near our site is barren (Figures 1A–1C), contrary to their claim that “natural plants thrive widely” (ordinary vegetation can hardly survive in desert where the groundwater depth is greater than 8 m). Our site is not “located in a lowland” and the 3 ponds inside our site cannot possibly raise the groundwater level as the bottoms are sealed with impervious membrane. We have clearly pointed out that soilization has been successfully conducted not only in the Ulan Buh Desert but also in other deserts. However, they only targeted the Ulan Buh Desert without mentioning other deserts. Those barren deserts do not have the so-called “shallow groundwater” nor are they near any river,
lake, or pond. For example, the Gobi desert in Ruoqiang County has a ground-water depth greater than 50 m, but our soilization was also successful under limited irrigation (Figures 1A–1C). As for the Ulan Buh Desert, even by the artificial lake in their Figure 1A (with its water level 14 m lower than the lowest altitude of our site), where the ground-water level is high and plants do grow, they can grow only after covered by a layer of borrowed soil under irrigation (Figure 1F). In our site, highly heat-tolerant plants\textsuperscript{1} thrive widely without irrigation in an area with the groundwater depth greater than 50 m, which forms a sharp contrast with the barren desert nearby (Figure 1G).

Third, they should ensure that they have understood the desert soilization principle and that their related claims were not fabricated. They claimed that carboxymethyl cellulose sodium (CMC-Na) is a common industrial polymer and cited their Reference [2] as evidence to prove that “such material has long been used as a water retention agent in agriculture and as a sand fixation agent in sand control practices since as early as 1930s.” However, after consulting the reference we found that the so-called “CMC-Na” or “water retention agent” in agriculture is not mentioned at all throughout the reference. The fact is that synthetic water retention agents were not developed until the 1960s.\textsuperscript{5} Obviously, their related statements were fabricated.

CMC-Na is different from either a water retention agent or a chemical sand fixation agent. CMC-Na is a solid organic substance dissolvable in water to become a solution. A water retention agent (or water retaining agent) is a highly water absorbent resin that becomes a gel (not a solution) after absorbing water. A chemical sand fixation agent is a polymer emulsion (not a solution). Our specially modified sodium carboxymethyl cellulose material is in a solid state when dry and is dissolvable in water to become a viscous solution.\textsuperscript{4,5} After mixed with sand granules and water, it will produce an omni-directional integrative constraint among the granules, and the constrained granules will exist in a rheological state like wet mud. When water evaporates, it will produce a fixed constraint, and the constrained granules will exist in a solid state like a dry soil mass. Due to their insufficient understanding about the soilization principle and lack of knowledge from practice, they questioned that “there was no change of sand particles” and drew a wrong conclusion that the constraint material has “no effect on dry loose particles.” The fact is that our “soil” agglomerates as natural soil does (Figure 1H). Furthermore, they confused the constraint material with a water retention agent and so drew some specious conclusions. They even arbitrarily “estimate” the price of our constraint material and the total soilization cost. Their conclusions are unreliable overall.

Last, they further applied the traditional soil-forming process and soil composition theory, as well as the assertion that “plants grow well with adequate water”, to deny desert soilization. We would like to say that it is not proper to confine the new development with the traditional knowledge or with such an assertion that “plants grow well with adequate water”. Desert soilization is an interdisciplinary and innovative research.

Desert soilization has been verified in 1,130 hectares in different places and under different conditions for years. It has been proved that besides desert sand, other granular materials such as coral sand, crushed stones, crushed concrete, and wood chips can also be soilized by imposing constraints.\textsuperscript{1} The soilized granular materials exist in a solid state when dry and in a rheological state when wet. They can retain water and nutrients and is favorable for plant growth, as natural soil does. In different deserts, sowing and planting can start immediately after soilization. The thriving growth of plants in the soilized sand forms a sharp contrast with the unsolized sand (see Figure 1D in this paper and Figures 1J and 1K in reference [1]). Moreover, the plants in the soilized deserts have higher biomass and higher yield with lower water consumption than those in the comparative natural soil.\textsuperscript{1} Our “soil” has no environmental risk (by third-party authorized institutions) and the “soil” characteristics are not degraded.\textsuperscript{1} Psammophytes gradually appear in the uncultivated area after soilization (Figure 1J). All these are facts. We believe that action speaks louder than words. Desert soilization is an effective approach rather than “a misleading way.”

Desert soilization is supported by scientific principles and facts. It has extensive prospects in desertification control, ecological recovery, land use and carbon sequestration. The emergency of such a new theory, method, and its application is not a bad but a good thing. We should have an open and inclusive mind toward it. We believe that exploration and action are more valuable than mere talk. We should do genuine research to address real problems. Innovation is always accompanied by questions and criticisms. We welcome them but they must be based upon sound claims.

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DECLARATION OF INTERESTS
The authors declare no competing interests.