



Saving the Earth with Biomass Utilization

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Do you know about Earth Overshoot Day (EOD)? The date is announced each year by the Global Footprint Network, an American think-tank. Assuming that on January 1, people start using the amount of natural resources that can be generated by the Earth for that year, EOD marks the date when nature's budget is exhausted. The EOD in 2018 was August 1, which means a deficit for about five months, from August 2 until December 31.

Take a look at this from another angle; the EOD of August 1 means that we consumed the entire year's resources in just 213 days (from January 1 to August 1). For everyone on Earth to live without a deficit, we need 1.71 Earths ($365/213 = 1.71$). Actually, EOD is determined based on this equation.

I was born in 1971. Using this equation, the EOD of 1971 is calculated to be December 20. Fortunately, humans at that time needed only a little more than one Earth (1.03). But since then, the EOD has arrived earlier and earlier, meaning that people need more and more Earth. In 2000, the EOD fell on September 23 (1.37 Earths), August 1 in 2018 (1.71 Earths), and will surely fall on a day in July in 2019. Soon, we will need two Earths. You might be tempted to ask, "How many Earths do you think we have?" Yes, I know, we have only one, and you should not remain idle while the EOD keeps coming earlier.

Toward the end of my college days, I had to shift my priorities from tennis to research, and I wanted a big goal. My final decision was "Save the Earth." I knew this was an impossible goal, but if we cannot save the Earth, we cannot survive. As a student in the Agricultural Department, I felt the importance of this goal more deeply than "Save people," which is a common goal of students in the medical and pharmaceutical departments. Honestly speaking, I simply wanted a major objective and I couldn't think of anything bigger than this. I was carried away by youthful enthusiasm, but I believed at the time that the bigger the goal, the better it was. When I was asked "What makes you do this research?" I always repeated this goal in order to remind myself.

I started my research in 1993, before any such concepts as EOD. Major environmental problems were related to pollution, and most of them had almost been solved; people's concerns were shifting to environmental hormones. Thus, environmental problems were limited and local. Under these circumstances, I set a global goal. Clearly, it was ridiculous.

Now, however, I am proud that I tried shooting for the moon. This viewpoint greatly influenced my present way of life. When I started talking about the Earth every day, I did not feel that the world was so large. I did not care about my position in Japan, either. Thanks to the Internet and other communication tools, the world has quickly shrunk, but way behind me!

But I worried about the day when my research on cellulose-degrading enzymes produced by microorganisms⁽¹⁾⁻⁽⁵⁾ would actually help save the Earth. In the 1990s, people did not value biomass. People often negatively asked me, "Why are you doing this research?" My research and resulting paper were regarded as fanatical and were not highly evaluated. If that social climate had continued, I might have abandoned my goal. But if you continue to do the right thing, you will be rewarded. In this century, the path I pursued is now widely accepted.

Then, another concern occurs this time. More and more people are paying attention to my research and understand the need to save the Earth. Is this good? Not really. It indicates that the Earth is in such a dangerous condition that everyone is worried. At the end of the 20th century, only a limited number of scientists including me were warning, "If things go on as they are, the Earth will not last for another 100 years." In this century, the time remaining has shortened by an order of magnitude. Today, people worry, "If things go on as they are, the Earth will not last for dozens of years." When the time remaining was 100 years people showed little concern, but when it shortened to dozens of years, they became nervous. I could not understand their attitude because I look at the carbon cycle over a span of hundreds of millions of years.

Probably, they felt this as a more realistic problem. In the previous century, environmental problems were left to great-grandchildren or their children, but have now become a problem that may occur at any time.

In the past, when the temperature exceeded 30°C, we called it a “tropical day.” Now, the temperature often exceeds 35°C, and we call it an “extremely hot day.” Heavy rains that used to fall every ten or twenty years now fall every year. People around the world are experiencing climate change. Although many nuclear power stations were built to reduce carbon dioxide emissions, the Great East Japan Earthquake in 2011 revealed that it was far from an ideal energy. Facing imminent danger, the United Nations had to declare Sustainable Development Goals (SDGs). We have only one Earth, and it is screaming for help. People have come to realize that they must abandon the old ways and shift their view to save the Earth.

When I started my research more than 20 years ago, I predicted this alarming condition. When I say this, some people see me as a prophet. In fact, many people were worried about today’s condition at that time and I gain no satisfaction that my prediction is coming true. This is the “prophet’s dilemma.”

“Your country shall be ruined if you continue such an attitude.” A prophet made this prediction to a king who was not interested in politics (I imagine a small country in Europe). What do you think the result was? If the king heeds the prophet’s words and implements good governance, the country will not be ruined, and no one will know whether the prediction was actually correct. If the prophet refrains from warning the king because he wants to see if his prediction is correct, the country could be ruined. It turns out that the prophet was right but is there any meaning to his existence, a prophet who does not share his predictions?

When my research was ignored, I understood this dilemma and was determined to continue warning people. If my prediction was wrong, the Earth would be saved, which would be good for me because my goal is to save the Earth. However, the Earth is facing dangers as expected or even beyond expectations. I am not happy that my prediction proved to be right. I would much rather have been wrong.

On December 1, 2017, we started the “One Earth Guardians” training program at the University of Tokyo under the slogan “No other Earth for us.” The aim is to develop human resources who will help the Earth 100 years from now. As expected, we received negative responses, such as “What silly thing are you trying to do?” After the concept was drawn up, it took us five years to start the program. Too long? I think it’s good that it did not take 50 years. My positive attitude is backed by the pride I have in going in the right direction, the confidence that people eventually pay attention to continuous warnings, and the firm belief in the importance of education. I will courageously act as a prophet without fear of being exposed as a fake. In 100 years, people may laugh at me, saying, “There was no need for earth guardians.” I do not worry about this because my goal is an Earth that does not need guardians. I believe we need a system that develops human resources who can identify today’s problems, solve them for the future, and accept the prophet’s dilemma along with me.

I found a photograph on the “sustainability” page on Yokogawa’s website, in which smiling children of diverse races are holding the Earth in their hands. I will continue my research on the use of biomass, imagining that children in 100 years will similarly smile, hold the Earth, and innocently ask, “What on earth is Earth Overshoot Day?” Such a life is not so bad.

REFERENCES

- (1) K. Igarashi, et al., “Cellobiose Dehydrogenase from the Fungi *Phanerochaete chrysosporium* and *Humicola insolens*,” *Journal of Biological Chemistry*, Vol. 274, No. 6, 1999, pp. 3338-3344
- (2) K. Igarashi, et al., “High Speed Atomic Force Microscopy Visualizes Processive Movement of *Trichoderma reesei* Cellobiohydrolase I on Crystalline Cellulose,” *Journal of Biological Chemistry*, Vol. 284, No. 52, 2009, pp. 36186-36190
- (3) K. Igarashi, T. Uchihashi, et al., “Traffic Jams Reduce Hydrolytic Efficiency of Cellulase on Cellulose Surface,” *Science*, Vol. 333, Issue 6047, 2011, pp. 1279-1282
- (4) K. Igarashi, “Cellulases: Cooperative biomass breakdown,” *Nature Chemical Biology*, Vol. 9, No. 6, 2013, pp. 350-351
- (5) K. Igarashi, T. Uchihashi, et al., “Two-way traffic of glycoside hydrolase family 18 processive chitinases on crystalline chitin,” *Nature Communications*, Vol. 5, id. 3975, 2014