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Reconceptualizing Japan's Food Security: Agricultural Biotechnology as a Mechanism for Mitigating Import Dependency

When most people think about food insecurity, their minds immediately jump to global hunger crises in regions such as sub-Saharan Africa or other developing and underdeveloped nations. What often goes unnoticed is that food insecurity is not confined to the Global South. Highly developed countries struggle with affordability and access to consistent, nutritious foods despite their technological, medical, and infrastructural advancements. Japan, a nation known for its supersonic bullet trains, high-end automotive vehicles, robots packed with futuristic technology, instant noodles, and karaoke, experiences food insecurity at a rate of 5.8%, impacting 7.11 million Japanese citizens in 2023 ("Prevalence of Moderate or Severe Food Insecurity…"). Food insecurity persists not only where resources are scarce, but also where wealth and innovation mask the vulnerabilities in a nation's socioeconomic and environmental issues. Japan's limited capacity to adequately meet its domestic food demand, driven by climate change and persistent geological challenges, places the nation in a position of vulnerability and heightens poverty.

Japan is a small but influential island nation, located about 120 miles northeast of South Korea's eastern coastline in the Pacific Ocean (Mia). Japan is an archipelago surrounding a central mainland. Its four largest islands Honshu, Hokkaido, Kyushu, and Shikoku form the mainland and are home to prominent cities Tokyo, Osaka, Kyoto, Nagasaki, Kobe, and Hiroshima. Beyond these major regions, Japan consists of over 14,125 islands (Subramaniam). A mapping from 2003 suggests that 421 islands are inhabitable (Kuwahara). The unique geographic composition shapes regional identity and influences climate, terrain, and occurrence of natural disasters.

The nation's terrain primarily consists of steep, rocky mountains, 200 of which are volcanoes, and 60 of which are active (Ministry of Land, Infrastructure, Transport and Tourism). The mountainous terrain covers over 80% (Petry) of the landmass and leaves limited fertile agricultural land. Japan lies on the junction of four tectonic plates and has constant seismic activity, making it one of the most unstable locations in the world (Geospatial Information Authority of Japan). The constant shifting of these plates results in over 1000 tremors yearly and aids the volatile "Ring of Fire" phenomenon (Britannica).

Japan's diverse subtropical and subarctic climates brought over 40 million tourists last year ("Japan Welcomes Record 42.7 Million…). Tourism is one of the highest sources of income for the Japanese constitutional monarchy, generating trillions of Japanese Yen and 7.5% of Japan's GDP.

On a typical day on the urban mainland (~75% of Japan's population), "salary men" or "office ladies" work corporate jobs (Unique Japan Tours). Train stations are the busiest during 7am to

9:30am and 5pm to 6:30pm. (Unique Japan Tours). City life is often busy and chaotic, and people usually return to their homes, called “mansions” in Japan (Unique Japan Tours).

While urban life can be a faster pace, rural life is the opposite. The country life is slower, proximal to nature, and generally comes with a lower cost of living. Agriculture is the primary profession, often as crop and meat farmers or in fisheries. Rural life comes with its own challenges, and housing quality is often not up to standard as there has been “no significant investment in Japan’s rural housing stocks” since 1990 (Lane).

Regardless of lifestyle, a transversal belief among all Japanese citizens are Buddhist and Shinto beliefs– practiced by over four million people in Japan (Lane). In 2021, about 48.6% of the population practiced Shinto, with Buddhism following close behind at 46% (O’Neill). Traditional food is an important part of Japanese culture, including a plethora of rice made dishes included plain cooked rice mixed with steamed vegetables or gravy, sushi and sashimi made with fresh seafood, onigiri (rice balls), fish (Salmon & Mackerel) miso soup (soybean and fish), tofu, udon and soba noodles, and fruits with the traditional sake drink (Japan Guide). Japan is ranked as the fourth healthiest country, yet traditional Japanese diets are shifting towards more Western-style processed eating as a result of the rising cost of basic staples pushing households toward cheaper, highly processed alternatives (Welch).

At its core, this pattern stems from Japan’s chronically low food self-sufficiency rates, which fuel import dependence, elevate prices, and ultimately intensify food insecurity. Japan’s food self-sufficiency rate stands at only 38%, a significant shortfall in domestic food production among developed nations (Fujiwara et al.). Japan’s arable land ranks at the lowest level, a driving factor for its dependency. Japanese agriculture has been shrinking annually due to a lack of farming successors, the rise of aging farmers, low wages in agriculture, and climate change.

Given Japan’s limited agricultural labor and arable land, crop production and yields are further hindered by the escalating complications associated with climate change. High temperatures, extreme rainfalls, regional climate difference, and extreme weather events consequently affect food security. Category 2 Typhoon Faxai and category 5 Typhoon Hagibis, in August and October 2019, were considered the most powerful storms to hit Japan in decades, and caused widespread flooding and $2.2 Billion in agricultural sector damages (Chiari-Hydes). Apart from natural disasters, rising temperatures were also responsible for the mutations of many crops that triggered low yields in a variety of crops, including rice, with the country facing a severe, ongoing rice crisis with high prices and intermittent shortages (Clark).

Japan’s government turns to reliance on imports for rice, soybeans, wheat, meat, and many fruits and vegetables, with the United States, EU, China, Australia, and Thailand making up more than 70% of food imports; this heavy dependence on imports is far from ideal (The Yomiuri Shimbun). As an island nation with limited natural resources, it is acutely vulnerable to disruptions in global supply chains and the shipment of essential goods. This reliance forces Japan to depend on the political and economic stability of its trading partners, creating a highly volatile and uncertain system that places Japan back in the place of food shortages and increased prices it was trying to avoid.

Japan's exposure to instability in its supplier countries ultimately translates into rising food insecurity. When political unrest, climate shocks, or export restrictions disrupt global supply, Japan has almost no leverage to absorb drastic shocks. The poverty rate in Japan is 15.7 percent, the highest among developed countries (Ueda). Save the Children Japan states that dependence on school lunches by low-income families has increased since 2024 ("Rising Prices Mean More Japanese Children…"). Families report they find meal quantity "not quite sufficient" or "sufficient" when school is not in session ("Rising Prices Mean More Japanese Children…").

Single mothers are the most high-risk social group with a poverty rate of 51.4%, contributing to the 14% and growing child poverty rate and 25.8% of poverty in the elderly–"40% of which are elderly women who live in one-person households" (Ueda). 44% of people in Japan have lost weight or gone an entire day without eating because they couldn't afford to buy food (Keisuke). Lack of consistent nutritional meals for the children, adults, and elders of Japan can lead to challenges in development, intellectual capacity, and productivity (Siddiqui et al).

These widespread issues all span from low self-sufficiency rates that drive food insecurity and are recognized by agricultural leaders and the Japanese government. The government addressed food insecurity and intervened to increase self-sufficiency rates by lowering domestic prices to maintain affordability and initiating programs to help combat climate change. Initially, the government proceeded to give out 900,000 tons of rice from its emergency reserves, but quickly recognized this was unsustainable.

Japan is learning to mitigate climate change while seeking to address the root problem. The government is accelerating the "Green Transition" by investing in renewable energy, nuclear power, promoting energy conservation, and implementing a 2 trillion Yen Green Innovation Fund to meet its goal of carbon neutrality by 2050 ("Overview of the Green Innovation Fund Projects"). Despite efforts, the Japan Times reports high rice prices in February 2026, at higher than 4,000 yen for a 5 kilo bag.

Japan can increase its self-sufficiency rates via investments in increasing the yield of plants through Genetic Modification ("GM"). Currently, Japan has limited domestic cultivation for traditional GM crops, while being a major importer of GM crops, plants whose DNA has been modified in a laboratory to introduce specific traits for better nutrition, increased yield, and disease, drought, and pest resistance (MedlinePlus). If Japan itself were to invest in GM crops, at a similar scale or other plant breeding methods to result in higher yields, it would be significantly cheaper while providing staples to regulate a balanced self-sufficiency rate.

Japan should consider rice as a major target for agricultural biotechnology, as it is a central staple in the Japanese diet. Golden Rice demonstrates how genetic modification can improve a staple crop for additional nutritional benefit; scientists modified rice so that its grain produces beta-carotene, a compound that the human body can convert into vitamin A ("The Golden Rice Story"). Japan could apply this principle to its own agricultural research by developing rice varieties that combine increased yield with traits such as resistance to pests, disease, environmental stress, or improved nutritional content.

Japan already has evidence that agricultural biotechnology can be developed domestically. In 2021, Japan introduced a genome-edited tomato with increased levels of gamma-aminobutyric

acid (GABA). By 2025, Japan had accepted four genome-edited food crops as non-GM crops under its regulatory framework: the GABA-rich tomato, a high-amylopectin corn, and a potato developed to produce more mini-tubers (Ishii).

Two prominent drawbacks remain: one being the speculation that GM crops are bad or harmful to human health, and the other being the funding source. Both the Food and Drug Administration (FDA) and World Health Organization (WHO) have deemed GM crops as safe to consume with over 20 years of data.

According to a 2025 analysis of Japanese consumer attitudes, the majority of people were not sufficiently familiar with genome editing, yet some expressed significant safety concerns (Ishii). The government produces yearly reports on the safety of GM crops and cultivation sites (Neo). Despite these efforts, public awareness remains low and continues to present a challenge to Japan's food self-sufficiency goals. The Frontiers study similarly argues that Japan needs greater communication about the potential benefits and risks of agricultural genome editing, and consumers are demanding transparent information about how individual crops were modified, what traits were changed, what safety testing was performed, and what agricultural or nutritional benefit the modification provides.

Youth should be incorporated into this effort as well. Instead of simply encouraging young people to eat or support GM foods, youth should be given an active role in agricultural biotechnology and public science communication. The World Economic Forum reports that Japanese youth are already participating in sustainability activism, communicating with government and political parties, creating policy proposals, and participating in COP27 (Kutty and Naoko Tochibayashi).

Japan could build on this existing youth involvement by establishing a "**Youth Agricultural Biotechnology Initiative"** that connects high school and university students with universities, researchers, and farmers. Students could participate in agricultural science programs, research competitions, farm-based experiments, and education campaigns explaining genetic modification and genome editing. For example, students could research how a hypothetical high-yield or disease-resistant rice variety could contribute to Japan's food self-sufficiency and then present their findings to their communities or policymakers. Youth participation could serve as a bridge between scientific research and public understanding. This initiative could also help address Japan's declining agricultural workforce. Agriculture is an increasingly technological field involving genetics, biotechnology, environmental science, and data analysis; by connecting agriculture to scientific innovation, Japan could make the sector more appealing to younger generations and create a cycle for youth to contribute to agricultural research while also becoming potential future farmers, researchers, and biotechnology specialists.

The second setback: funding. Currently, the Japanese government acts as a facilitator for crop production in Africa through the Official Development Assistance (ODA) and the Tokyo International Conference on African Development (TICAD). It provides technical expertise and $30 billion toward private sector investment and productivity (Bank). The country could consider redirecting a portion of its existing agricultural and economic resources toward domestic agricultural biotechnology.

Building on its research programs and expanding them into a larger public-private agricultural biotechnology initiative is another approach. Japan's National Agriculture and Food Research Organization (NARO) conducts research on genetic modification and genome editing through its Institute of Agrobiological Sciences and would be a strong partner for this proposal. NARO's Department of Crop Genome Editing identifies Japan's shrinking agricultural workforce, climate change, and food security as problems that genome editing can help address. Its researchers are developing crops with greater environmental adaptability and are also working on domestically developed genome-editing technologies. Japan could then expand funding for NARO and connect its research more directly with universities, farmers, companies, and young researchers. NARO is already conducting field experiments on genome-edited rice. In 2025 and 2026, researchers tested rice lines in which genes associated with seed number and size, photosynthetic and nutrient-absorption abilities, and sugar and starch metabolism had been modified. The government could establish competitive grants that prioritize measurable outcomes, such as increased rice yield per hectare, reduced agricultural resource requirements, improved nutritional content, and reduced dependence on imported food.

The program could also involve Japanese universities and companies that already possess expertise in agricultural biotechnology. Government funding would reduce the financial risk of long-term agricultural research, while private companies could contribute biotechnology expertise, equipment, commercialization experience, and additional investment. Farmers could then test varieties with potential under field conditions to determine whether a crop that performs well in a laboratory also provides a meaningful advantage under Japanese conditions.

Japan's struggle with food insecurity ultimately reveals a nation caught between its sophistication and its structural fragilities in geography, demographics, and climate. As rising temperatures, extreme weather, and an aging agricultural workforce continue to erode domestic production, Japan's dependency on foreign supplies exposes it to global volatility that isn't controllable. This results in the cycle of low self-sufficiency and high import dependency, leading to price shocks and instability. While government interventions, climate-adaptive farming, and a long-term decarbonization goal mark important steps forward, they remain inadequate without a fundamental reinvestment in domestic capacity. Genetic Modification of crops and organisms could prove to be a great success in Japan, as it has been in nations like the United States and Australia. If given the chance to grow through sustained, coordinated investment, Japan can easily replicate and thrive with increased GM adoption.

Japan's future stability depends on its ability to transform food from a probability to a guarantee, ensuring that every household, from rural low-income families to urban families, has access to the nourishment necessary to thrive. **Only by confronting these hidden vulnerabilities can we truly look beyond the cherry blossoms and understand the deeper realities of Japan.**

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