

An Investigation into the Roots of the Paradox of Vegetable Supply Diversity in Japan

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ABSTRACT

Japan is a long and narrow country with a climate ranging from subarctic to subtropical—environmental conditions favourable to vegetable diversity in theory. However, at the retail level, a paradox of vegetable diversity exists in Japan—“limited variety, low vegetable per capita consumption, and prices with sharp spikes”. It deconstructs vegetable diversity into biological diversity and market product diversity, takes a big perspective that integrates institutional analysis, distribution economics, and the food consumption cultural inertia to systematically expose three real reasons: the price stabilization system of “designated vegetables + specific vegetables” locks over 70% of agricultural land to 49 “policy varieties” through subsidy thresholds and area entrance restrictions in a way, resulting in “institutional homogeneity” at the production level; a vertical monopoly structure centered on the National Federation of Agricultural Cooperatives (JA Zen-Noh) at the center suppresses variety diversification into a distribution structure with uniform specifications through rigorous grading standards and decent settling methods; A “white rice-centered” dietary pattern dating back to the Edo period, accompanied by a certain food culture and consumer inertia modes that take safety, reassurance, perfect appearance, matching seasons into consideration, collectively put the Japanese vegetable system at a low-level equilibrium trap spanning “production–distribution–consumption”, resulting in a paradox of vegetable supply diversity.

Keywords: *Policy and institutional frameworks, Distribution structures, Consumer inertia.*

1. INTRODUCTION

The variety of vegetables available year-round in Tokyo's busiest supermarkets is certainly not as rich as what one can possibly buy at a farmers' market in a third tier Chinese city. The puzzle of this “conundrum” features a profound question: Why has the vegetable supply system in a country with better natural resources and advanced agricultural technology fallen into the predicament of “diminishing variety”? This paper calls this phenomenon the “diversity paradox” of Japan's vegetable supply that is, with rich potentiality in biological diversity, the market is entering into a predicament which is, contradictory to its potentiality, suffering from deficient product diversity, falling continuously in per capita vegetable consumption, and vulnerable price volatility.

Arable land accounts for only 11% of the land area in Japan, with 0.02 hectares of arable land per capita (considerably lower than China's 0.09 hectares). Japan's 1.404 million farming households (the vast majority of which are elderly) have been maintaining Japan's primary food self-sufficiency of its nearly 130 million people. In the 1970s, Japan achieved almost 90% vegetable self-sufficiency through a “suburban agriculture and technology-intensive model”. Starting from the 1980s, Japan's self-sufficiency rate has continually dropped. By 2022, Japan's vegetable self-sufficiency rate had dropped to 79.5%, and the fruit self-sufficiency rate was only 36.8%. Far from this, the product structure at the retail level has exhibited huge stability: any ordinary supermarket within 23 wards in Tokyo will stock approximately 35–45 types of vegetables year-round, and 14 “designated vegetables” will account for more than 60% of sales.

(Ministry of Agriculture, Forestry and Fisheries, 2023[1]). During the same period, per capita supply of vegetables in Japan also reduced from a peak of 143.9 kg in 1968 to 101.4 kg in 2022. How can “small-scale, high-efficiency agriculture” as this model coexist with the decreasing variety of vegetables? This article will make an overall analysis from three aspects: policy, distribution, and consumption, to discuss the cause behind this “diversity paradox” in vegetable market.

2. THE IMPACT OF POLICIES AND REGULATIONS ON VEGETABLE DIVERSITY

When the Vegetable Production and Marketing Stabilization Act was promulgated in 1966, “the designated vegetable” system was introduced to “provide subsidies to the growers when the market prices in the vegetables fall markedly, and providing stable supply to consumers”. In 2015, the system introduced a “specific vegetables” system,

making up a list of “14 designated vegetables + 35 specific vegetables” (from 2026 onwards, after adding broccoli, the list will total 50 vegetables, including some fruits). Criteria on triggering subsidies are: “specific conditions” as follows [2-3] (“Figure 1”):

Designated vegetables—when the market price is between 60% and 90% of the average market price in the past 6 years (benchmark price), the national and county governments and producer organizations subscribe jointly to subsidize. Depending on the place of origin, the subsidy rate is from 70% to 90%, and the normal subsidy rate is 90% of the benchmark price;

Certain vegetables—when the market price is between 80% and 55% of the benchmark price, subsidies for changing price to 80% of the benchmark price will be provided;

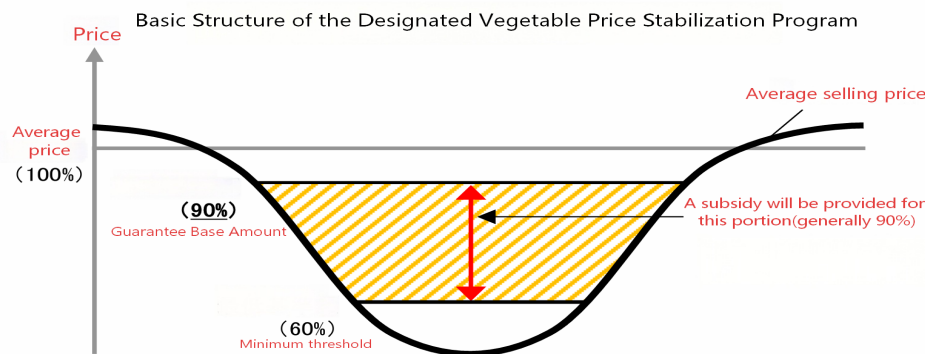


Figure 1 Basic structure of the designated vegetable price stabilization program.

One point is that “subsidize base equals ‘certified area’ × standard yield per unit area” and the area requirement is that the average size of “the certified production area by government” has to be

no less than 10 hectares and some vegetable-grown areas have to exceed 20 hectares, which directly rules out smallscale farmers and specialty varieties to benefit from the policy benefits. (“Table 1”)

Table 1. Criteria for Designated Origin

Category	Specified Origin	Specific region	
	Specific vegetables	Certain vegetables	Specific vegetables
Cultivated area	Stems, leaves, and roots: 20 hectares or more Fruit and vegetables (summer and fall): 12 hectares or more Fruit and vegetables (winter and spring): 8 hectares or more	Approximately 5 hectares or more	Stems, Leaves, and Roots Approximately 10 hectares or more Fruits and Vegetables Approximately 5 hectares or more
Shipment ratio	more than two-thirds	Roughly two-thirds or more	Roughly more than half

a * Certain flexibility measures apply to factors such as cultivated area and shipment ratios, depending on specific circumstances.

In other words, to capture the policy incentives, farmers have to grow crop varieties specified in the '14 + 35' catalog and grow these on a large scale. Policy subsidies introduce externalities of 'price risk' to farmers' costs but basically only subsidize catalog varieties. It strongly pushes farmers' farmland, cold warehouse, organization resources to concentrate on policy varieties, and eventually leads to 'path dependence'. The 1966 Vegetable Production and Shipping Stabilization Act stabilizes prices while shaping the variety composition on the supply side, embodying 'dependency on policy designated varieties'.

Once the distribution sector gets established around specialized assets (for example, pre-cooling warehouses and fruit-sorting lines), it will in turn require production areas to continue to expand the planting area of the vegetable varieties defined by policy design, in order to amortize fixed costs, thus

forming a positive feedback loop between "production and distribution". Meanwhile, at the demand end of vegetable market, consumers follow their unique dietary habits and are very willing to consume domestic vegetables, which gives consumers very low price elasticity of demand. This makes the cyclic model of a small number of vegetable varieties maintain a long-run equilibrium status.

In 2022, designated vegetables occupied 70.4% of total vegetable cultivated area and 80.1% of shipments of total vegetables, while specific vegetables occupied 37% and 23% respectively. Taking into account the combined share of the two (excluding overlap), it amounted to 107%. This number obviously reflects the fact that "policy vegetables" have "overbooked" the crop rotation period on arable land, squeezed the survival space of other non-policy varieties.

Table 2. Simulation of production trends for designated vegetables and traditional local varieties in Japan over the past 30 years [4] (1995–2022)

Year	Indicators	Selected vegetables (14 varieties)	Traditional local varieties (estimated)	Total Vegetables
1995	Cultivated area (hectares)	410,000	55,000	650,000
	Production capacity (tons)	13,500,000	1,400,000	18,000,000
	Percentage of total area	63.1%	8.5%	100%
2005	Cultivated area (hectares)	395,000	48,000	600,000
	Production capacity (tons)	13,800,000	1,200,000	17,500,000
	Percentage of total area	65.8%	8.0%	100%
2015	Cultivated area (hectares)	380,000	38,000	550,000
	Production capacity (tons)	14,000,000	950,000	16,500,000
	Percentage of total area	69.1%	6.9%	100%
2022	Cultivated area (hectares)	370,000	30,000	520,000
	Production capacity (tons)	14,200,000	750,000	15,800,000
	Percentage of total area	71.2%	5.8%	100%

a Note: The data in this "Table 2" are estimates based on publicly available sources, such as the Ministry of Agriculture, Forestry and Fisheries' *Crop Statistics*, and trends in academic research. They are intended to illustrate structural changes; please refer to official statistics for precise figures. Due to the lack of official statistics, the figures for "traditional local varieties" are estimates and primarily include regional brand varieties such as Kyoto vegetables and Kaga vegetables.

As clearly demonstrated in the "Table 2" above, in nearly 30 years over, although Japan's total vegetable cultivation area had markedly decreased

from 650 thousand ha to 520 thousand ha (reduced by about 20%), the area of cultivation for the 14 vegetables stipulated vegetables only slightly

reduced from 410 thousand ha to 370 thousand ha, while the proportion of the total area increased from 63.1% to 71.2%. In the face of overall contraction of the agricultural industry, the price stabilization system has acted as an “anchor”, firmly locking scarce land resources into policy stipulated vegetables. Before market risks and lack of resources, farmers rationally selected “safe choice” of crop subsidies, thus resulting in a more “localization” of cultivation to policy stipulated vegetables, and promoting a trend of “institutional monoculture”.

Obviously, in stark contrast to steady growth of designated vegetable varieties, the market share of traditional local varieties is shrinking fast. Their cultivated area has decreased from 55,000 hectares to 30,000 hectares, a drop of 45%, far more than total vegetable cultivated area drop in total. Their share of the total area has also shrunk from 8.5% to less than 6%.

These data show how tragic is the “crowding-out effect”. When arable land is scarce, the first varieties to be dropped by farmers are the local varieties — those without subsidies and most difficult to enter the mainstream marketing channels. It is not merely an economic choice—it is an inevitability given to us by institutional conditions. The history of Kyoto’s traditional vegetable varieties, which it calls “Kyoyasai”, is just one example of this macro trend. “Kyoyasai” started out with more than 60 varieties, but had shrunk to fewer than 20 varieties by 2023 — a reduction of more than 66%. Although five varieties—Kujo Leek and Horikawa Burdock—are designated as “Specific Vegetables”, most of the remaining varieties—Shogoin Radish and Kamo Eggplant, for example — are grown on small farms. Since their cultivation area is less than 3 ha, they fail to meet the area threshold (10 ha) for “Certified Production Areas” and cannot receive a subsidy of “specific vegetable”. Thus they have considerable difficulties in competition in the market. Unless they can bid up the prices, probably with a branding strategy like GI, it is difficult to turn the situation around. Facing the market risks, farmers have no choice but to shift to the designee varieties, “cabbage and daikon radish”, which are guaranteed to offer better returns. It is one of the most direct ways to see how the policy systems are leading to decline of the number of vegetable varieties in Japan.

If we plot the trend lines for the share of designated vegetables and that of traditional local varieties side by side, a classic “scissors gap” pattern shows immediately: one line (the share of designated vegetables) rises steadily, the other (share of traditional local varieties) still falls. The area inside this “scissors gap” is the space for diversity that has been “squeezed out” by this system. This means that, in order to cover up the planting quotas of policy-designated varieties, farmland is being exploited intensively and monotonously, squeezing out the space for crop rotation, fallow periods, or the growth of minor varieties. Such an “over-allocation” guarantees the supply of designated vegetables in the short term; in the long term, this comes at the expense of the health of the soil and ecosystems, as well as the resilience of the agricultural system.

3. THE IMPACT OF DISTRIBUTION CHANNELS ON VEGETABLE DIVERSITY

For many years, Japan has been relying on a system in which farmers sell their crops to wholesale markets, which then sell to supermarkets that sell to the consumer. This system guarantees a reliable supply of a large quantity of agricultural products to our dining table and is the foundation of Japanese food culture.[5]

JA Zen-Noh has statistics that over 57% of the agricultural product supply companies in Japan are controlled by it and has more than 5,300 collection stations and 3,100 fruit sorting lines. JA Zen-Noh has reached the first level of the standardization of the process of “farm-to-retail”. In mainstream national wholesale systems, once a vegetable arrives at market, before it leaves the market it will undergo sorting and grading at sorting facilities according to strict grading standards like size, shape, colour and sugar content. Distribution cost from farmer to consumer accounts for 16.9% collection charges, 5.0% wholesale charges, 10.3% intermediary charges and 20.4% retail charges, with total distribution charges of 52.6%. That means, for a consumer that pays 100 yen for a product, only about 47.4 yen of it goes to the farmers.

If a farmer has just a little croissant piece of non-standard local varieties, then these varieties could not enter the JA’s standard sort lines because the cost to change molds and sort is too high. The cost of unit distribution could be as high as 70%;

this means that for every 100 yen of selling price by consumers, a farmer would receive only about 30 yen. Therefore, the traditional local vegetable varieties are excluded from the mainstream distribution channels right from the start. Only “policy varieties”—such as cabbage and daikon radish—can be produced in very large scale and are very standardized that could function efficiently within this system, and the cost is handed out to every stage. This in turn causes the incentive for local farmers to grow only the “safe varieties”.

Although direct-sales markets for vegetables are one channel for the supply of vegetables in Japan, these direct-sales markets are all located along roads within 30 kilometres of production areas and do not bring significant varieties of vegetables onto the dining tables of urban residents.

Japanese agriculture is particularly demanding on product quality management, aiming for high-quality, safe, and organic agricultural products as well as providing effective value-added to products to continually improve product value-added [6]. To improve efficiency and standardization, from as early as 1989, Japanese company, Mitsui Metal, launched a near-infrared (NIR) sugar content sorter; in 2019, the fruit distributor Shizuoka JA Mikkan introduced an artificial intelligence (AI) image recognition and NIR integrated sorter; the accuracy reached 99% and labor decreased by 40%. Yet the standardization depends on high initial investment of the equipment for each fruit sorting plant—roughly 3 billion yen—and so is profitable only for a designated variety that are “big and applicable to subsidies”. On one hand, investments in high-efficiency and standardized equipment have partly alleviated the serious problem of ageing agricultural workforce in Japan; on the other hand, they have further tamed the crop variety structure, resulting in a classic technological lock-in.

4. THE IMPACT OF CONSUMER INERTIA ON VEGETABLE DIVERSITY

Japanese dietary patterns do not put a lot of demand on vegetables. In the late Edo period, “one soup and one dish” model focused on “rice and pickles”, with vegetables playing at best the role of “snacks.” The Meiji army used “six cups of white rice” to lure recruits, and furthered the path dependence of “rice culture.” A survey in 2023 showed that 85% of the population “eats rice every

day”, and the side food remains “rice companions” (natto and raw eggs), etc. The Japanese eat only 256 g of vegetables per day, far from the target level (350 g) set by the Ministry of Health, Labour and Welfare. Plus, the fast life rhythm of modern society leads to an increasing demand for “not eating vegetables”.

A survey by Kagome on the reasons for “not eating vegetables” showed that the two most frequent reasons were no time to cook vegetables (28.5%) and the high cost of vegetables (13.9%). In 2024, cabbage prices soared by 250%, with a head of cabbage selling at more than 1000 yen. Since the demand for “pre-washed vegetables” and “frozen vegetables” has been increasing, pre-washed vegetables are mostly in the forms of salad kits, featuring “specific vegetables”, which further enhance the monotonous production;

Secondly, for Japanese consumers, the taste of vegetables grown in Japan in the right season by farmers who have understood the local climate can truly “express” the essence of “shun” (the “peak of the season”). “Local production for local consumption” is not only a consumer philosophy. It is also a sense of regional pride and pride in local communities. Enjoying local specialties means supporting and protecting local culture. The freshness and emotion behind “local production for local consumption” is incomparable to vegetables of other regions and imported ones from overseas.

At the same time, to facilitate transportation, vegetables from other places or imported vegetables are harvested before they ripen, even if they look the same, their “soul” and “vitality” have been lost. As a result, customers are quite anxious to buy seasonal vegetables when they go shopping. “Seasonal vegetables” is the brief time in a year when vegetables reach the absolutely best taste, nutrition and texture. It is a culture seeking the deliciousness at its zenith, a visual aspect full of Zen thinking and a conception of nature. Japanese food culture believes that appreciating ingredients when they are “shun” (peak season) is the “closest dialogue with nature”, a way to show its thanks to heaven and earth.

Consequently, this obsession for “shun” (peak season) has strengthened the demand for mainstream, classic varieties. Because the “shun” (peak season) of “designated vegetables” such as cabbage, daikon radish and turnips is known to the general public, stable public demands have been

created. Meanwhile, some niche regional varieties, whose “shun” (peak season) is not known to the general public, struggle to enter the mainstream consumer culture, and are thus squeezed out of the market.

More, the collective psychological fixation to “safety and peace of mind” has also indirectly affected the vegetable diversity of Japan. “Safety” has the objective technical standard (such as the level of pesticide residue not exceeding the limit), and “peace of mind” is a subjective emotional state (“I am reassured”). “Produced in Japan” is almost the same as “peace of mind”; consumers believe (or choose to believe) Japan’s production rules of agriculture and daily life, their regulatory systems, and farmers’ professional morality. Otherwise, no matter how seriously an imported vegetable product is tested, it always carries a psychological “shadow of ‘unknown’ and ‘uncontrollable’.” This stubborn pursuit of “peace of mind” is perfectly suitable to explain why the JA’s standardized, high-price distribution system has been maintained for so long. Consumers are willing to pay high price for this “traceability and assurance”.

And with fruit selection and grading, the JA system provides just these standardized “reassuring products” exactly. This creates a closed loop: consumers want assurance → this drives the JA standardization system → the standardization system puts non-existent and non-standard varieties aside → consumers have a limited number of choices, but feel a greater sense of “reassurance” over their limited options.

Ultimately, Japanese aesthetics aim for the ultimate in simplicity, harmony and perfection. This aesthetic standard applies to the food ingredients. A ‘good’ vegetable, in particular, must taste delicious but also look pleasant — with a perfect shape, a uniform size, a bright colour and no defects. Underneath this is the appreciation for the producer’s ‘craftsmanship’—for farmers are seen as craftsmen attempting to achieve perfection. JA’s vegetable sorting facilities are the actual cultural manifestations of the Japanese aesthetic demand. Using optical sensors and manual sorting, vegetables are rigorously graded into SS, S, M, and L grades, while all ‘non-conforming’ products are weeded out. Consumers have become accustomed to seeing a plate of vegetables in a grocery store that looks like vegetables ‘copied and pasted’ and

consider this to be the symbol of quality. Domestic vegetables, especially JA-processed vegetables, best exemplify this visual ‘obsession with perfection’.

For niche or traditional varieties, though, their natural characteristics can include “irregular shapes” and “varying sizes.” Under JA’s strict standard, most of them are seen as “substandard” or “out of specification” and barred from large-scale sale channels and marketed at very low prices. So to have the products marketed, producers need to choose “policy-designated varieties”, which is easier to make standard, and lose the diversity of the product. Japanese consumers are not averse to a diverse set of vegetables; rather, their cultural preferences systemically mean that there is a certain type of vegetable preferred (one is safe, reassuring, pretty, in season and has a story behind it—related to the producer or the region). These cultural preferences solidified the categories of vegetables available and have ultimately sacrificed vegetable diversity.

These mixed vegetable varieties of Japan are not paradoxical because of the country lacking natural resources, but rather because of a triple lock-in affecting price stabilization policies—the JA distribution system — and sociocultural aspects. “The price stabilization system makes sure a surplus of the major varieties is available; this satisfies consumers’ basic needs for “peace of mind” and a “sense of seasonality.” Through standardization, the JA distribution system fully meets consumers’ expectations for “perfect appearance” and “peace of mind.” Consumers are immersed in a well-edited “high quality-high reassurance” consumption experience; but they do not realize that this experience itself has a cost to them in a broader world of vegetables that might be more delicious and with richer cultural meanings. Consumer inertia has created a system extremely well optimized for satisfying cultural preferences at the expense of vegetable variety.

“Triple lock” analysis employed in this paper not only provides an interesting insight into the Japanese context but also gives a true lesson of caution to the other countries tackling “efficiency, openness, and diversity” as an aim of agricultural modernization. Truly achieving diverse supply entails systemic change that includes production subsidy, distribution structure, consumer culture, global competitiveness structure, and its ultimate

aim is to build sustainable social system to fulfil basic needs with adequate resilience.

5. CONCLUSION

These mixed vegetable varieties of Japan are not paradoxical because of the country lacking natural resources, but rather because of a triple lock-in affecting "price stabilization policies—the JA distribution system—and sociocultural aspects." The price stabilization system makes sure a surplus of the major varieties is available; this satisfies consumers' basic needs for "peace of mind" and a "sense of seasonality." Through standardization, the JA distribution system fully meets consumers' expectations for "perfect appearance" and "peace of mind." Consumers are immersed in a well-edited "high quality-high reassurance" consumption experience; but they do not realize that this experience itself has a cost to them in a broader world of vegetables that might be more delicious and with richer cultural meanings. Consumer inertia has created a system extremely well optimized for satisfying cultural preferences at the expense of vegetable variety.

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