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Consumers' values and preferences for long-term policies in multifaceted rice production and consumption: a deliberative experiment incorporating the perspective of future generations in 2050

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Abstract

Non-technical summary. The design of food systems is a common theme that requires stakeholders to prioritize long-term perspectives and balance between benefits for the present and future generations. Building on this theme, this study aims to demonstrate an intervention in individuals' policy preferences by helping them voluntarily adopt values for long-term policies and assessing its effectiveness through online deliberation experiments involving randomly selected consumers. The findings indicate that interventions incorporating the concept of imaginary future generations significantly influence individuals' food preferences and values.

Technical summary. Food systems are indispensable for the survival of the present generation and simultaneously have various effects on future generations. Therefore, the design of food systems is a typical theme requiring stakeholders to find value in a long-term perspective that achieves an appropriate balance between the benefits for the present and future generations. In this context, this study aims to demonstrate an intervention in individuals' policy preferences by assisting them in voluntarily acquiring values for long-term policies and verifying their effectiveness through online deliberation experiments with randomly selected food consumers ($n = 153$). The intervention used the future design method and the core concept of imaginary future people. The topic of this experimental study is policies on rice production and consumption in Japan. The findings suggest that interventions that incorporate the concept of imaginary future generations significantly influence individuals' food preferences and values, encouraging a shift toward a sustainable system through fundamental transformation rather than maintaining the current status quo. Based on these results, the authors discuss a pathway toward achieving a sustainable food system, in which collaborative efforts that transcend the individual positions of stakeholders are driven by forming a group identity among individuals willing to adopt the viewpoint of future generations.

Social media summary. The design of food systems is a common theme that requires stakeholders to prioritize long-term perspectives and balance between benefits for the present and future generations. Building on this theme, this study aims to demonstrate an intervention in individuals' policy preferences by helping them voluntarily adopt values for long-term policies and assessing its effectiveness through online deliberation experiments involving randomly selected consumers. The findings indicate that interventions incorporating the concept of imaginary future generations significantly influence individuals' food preferences and values. This concept has the potential to contribute to the realization of a sustainable food system through the establishment of collaborative relationships among various stakeholders.

1. Introduction

Food systems affect future generations in many ways. Earlier studies discussed how improving food systems is related to achieving the UN's (2016) Sustainable Development Goals (SDG) (CGL from France, 2019; Djekic et al., 2021) such as zero hunger (SDG 2), clean water and sanitation (SDG 6), responsible consumption and production (SDG 12), climate action (SDG 13), and life on land (SDG 15), and thus to relate the benefit of the future generations. For example, SDG 2 benefits future generations by breaking the intergenerational transmission

of undernutrition (Acosta & Haddad, 2014; Gupte & Longhurst, 2019; Lentz & Barrett, 2013). SDG 12 benefits future generations by achieving sustainable nitrogen use (e.g. Udvardi et al., 2021). According to SDG 13, it is also crucial to reduce greenhouse gas emissions from the food sector, including nitrogen emissions from chemically fertilized soils (e.g. Clune et al., 2017) to benefit future generations. Thus, actors must consider the future of food systems from a long-term perspective.

However, agreeing to adopt such a perspective is not straightforward for at least three reasons. First, as Spijkers (2018) notes, increasing attention has been paid to intergenerational equity by the global society; however, this is perceived, particularly by the developing world, as a threat to the interests of the people today, because benefiting future generations would come at the expense of the poor people of the present generation. This intergenerational dilemma may become apparent in designing food systems because the current generation must bear the cost of choosing system transformation over maintaining the status quo.

Second, the SDGs and their targets relevant to the food system are not uniform in terms of whether achieving them is an urgent concern for the current generation or is expected to become an urgent concern in the future. Thus, prioritizing the latter over the former may serve as a threat to some current-generation actors. For example, billions of people lack access to affordable, healthy diets and are at risk of poor health (Fanzo et al., 2021). This requires urgently improving the capacity of the food supply (i.e. SDG 2) to benefit the present generation and breaking the intergenerational transmission of undernutrition for future generations. Conversely, SDGs protecting the natural environment (i.e. SDGs 6, 13, and 15) may be particularly critical for future generations.

Third, there is no guarantee that the SDGs and their targets relevant to the food system are compatible with one another (e.g. Kroll et al., 2019; Scherer et al., 2018). To further complicate the situation, a single SDG, such as zero hunger, may consist of multiple targets, each with trade-offs (Hegre et al., 2020; Kroll et al., 2019). Thus, in pursuing a specific SDG (or its target) that is also beneficial for the present generation, other SDGs (or targets) may serve as constraints, decreasing the benefits for today's population. For example, enhancing the food supply capacity to achieve zero hunger must be approached urgently and carefully, considering that food systems may serve as a major driver of environmental pressures (Willett et al., 2019; Wood et al., 2023). In fact, food production and waste are responsible for 21–37% of global greenhouse gas emissions and contribute to many other types of environmental degradation threatening the Earth's systems (Fanzo et al., 2021). Acknowledging the very challenging potential scenario where the eradication of hunger leads to population growth, which in turn could increase environmental burdens, is imperative (e.g. Saijo, 2022).

For these reasons, the design of food systems is a typical theme requiring stakeholders to find value in a long-term perspective to achieve an appropriate balance between the benefits for the present and future generations. In this context, this study demonstrates an intervention in individuals' policy preferences by assisting them in voluntarily acquiring such values and verifying their effectiveness through online deliberation experiments with 153 randomly selected food consumers.

In sustainability science and future studies, the future design (FD) concept and its core idea of 'imaginary future people' (Saijo, 2020) has been attracting a great deal of attention recently, partly because it affects individuals' preferences and even their way of living (Takahashi et al., 2024), without relying on economic incentives, punishments, or enforcement of adherence to specific social norms (Pandit et al., 2021). The present study considers the intervention measure that incorporates this concept.

Several studies have conducted experiments to better explain food consumers' preferences (e.g. Asioli et al., 2022; Kee et al., 2023; Kliem & Sagebiel, 2023; Lehberger & Grüner, 2021; Vroegindewey et al., 2021). However, few earlier studies have considered more challenging questions about how thinking or fundamental consumer values affect their preferences regarding specific policies or their behaviors in specific contexts. As Druckman and Lupia (2016) note, a policy preference is a comparative valuation of (i.e. a ranking over) a set of objects, which is guided by a value that is less dependent on the situation than the preference. The present study aims to assess how the proposed intervention affects consumers' values (rather than policy preferences).

2. Context of the study

The topic in this experimental study is policies related to rice production and consumption in Japan. Rice is a staple crop of Japan, accounting for approximately 20% of the agricultural production value in the last decade (Takahashi, 2012). The Japanese government has struggled to balance preventing a decline in rice prices to sustain rice farmers' livelihoods and limiting the government's financial burdens. One method to achieve this balance has been to reduce the rice supply in tandem with a decrease in the demand for rice, to maintain an equilibrium between supply and demand. According to Nakawatari (2010) and Inakuma (2014), Japan's rice policy over the past half-century, until the 2010s, can be summarized as follows.

During World War II, the government aimed to distribute a certain amount of rice to consumers amidst food shortages, establishing a food control system to purchase a specified quantity of rice at government-set prices to promote rice production. In the high economic growth era, the government maintained this system to address the disparity between agriculture and industry by establishing the price of rice. However, by the 1960s, the situation had reversed, and Japan began to experience a rice surplus. At this time, the Japanese government sought to balance the demand and supply of rice through fallowing and crop rotation. In the late 1960s, a system was introduced where the government determined the annual area of rotation and allocated it to each prefecture.

In the 1970s, recognizing the importance of food self-sufficiency due to the oil shock, crop rotation gained more emphasis than fallowing, and incentives for crop rotation, particularly of wheat, soybeans, and feed crops, were increased. In the 1990s, against the backdrop of the GATT Uruguay Round agreement, the food control system was abolished, and the means for achieving price stabilization through government-set rice prices were lost. Thus, in the late 1990s, crop rotation was further encouraged so that the rice supply would not be excessive and prices would stabilize.

From 2004, the allocation of rotation areas, which had a negative connotation, was abandoned; in its place, the government allocated production quotas to each prefecture. In 2009, there was a growing momentum to reassess this longstanding policy, driven by concerns that the policy to maintain the price of rice hindered the development of large-scale farmers and the consolidation of agricultural land. There was also a realization that lowering rice prices internationally could potentially elevate rice to a growth industry. (This idea is incorporated in the fourth policy option created for the experiment in this study. Refer to Appendix A for details.) In 2018, the allocation of production

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targets was abolished, commonly considered a turning point in Japan's rice policy. However, as of 2023, the subsidy system for crop rotation, transitioning from rice to other crops, still exists.

In 2021, the Ministry of Agriculture, Forestry and Fisheries formulated a long-term strategy: the MIDORI Sustainable Food System Strategy. This strategy aimed to achieve a balance between enhancing the productivity of food, including rice, and considering environmental concerns using data and artificial intelligence. Specifically, the strategy outlines targets such as achieving zero CO_2 emissions in the agriculture, forestry, and fisheries industry by 2050, reducing the use of chemical pesticides (risk-adjusted) by 50%, and decreasing the use of chemical fertilizers by 30% (https://www.maff.go.jp/j/kanbo/kankyo/seisaku/midori/#Midorisennryaku).

However, achieving these goals may not be straightforward. In fact, the European Parliament recently rejected the contentious Sustainable Use of Pesticides Regulation proposal. This proposal aimed to slash the use and risk of pesticides in half by 2030, as set out in the European Union's flagship food policy, the Farm to Fork strategy (https://www.euractiv.com/sections/agriculture-food/). This strategy served as inspiration for the Japanese government in formulating the MIDORI Sustainable Food System Strategy.

Due to the aforementioned policies over the past half-century, Japan's rice production has fallen by over 40%, from 12.5 million tons in 1970 to 7.8 million tons in 2020. The reduction in the paddy field area followed a similar trend. This has several implications for Japan, including a decline in food self-sufficiency, a deterioration of Japan's food culture centered around rice, and the loss of multifunctional aspects of paddy fields such as flood prevention, groundwater recharge, and biodiversity conservation. Looking ahead to the coming decades, determining how to control rice production and consumption in Japan is a very challenging policy issue. The current trajectory suggests that Japan is at a crossroads. Thus, our interest lies in determining whether there are differences in the values and preferences of stakeholders regarding which direction Japan should adopt toward the year 2050 in terms of rice production and consumption, when there are interventions that encourage the adoption of a long-term perspective and when there are not.

While this study was conducted in Japan, the intention is to extrapolate the insights gained to other countries, particularly those with comparable food control systems. For instance, India is recognized for its distribution of food grains to households through the government-controlled Public Distribution System. In this system, food grains are procured from farmers at a price higher than the market rate and subsequently distributed to consumers through fair price or ration shops. Although crucial for ensuring food and nutritional security, scholars have raised concerns about its operational inefficiency (George & McKay, 2019). Furthermore, as will be discussed later, Japan's food system is currently at a significant crossroads due to interrelated factors such as population decline, aging demographics, reduced demand for agricultural products, and diminishing agricultural land. The study findings are expected to provide substantial insights for countries experiencing similar socioeconomic trends when contemplating the future of their food systems with a long-term perspective.

3. Future design

Several approaches have been devised to protect the interests of future generations that do not have a voice in the negotiations of the current generation. Of these, FD is attracting particular attention as a means of systematizing how policymakers conceive of policies from the perspective of future generations (e.g. MacAskill, 2022). FD is an emerging methodology in future studies and sustainability science that aims to design social systems that stimulate people's inherent desire to care for future generations rather than adhere to presentism (e.g. Saijo, 2020). This methodology relies on the working hypothesis that humans experience increased happiness due to foregoing current benefits for the betterment of future generations. In participatory envisioning processes where organizational, regional or larger-scale visions are created by inviting relevant stakeholders, FD can be implemented by participants adopting the perspective of future generations and deliberate in groups on the desired future state (e.g. Hara et al., 2019). Experimental studies have found that this deliberative exercise affects individuals' attitudes sustainably (e.g. Nakagawa et al., 2019a, 2019b) and can stimulate individuals' creativity (Nakagawa, 2020). Introducing the FD methodology into a workshop conducted by an organization is intended to bring about change in the output of the workshop and transform the awareness of participants and organizers. This transformation aims to alter the organizational culture, fostering a broader, more long-term thinking style that extends beyond one organization.

4. Methods and materials

4.1 Sample

The experiment was implemented online using an internet research company, Cross Marketing, Inc., one of the largest internet survey companies with about 5.6 million registered monitors across Japan. At the company's request, a total of 9,511 registered monitors responded to a survey designed to confirm their willingness to participate in this study. Of them, 499 aged between 20 and 69 agreed to participate. From this group, 153 individuals who were chosen to ensure an approximately uniform distribution in age and gender participated in the experiment. This process was designed to ensure that the sample represents the entire Japanese population as accurately as possible.

4.2 Materials

Following Barnes et al. (1994), Wassermann (1994), Andersen and Schiano (2014), and Nakagawa et al. (2019a, 2019b), we employed and developed a case-method approach to provide the participants with sufficient scientific information and facts for the rice agenda in Japan. The case-method material consists of a story that describes how the production and consumption of rice is associated with the life of Japanese people in many ways, and how rice's role in Japanese society has changed in the last half-century. (See Electric Supplementary Material for details.) The material also included four options for Japan's future as it looks ahead 50 years from today. The four-stage set of options ranged from maintaining the status quo to a more fundamental food system transformation, as shown below. For more detailed explanations of these options, see Appendix A.

Option 1: Acceptance of the Decline of Rice Consumption in Japanese Food Culture.

Option 2: Acceptance of the Decline of Rice Consumption and Maintenance of Potential Production Capacity.

Option 3: Halting the Decline of Rice Consumption in Japanese Food

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Culture through ICT (Information and Communication Technologies).
Option 4: Seeking Reconstruction of Rice Consumption in Japanese Food Culture through ICT and Historical Policy Transformation.

In the material, it was also noted that the abovementioned options can be evaluated in terms of four different criteria (A to D):

Criterion A: Ease of actions Japan can take in 2023 to achieve it.
Criterion B: Inheritance of the rice culture in Japan in 2053.
Criterion C: Environmental conservation in Japan in 2053.
Criterion D: Food security in Japan in 2053.

Based on Criterion A, the option that maintains the status quo, without aiming for a significant societal transformation, receives the highest rating. This is because the more ambitious the option for seeking significant change, the more likely it will face resistance and the greater the need for consensus among various segments of society. Furthermore, there is a higher likelihood that the country will have to bear a financial burden for implementing the policies. Based on Criterion B, the option where the rice-based food culture continues and rice remains at the center of Japanese dietary habits, receives a high rating. In this option, traditional Japanese culture associated with rice and the unique regional cultures throughout Japan will continue to thrive. Criterion C, the option that maintains Japanese rice paddies and operates them with consideration for the natural environment, receives the highest rating. In establishing these criteria, we were inspired by the fact that the Food and Agriculture Organization has designated 15 regions in Japan as Globally Important Agricultural Heritage Systems (GIAHS). GIAHS refers to regions considered agricultural heritage systems, globally recognized for practicing unique traditional agricultural, forestry, and fishery industries that have been passed down over multiple generations, intimately connected with culture, landscapes, seascapes, and agricultural biodiversity, adapting to both societal and environmental changes (Koohafkan & Altieri, 2011). Finally, based on Criterion D, the option that increases the likelihood of Japan being able to secure food reliably, even in times of crisis, receives the highest rating.

The association between the options and the criteria are summarized in Table 1. This table shows the extent to which each option can be highly rated in each evaluation criterion. '+++' indicates a very high rating, '++' indicates a high rating, and '+' indicates a somewhat high rating. This table indicates that the cost to the current generation for realizing each option increases with the option number. Additionally, the preferences shift toward seeking greater long-term sustainability and benefits for future generations.

The above options and criteria list indicate that Japan's rice policy issues involve intergenerational trade-offs. In fact, as the option number increases, the sustainability of the food system and the benefits for future generations increase. However, achieving the options with higher numbers requires a fundamental food system transformation. Individuals of the current generation bear the costs for such a transformation in many different ways. In Option 4, the individuals shouldering the most significant costs are small-scale farmers.

4.3 Measures

The experimental procedure is summarized in Figure 1. Approximately one week before the discussion, the paper version of the case-method material was sent to the participants. Additionally, participants were provided with a URL to access a 10 minute and 21 second video introducing the four options. Participants thoroughly reviewed the materials, watched the video, and participated in the first-round of the questionnaire survey before the day of the discussion. The questionnaire included (i) preferences for the most favorable option of the participants, (ii) beliefs regarding which of the two criteria should be prioritized when selecting an option (this question was posed for all six pairs created by selecting two criteria from the four), (iii) demographic variables (age, gender), and (iv) psychological characteristics.

Of the four categories, (ii) was included to understand the values behind participants' preferences. The items were inspired by the analytic hierarchy process (Saaty, 1987), a mathematical and psychological method for organizing and analyzing complex decisions, in which a decision problem (i.e. selection of an option among alternatives) is decomposed into a multicriteria evaluation of each alternative and the pairwise comparison of the set of criteria.

Regarding (iv), the generative behavior subscale of the Revised Japanese Version of Generativity Scale (JGS-R; Murayama et al., 2021) was adopted, comprising four items about the frequency of supporting younger generations by sharing one's life experiences in the six-point scale. This scale was implemented following Nakagawa et al. (2019b), who proposed a theoretical framework to connect the developmental psychological construct of generativity (McAdams & de St. Aubin, 1992) to individuals' ability to accept the perspective of the future generation under the FD intervention, so as to adopt the concept of the imaginary future generation.

4.4 Experimental procedure

On the day of the deliberation, the participants were divided into 41 teams, each comprising four members, except for four teams

Table 1. The correlation between the four options and four criteria

	Criterion A	Criterion B	Criterion C	Criterion D
Option 1: Acceptance of the decline of the rice-eating culture.	+++			
Option 2: Accepting the Decline of Rice Eating Culture and Maintaining Potential Productivity.	+++			+
Option 3: Stopping the decline of rice-eating culture through ICT.	++	+	+++	++
Option 4: Reconstruction of rice-eating culture through ICT and historical changes in policy.		+++	+++	+++

Note: The number of the '+' signs represent the degree to which the option is highly evaluated with respect to the criterion.
Criterion A: Feasibility for the *present* Japan.
Criterion B: Inheritance of rice-eating culture to the *future* Japan.
Criterion C: Environmental conservation in the *future* Japan.
Criterion D: Food security of the *future* Japan.

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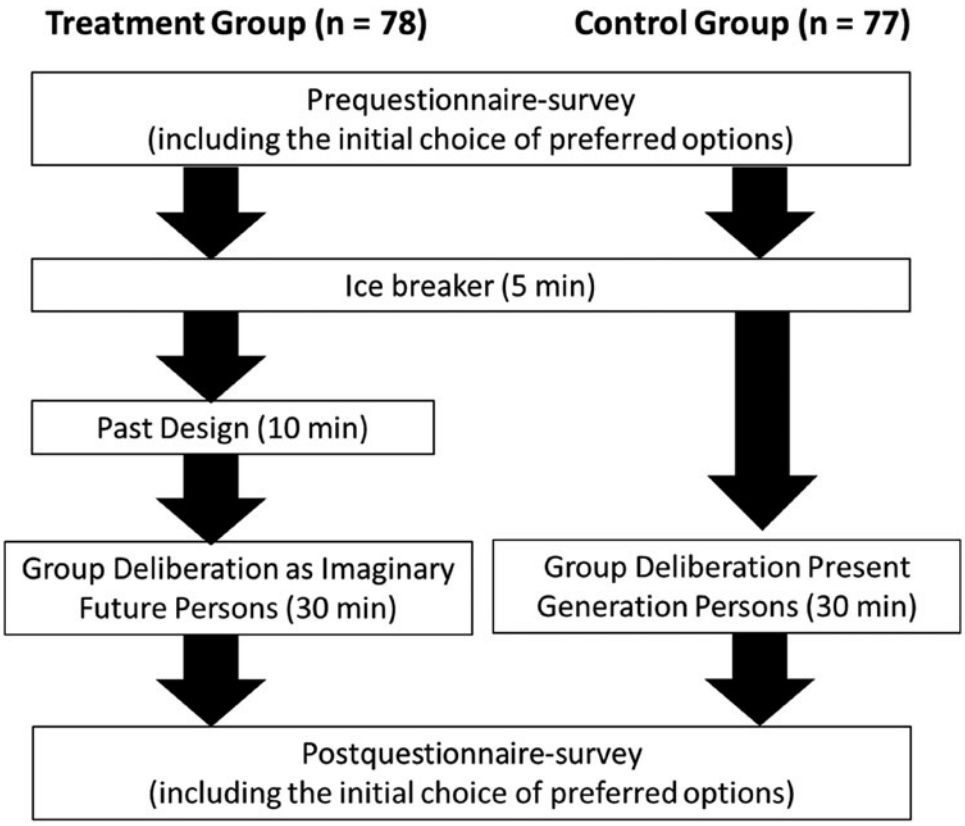

Figure 1. Experimental procedure.

with three members and one team with two members for practical reasons. The 41 teams were then divided into the treatment group (21 teams; $n = 78$) and the control group (20 teams; $n = 77$).

All participants held 30 minute discussions within their teams to make collective decisions on the most preferred options among the four alternatives, and then individually participated in the second-round questionnaire survey. Of the four categories of items in the first-round survey, the second-round survey included only two categories: (i) the preference for the most-favorable option and (ii) the preference for which two of the four criteria to prioritize in selecting an option.

The difference between the treatment and control groups lies in their perspective when participating in the exercise. It was implicitly suggested to the control participants that they participate from the perspective of the present generation, using the instruction: 'In 2023, which of options 1 through 4 do you believe is best for us to choose as our first step toward 2053?'

In contrast, in the treatment group, the participants considered the same issue from the future generation's perspective, using the instructional remark: 'In 2053, which of the options 1 through 4 do you want people in 2023 to *have chosen* as their first step toward 2053?' Furthermore, to guarantee that they adopt the future generation's perspective, they also received the following instruction: 'Throughout the 30 minutes, please always start your statements with the phrase *Now, in 2053*.' Additionally, the Past Design session was only implemented in the treatment group teams, following Nakagawa et al. (2019b). After presenting an issue not related to the rice or food policy issue that attracted a great deal of attention of Japanese in 1980s, the participants were requested to hold 10 min discussions about the message(s) they would like to send to the generation that used to live in the 1980s, for example, messages of regret and gratitude (Noblet et al., 2015). The issue adopted here was on the debate about whether the business model of rental record stores brings prosperity to the music industry or accelerates its decline. The Past Design methodology is considered an effective training to convey a message to the society of 2023 from the perspective of the future generation. In fact, both involve a commonality in sending messages to society decades ago from a certain point in the future.

We should note that during the second-round questionnaire survey, participants in the treatment group were explicitly instructed that the scenario of the imaginary future people had concluded. They were then required to make choices, such as selecting options, in the role of a contemporary person living in 2023 and prioritizing preferences between criteria. This was done to elicit preferences under the same conditions as the control group to accurately identify the effects of the intervention.

4.5 Analysis method

The analysis is divided into two parts. The first aims to answer the question of whether the treatment influenced participants' individual option choices. The four options range from maintaining the status quo (Option 1) to drastically overhauling the food system (Option 4). The participants' individual option choices were used as the dependent variable, and the ordered logistic analysis was conducted with the presence or absence of treatment as a dummy variable explaining the independent variable.

The second part of the analysis is conducted if the treatment had a significant effect in the first analysis, aiming to identify the cause. For all pairs created from the four criteria (a total of six pairs), the participants' responses regarding which of the

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Table 2. Sample characteristics

	N	%	*M*	SD	Cronbach's alpha
Sex					
Male	76	49.7			
Female	77	50.3			
Age					
20–29	29	19.0			
30–39	38	24.8			
40–49	35	22.9			
50–59	19	12.4			
60–69	32	20.9			
Generativity					
Behavior[a]			10.8	4.5	0.92
Concern[a]			14.2	4.7	0.92
Achievement[a]			11.2	4.2	0.93
Group assignment					
Treatment	77	50.3			
Control	76	49.7			

Note: [a]Theoretical range = 6–24.

two criteria in each pair they prioritized were used as the dependent variable. Demographic and psychological variables were used as explanatory variables, and the multivariate linear regression analysis was performed.

5. Results

Sample characteristics are summarized in Table 2. With regard to the behavior subscale of the Revised Japanese Version of Generativity Scale (JGS-R), the Cronbach's alpha coefficient was 0.92, suggesting a sufficient level of internal consistency. The concern and achievement subscales of JGS-R were also measured, and their mean, SD, and Cronbach's alpha are also shown. Note that these two subscales were not utilized in the analyses because they exhibited a high correlation with the behavior subscale ($r = 0.70$ and 0.71, respectively).

Table 3 displays the distributions of the most favored options selected by the subjects. Both in the treatment and control groups, the percentages of subjects choosing Option 4, representing the most drastic change, increased due to the team discussions. The χ^2 test of independence revealed that the change in the distribution due to the team discussion was significantly different in neither the treatment nor control groups ($p = 0.10$ and 0.59, respectively). However, the McNemar test revealed that the number of participants in the treatment group who changed their opinion in the direction of increasing option numbers (i.e. from Option 1 to Options 2–4; from Option 2 to Options 3–4; and from Option 3 to Option 4; $n = 18$) was significantly greater than those who changed their opinions in the opposite direction ($n = 7$) (i.e. χ^2 static = 4.00; $p < 0.05$). In the control group, the number of participants who changed their opinion in the direction of increasing option numbers ($n = 19$) was also significantly greater than the number of those who changed in the opposite direction ($n = 8$), but only at the 10% level (i.e. χ^2 static = 3.70; $p < 0.10$).

Table 4 displays the result of the ordered logistic regression analysis results, where the chosen option (Nos. 1 to 4) was adopted as the objective variable. As predictive variables, Model 1 includes sex, age, generativity, and the treatment dummy (i.e. the dummy variable that took a value of one when a participant was allocated to the treatment group). Generativity (coefficient = 0.45; odds ratio = 1.57) and the treatment dummy (coefficient = 0.75; odds ratio = 2.12) were found to be significantly associated with preferring the higher number options ($p < 0.01$ and $p < 0.05$, respectively).

In Model 2, the interacting effect of generativity and treatment was taken into account. Specifically, two dummy variables were defined and included rather than including a single treatment dummy. The first dummy took a value of one if a participant had a higher generativity score than the median and was allocated to the treatment group. The second dummy took a value of one if a participant had a lower generativity score than the median and was allocated to the treatment group. It was found that generativity (coefficient = 0.50; odds ratio = 1.65) and the treatment for *lower* generativity score holders (coefficient = 0.88; odds ratio = 2.41) were significant ($p < 0.01$ and $p < 0.05$, respectively), while the treatment for *higher* generativity score holders was not significant. One possible interpretation for this unexpected outcome is as follows:

Table 3. Distributions of the preferences of the treatment and control groups

	Treatment group ($n = 77$)				Control group ($n = 78$)			
	Initial		Final		Initial		Final	
	n	%	*n*	%	*n*	%	*n*	%
Option 1	4	5.2	6	7.8	3	3.8	3	3.8
Option 2	10	13.0	3	3.9	20	25.6	13	16.7
Option 3	23	29.9	18	23.4	22	28.2	25	32.1
Option 4	40	51.9	50	64.9	31	39.7	35	44.9

Notes:
Option 1: Acceptance of the decline of the rice-eating culture.
Option 2: Accepting the decline of rice eating culture and maintaining potential productivity.
Option 3: Stopping the decline of rice-eating culture through ICT.
Option 4: Reconstruction of rice-eating culture through ICT and historical changes in policy.

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Table 4. Ordered logistic regression analysis result

	Model 1				Model 2			
Predictors	coeff.	s. e.	OR	(95% CI)	coeff.	s. e.	OR	(95% CI)
Sex								
Male	−0.45	0.32	0.64	(0.34–1.19)	−0.44	0.32	0.64	(0.34–1.21)
Female (reference)								
Age[a]	0.01	0.16	1.01	(0.74–1.38)	0.02	0.17	1.02	(0.73–1.42)
Generativity[a,b]	0.45**	0.17	1.57	(1.12–2.19)	0.50**	0.19	1.65	(1.14–2.39)
Group assignment								
Treatment	0.75*	0.33	2.12	(1.11–4.04)				
Treatment on more generative individuals[c]					0.60	0.44	1.82	(0.77–4.32)
Treatment on less generative individuals[d]					0.88*	0.42	2.41	(1.06–5.49)
Control (reference)								

The chosen option (Nos. 1–4) was adopted as the objective variable.
Note: *$p < 0.05$; **$p < 0.01$.
[a]Data were standardized before the analysis.
[b]Generative Behavior Subscale score.
[c]Defind as 0 if an individual had a generativity score greater than or equal to the median (i.e. 11 points) and was allocated to the treatment group.
[d]Defind as 0 if an individual had a generativity score less than the median (i.e. 11 points) and was allocated to the treatment group.

People with a high generativity score tend to prefer higher-numbered options, whether or not they undergo treatment, and even if they receive treatment, no additional effects are observed. In contrast, individuals with a low generativity score tend to prefer lower-numbered options, but this tendency is offset when they undergo treatment.

Finally, Table 5 presents the multivariate regression analysis results, where the degree of prioritizing one criterion over another, as measured in the seven-point scale, was adopted as the objective variable. Regarding the explanatory variables, the same ones introduced in Model 2 of Table 4 were also

Table 5. Multivariate regression analysis results

	Objective variable											
	Prioritizing criterion B over A		Prioritizing criterion C over A		Prioritizing criterion D over A		Prioritizing criterion C over B		Prioritizing criterion D over B		Prioritizing criterion D over C	
Predictor	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.	coeff.	s.e.
Sex												
Male	−0.13	0.28	−0.30	0.27	−0.18	0.26	−0.42	0.29	−0.22	0.30	0.17	0.26
Female (reference)												
Age[a]	0.03	0.10	0.24*	0.10	0.04	0.10	0.32**	0.11	0.12	0.11	−0.05	0.10
Generativity[c,b]	0.07†	0.04	0.05	0.04	0.05	0.03	0.03	0.04	−0.05	0.04	0.00	0.03
Group assignment												
Treatment on more generative individuals[c]	0.37	0.36	0.17	0.34	0.29	0.34	−0.01	0.37	0.43	0.39	0.73*	0.34
Treatment on less generative individuals[d]	0.62†	0.37	0.55	0.35	0.58†	0.34	0.36	0.37	−0.02	0.39	0.28	0.34
Control (reference)												

The degree of prioritizing one criterion over another, as measured in the seven-point scale, is adopted as the objective variable.
Note: †$p < 0.10$; *$p < 0.05$; **$p < 0.01$.
[a]Data were standardized before the analysis.
[b]Generative Behavior Subscale score.
[c]Defind as 0 if an individual had a generativity score greater than or equal to the median (i.e. 11 points) and was allocated to the treatment group.
[d]Defind as 0 if an individual had a generativity score less than the median (i.e. 11 points) and was allocated to the treatment group.

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incorporated here. Regarding the comparison of criterion A (i.e. benefit for the *present* Japan) with the other three criteria that benefit *future* Japan, the treatment dummy for a lower generativity score holder was found to be a significant predictor of prioritizing *future* Japan in two of the three comparisons (i.e. criteria B and D; $p < 0.10$ and $p < 0.10$, respectively). This suggests that the FD treatment compensates the unwillingness of the low generativity score holders to benefit future generations. Regarding the comparison among the benefits of *future* Japan, it was found that the treatment dummy for more generative participants is a significantly positive predictor (coefficient = 0.73) of prioritizing criterion D (food security for future Japan) over criterion C (environmental conservation for the *future* Japan). Figure 2 provides a visual representation of the comparison between pairs of any two criteria among the four, indicating where the treatment significantly impacted the participants.

6. Discussion

6.1 Major findings

In this study, we conducted deliberative experiments involving consumers to address the issues of food policies that encompass the structure of intergenerational trade-offs. The objective was to determine whether an intervention method using the conceptual device of 'imaginary future people', as proposed by FD, changed consumers' values and policy preferences.

There were three significant findings. First, the experiment's results revealed that through the intervention method employing the conceptual device of imaginary future people, individuals tended to prefer options that involved more fundamental changes to the current food system rather than maintaining the status quo. More specifically, individuals who originally had a generative tendency to consider future generations preferred options involving fundamental changes, regardless of the presence of this conceptual device. The effectiveness of this conceptual device was greater among individuals who did not possess a generative tendency.

Second, we examined how the conceptual device of imaginary future people altered the relative weighting of criteria in selecting options, to estimate the reasons for such shifts in preferences. As a result, it was confirmed (at the 10% significance level) that this intervention caused a change in people's values toward placing greater emphasis on leaving a legacy of a rice-eating culture and food security for future generations, compared to the ease of realization for the current generation. This finding is evidence that the observed changes in option preferences were due to gaining a long-term perspective.

Third, acquiring a long-term perspective led to a shift in the balance between the interests of the current generation and those of future generations and to the change in balance between different interests within future generations. Specifically, it was revealed that individuals with high generativity, when subjected to intervention regarding the concept of imaginary future people, prioritized improving food security for future generations over conserving the natural environment for future generations. This shift occurred as a consequence of the intervention, where, compared to the low cost of realization for the current generation, the relative weight of the former value remained unchanged, while the relative weight of the latter value increased.

The first and second findings, taken together, have important theoretical implications. In contrast to studies that aim to understand food consumers' preferences (e.g. Asioli et al., 2022; Kee et al., 2023; Kliem & Sagebiel, 2023; Lehberger & Grüner, 2021; Vroegindewey et al., 2021), the present research demonstrated how to intervene with their values on which such preferences are formed. Druckman and Lupia (2016) argue that values affect preferences by influencing the kinds of appeals people are willing to pay attention to and the types of information they find credible. The intervention proposed in this study can be characterized as an intervention targeting their 'values'. As outlined in the introduction, food systems are intricately linked to several SDGs, necessitating their future designs by integrating multifaceted perspectives. This is a highly challenging task. In this study, consumers who underwent the intervention are believed to have

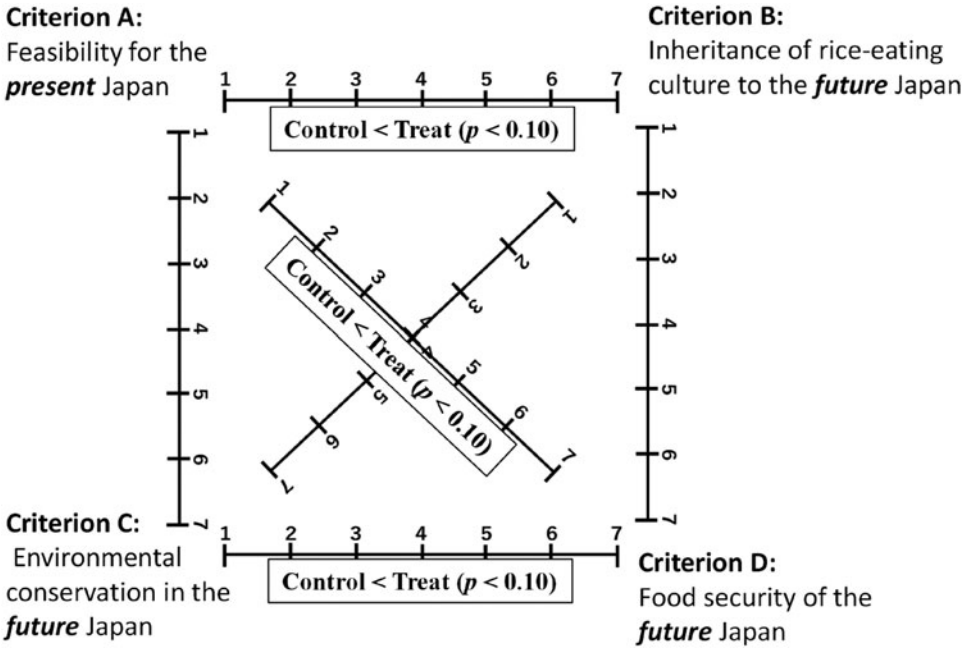

Figure 2. Visualization of the multivariate regression analysis result. The degree of prioritizing one criterion over another, as measured in the seven-point scale, is adopted as the objective variable.

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acquired the value of 'thinking long-term from the perspective of future generations'. They integrated information about various facets of the food system in their own way and formed policy preferences. The significant contribution of this study lies in demonstrating the feasibility of such interventions.

Group identity is an effective concept for connecting the intervention proposed in this study to the long-term transformation of food systems. Druckman and Lupia (2016), in the same paper, argue that group identities provide individuals with a sense of pride and self-esteem, leading them to differentiate between similar others (the in-group) and different others (the out-group), significantly influencing the formation of people's political preferences. The intervention proposed in this study could be positioned as an attempt to increase the number of people who value considering the food system from the perspective of future generations and granting them a sense of group identity. Forming a common group identity transcending differences in positions (producers, consumers, policymakers, etc.) among various stakeholders involved in the food system is expected to be a significant driving force for achieving a sustainable food system.

6.2 Policy implications

Food security is the central objective of agricultural and food policies, playing a crucial role in securing the well-being of future generations. However, attaining this goal requires navigating trade-offs with other objectives contributing to the benefit of future generations. For example, concerns arise regarding the impact of agricultural expansion on biodiversity in Europe (e.g. Henle et al., 2008), the effects of livestock production on water quality and the emission of greenhouse gases such as methane in the Netherlands and New Zealand (e.g. Post et al., 2020), and the influence of rice paddies on methane emissions in monsoon Asia, including Japan (e.g. Ouyang et al., 2023).

Considering these concerns, the empirical findings indicate two policy implications. First, as this study suggests, acquiring a long-term perspective may be beneficial for current generations to consider goals that benefit future generations, even at the cost of policy burdens. Therefore, in formulating high-level policies to achieve these goals, policymakers should foster an open atmosphere and discuss them with various stakeholders such as farmers, consumers, food manufacturers, and investors from a long-term perspective. Utilizing the thought device of an imaginary future generation in such discussions may prove useful. Cultivating such an atmosphere is likely to enhance motivation for close collaboration among sectors.

Second, as current generations gain a long-term perspective and become more sympathetic to future generations, goals that were not previously recognized as sufficiently important may receive greater attention. This can lead to changes in stakeholders' thinking regarding how to balance policies among many interconnected goals benefitting future generations. Consequently, this may alter the direction of policy formation. Therefore, to make the policy-formulation process more efficient, policymakers should support the acquisition of long-term perspectives by stakeholders during the early stages of the process. Although this may initially complicate policy formulation by necessitating the consideration of goals that were initially not deemed necessary, in the long run, it proves to be more efficient.

6.3 Limitations

Despite the contributions of this study, three significant limitations exist. The first pertains to the effectiveness of the intervention. Since this study was a cross-sectional experimental research, it has not provided empirical evidence of the duration of the proposed intervention's effects. Future research should conduct longitudinal investigations to verify their sustainability. The second limitation concerns the generalizability of the study's findings. While achieving zero hunger (SDG 2) is an urgent global issue, Japan enjoys relatively abundant food resources. Thus, it is crucial to acknowledge that this research was conducted in such a unique environment. Third, the study focused exclusively on general consumers among the diverse food system stakeholders. Investigating how other types of actors might alter their preferences in response to the same intervention is an essential avenue for future research. Fourth, while this study considered policy options that incorporate the use of ICT within the context of enhancing the efficiency of agricultural production, this technology should also be utilized for monitoring the complex interactions between agriculture and the ecosystem. This would enable a holistic understanding of the implications of specific policy interventions. This limitation is connected to the fifth limitation, which concerns the geographical scope of this study. Future studies should explore how actors in food systems from different countries can collaborate to assess the long-term impact of regional food policies on the global ecosystem. This study, therefore, represents just the first step toward that goal.

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Appendix A: Options and explanations

The list of four options and their detailed explanations are provided below.

Option 1: Acceptance of the decline of rice consumption in Japanese food culture

> Over the approximately 60 years leading up to 2023, rice production and per capita rice consumption in Japan have nearly halved. One of the key reasons for this decline is the Westernization of the Japanese diet. Trying to forcibly change this trend is difficult and may not be desirable in the first place. Therefore, in Option 1, the country chooses to accept this trend. The government will reduce rice production through measures such as converting farmland to other uses to match the consumer-determined rice consumption. This can be seen as an option that respects the freedom of consumers' dietary preferences. In this option, the decline of Japan's traditional rice-eating culture is considered inevitable.

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Option 2: Acceptance of the decline of rice consumption and maintenance of potential production capacity

Similar to Option 1, the country does not attempt to forcibly change the decreasing trend in rice consumption by the Japanese people. However, if the per capita consumption of domestically produced rice remains low beyond 2023, it will be a challenge to improve food self-sufficiency, giving rise to concerns about food security during war or large-scale disasters. Therefore, while giving up on improving food self-sufficiency, the country aims to maintain the potential capacity to produce essential crops in case of emergencies. Specifically, this involves cultivating non-food crops (such as flowers) or maintaining fallow land on the farmland currently in use in 2023, with the possibility of converting to food crop production in emergencies.

Option 3: Halting the decline of rice consumption in Japanese food culture through ICT

The country fully supports the digitization of rice cultivation, where farmers gather information using computers and the internet to enhance rice production and make it more efficient. Even as the agricultural workforce decreases, the country aims to maintain the rice paddy area at the 2023 level. This approach strengthens the multifaceted functions of rice paddies (ecosystem preservation, flood prevention, groundwater recharge, natural landscape conservation), preserves rural communities and traditional culture through rice farming, and alleviates environmental burdens in agriculture. Additionally, measures are taken to protect small-scale farmers who cannot be rescued through digitization and to maintain the rice paddy fields. In this option, the rice production in 2053 is expected to be higher than in Options 1 and 2; thus, the country will take various measures to increase domestic rice consumption to match it. With a 20% decrease in population from 2023 to 2053, maintaining the same production would result in an oversupply of rice. Significantly increasing per capita consumption in the face of a rapid decline in consumption is a significant challenge.

Option 4: Reconstruction of rice consumption in Japanese food culture through ICT and historical policy transformation

In addition to the efforts in Option 3 for digitization, the country implements initiatives to significantly expand rice production and increase the demand for rice in domestic and international markets. This allows for the much longer-term maintenance of the functions of rice paddies and rice cultivation compared to Option 3. However, to achieve the expansion of production and demand, the country must fundamentally reconsider its past agricultural policies. This will have painful consequences, such as closing small-scale farms and abandoning parts of the rice fields. Therefore, the path to realization is much more challenging than in Option 3.

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