

5. Agriculture, forestry, fisheries, and foods field

5.1. Overview

The world population has increased at a rapid pace and is currently an estimated 6 billion. The countries with the largest populations, such as China and India, however, have slowed their growth rates, and although the United Nations estimates that the world population will reach 9.3 billion by 2050, it also predicts that world population will stabilize for the first time in human history. On the other hand, the number of urban dwellers will only increase, and in 2005 is predicted to account for a majority of the world population for the first time ever.

As the population has rapidly increased, the spread of irrigated agriculture and varietal improvement have increased crop yield, supporting food supplies. Many believe that in the future, however, loss of farmland through urbanization, limitations on irrigation due to pressure on water resources, and other factors will limit the growth of productivity. In addition, gaps between developed and developing countries are widening in terms of both supply and demand, famine, conflict, the connections among poverty, food issues, and environmental degradation, as well as the domestic gap through rapid growth in developing countries causing differences between urban and rural incomes, and so on.

The survey asked respondents for predictions regarding such population dynamics and food supplies 30 years from now (in 2035). There is a shared awareness of the situation, with approximately 70 percent saying that population will hit a ceiling, while demand for agricultural products will increase through advanced consumption such as demand for livestock products. At the same time, regarding food production and technology, 72 percent say there is a concern that environmental issues such as global warming, desertification, and deforestation will cause production to stagnate. In addition, regarding values and standards 30 years from now, 74 percent responded that with global environmental degradation advancing, they expect that the agriculture, forestry, and fisheries will play a role in managing cyclical use of both of the natural and local resources. They expect use of biomass resources and energy and technology for environmentally-friendly agriculture to further advance.

Looking at the history of science and technology, no sooner had the fruits of the 19th century Industrial Revolution period, in other words, the discovery of photosynthesis, Mendelian genetics, Pasteur's principles of biology, Liebig's doctrines on crop nutrition, the mechanization of agriculture that accompanied the development of machinery, and so on, been perfected in the second half of the 20th century as modern agricultural technology, than leaps in science and technology changed our views of the world and of life. Awareness of the scarcity and finiteness of the global ecosystem, the discovery of DNA, the development of electronics and information science and technology, and so on, have created expectations for 21st century innovation in agricultural technology. Fifty years later, the appearance of individual new technologies such as genetic engineering, warnings about the emergence of global environmental problems, and other information is democratized with unprecedented speed, forming opinions faster than ever before. Science and technology have yet to form a prevailing conceptual framework.

This foresight survey reflects this era through the fact that 74 percent of responses on values 30 years from now concentrated in the contributions of agriculture, forestry, and fisheries to natural cycles and conservation of the environment.

For this survey we therefore created an overview by selecting the five areas below based on the twin axes of how far the shift of agriculture, forestry, and fisheries technology that is inseparable from issues

such as population and the environment in 21st century technological innovation will advance in the context of science and technology, and how society will form new conceptual frameworks.

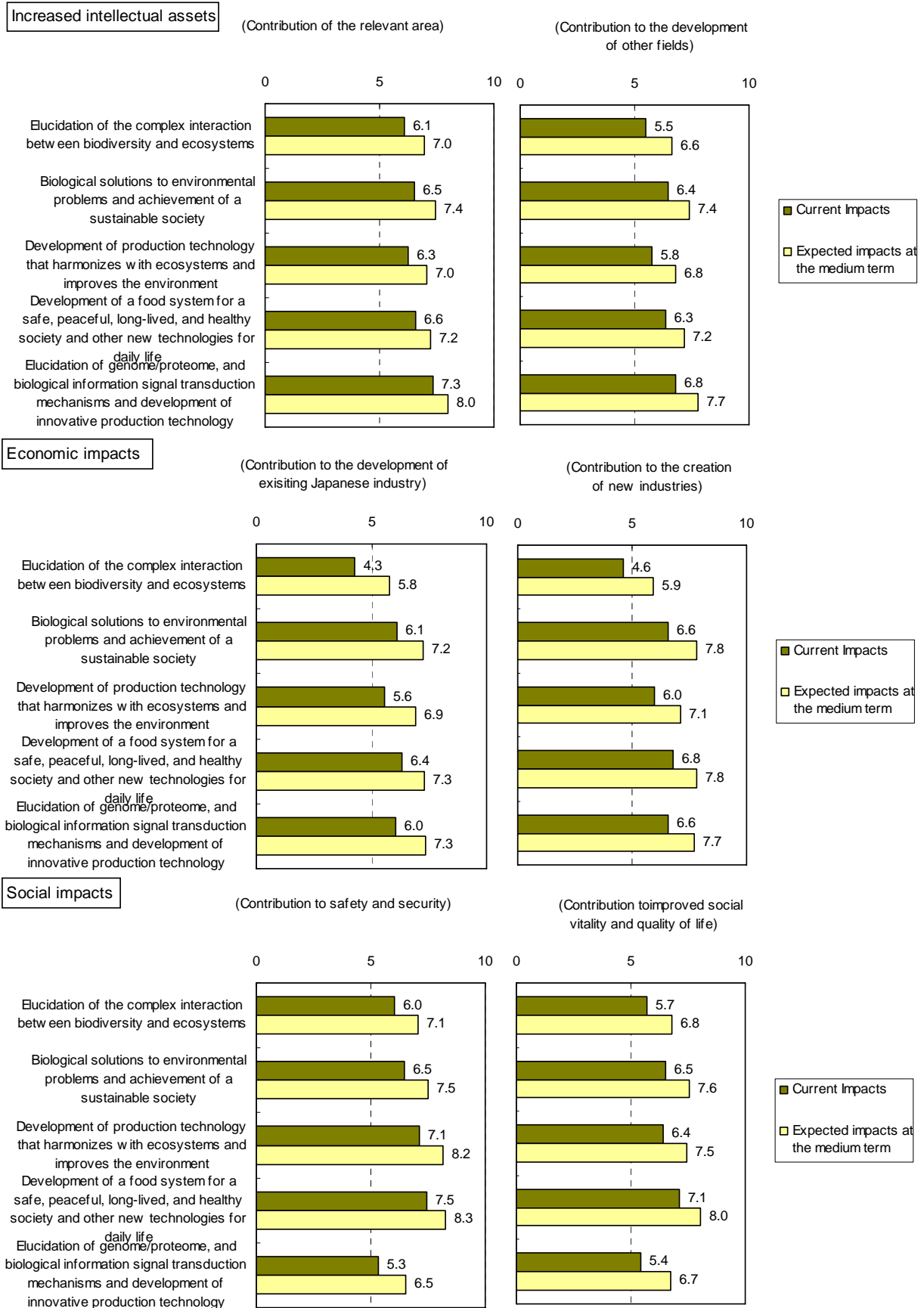
- ◆ Elucidation of the complex interaction between biodiversity and ecosystems
- ◆ Biological solutions to environmental problems and achievement of a sustainable society
- ◆ Development of production technology that harmonizes with ecosystems and improves the environment
- ◆ Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life
- ◆ Elucidation of genome/proteome, and biological information signal transduction mechanisms and development of innovative production technology

In other words, we set four areas by asking the following in the context of science and technology. How much ecological knowledge related to agriculture, forestry, and fisheries can be obtained (area 1)? How can it be brought into innovation in the technology of agriculture, forestry, and fisheries (area 3)? Once chemical analysis of genes, such as the sequencing of the rice-plant genome, is complete, how far will our understanding of molecular biological phenomena advance (area 5)? How can that be brought into innovation in the technology of agriculture, forestry, and fisheries (area 2)? In addition, regarding the food system that will play a leading role in forming society's conceptual framework on agriculture, forestry, and fisheries technology, in response to the deepening of the aging society and consumer trends on safety and peace of mind, we set new developments as a science of life with all respondents as consumers (area 4). Here we see that science and technology and the environment and production and the environment were antithetical to each other with 20th century technology and the prevailing opinion was that society should rethink science and technology with the environment as a higher priority. Regarding a safe and peaceful life as well, we see the stereotypical concept that science and technology should be rethought in order to avoid new risk. We can see how far science and technology will progress over the coming 30 years in fields in which the persistence of these 20th century ideas influences the direction of development of science and technology. In addition, the influence of the rapid progress of information science and technology in each area is also predicted, and this is reflected in the setting of questions for each area.

(MIWA Eitaro)

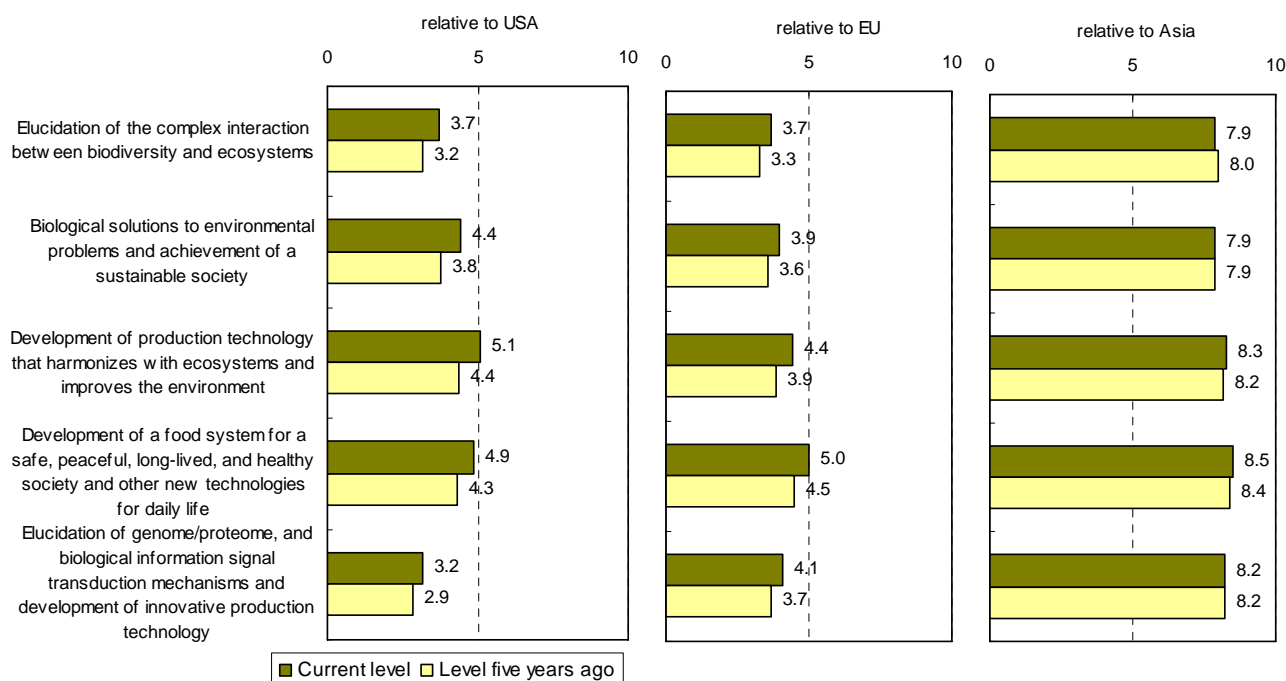
5.2. Main results

A. Impacts



*Responses are indexed on a 10-point scale.

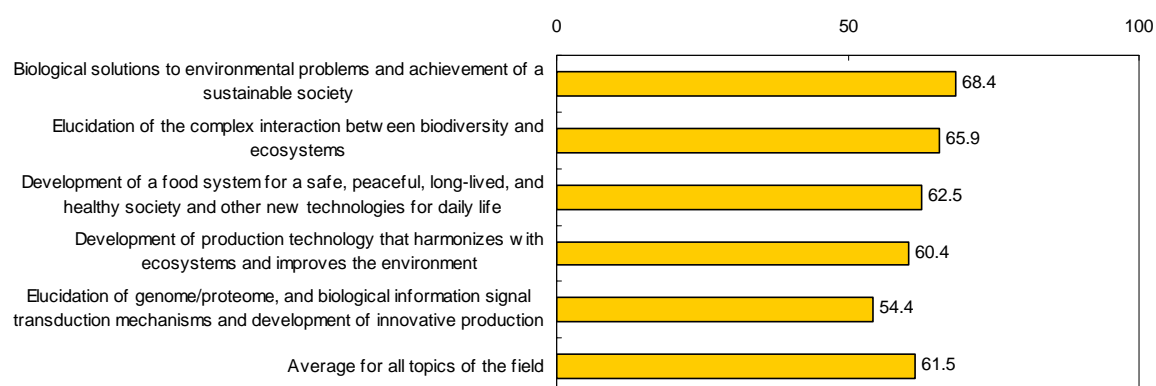
B. Japan's R&D Level



*Responses are indexed on a 10-point scale.

C. Importance to Japan

Average importance index by area



The most important 10 topics

Topic	Index	Year T*	Year S*
1 33: Risk management technology for harmful chemicals (endocrine disruptors, heavy metals, etc.) based on elucidation of their long-term impacts on human beings, crops, livestock, and ecosystems.	93	2015	2024
2 34: Formation of positive understanding and consensus on genetically engineered plants and foods.	90		2015
3 32: Prevention, diagnosis, and treatment technology through the complete elucidation of BSE onset.	89	2013	2020
4 15: Achievement of low costs agriculture and forestry and rural communities oriented towards zero emissions by using local agricultural and forestry resources, organic waste, and other sources of biomass energy.	88	2014	2022
5 02: Technology to estimate long-term changes in resource amounts in order to appropriately manage true sardines and other important fisheries resources.	87	2015	2022

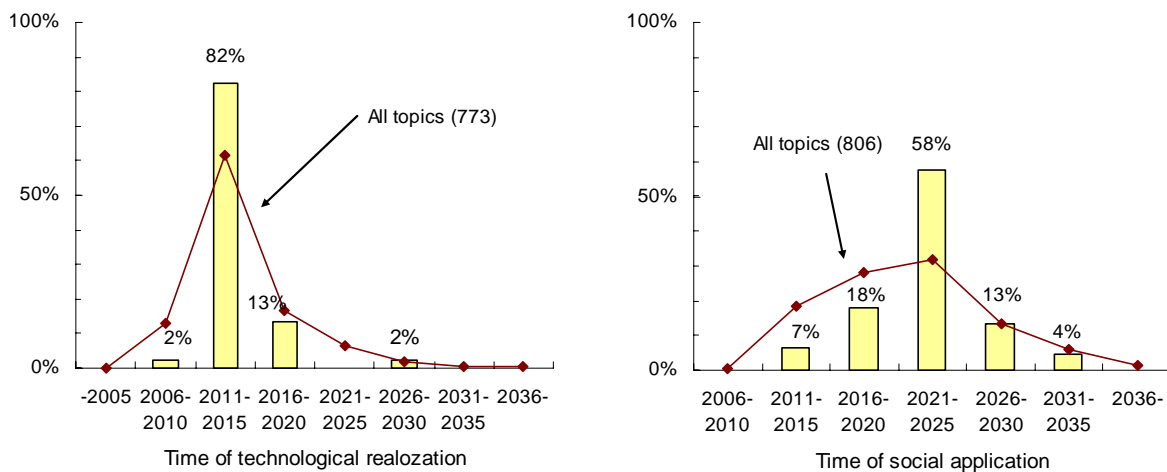
Topic	Index	Year T*	Year S*
6 18: Technology to restore coastal environments such as marine forests and tidal flats based on elucidation of material cycling systems that connect land, river, and coastal areas.	83	2015	2026
7 01: Technology to assess the impact of global climate change and environmental changes on an ocean-wide scale in particular on changes in the amount of large migratory fish resources such as salmon and tuna.	82	2015	2023
8 14: Technology to effectively remove dioxins and heavy metals from soil by utilizing plants and microorganisms.	80	2014	2022
9 26: Foods and diets especially for the elderly that prevent declines in antioxidant, brain, and mastication functions and that use food to support a healthy aging society.	78	2013	2020
10 46: Genetically engineered plants in which artificially introduced genes do not spread over the environment because of the special timing/site expression of genes.	78	2014	2025

Year T: Time of technological realization Year S: Time of social application

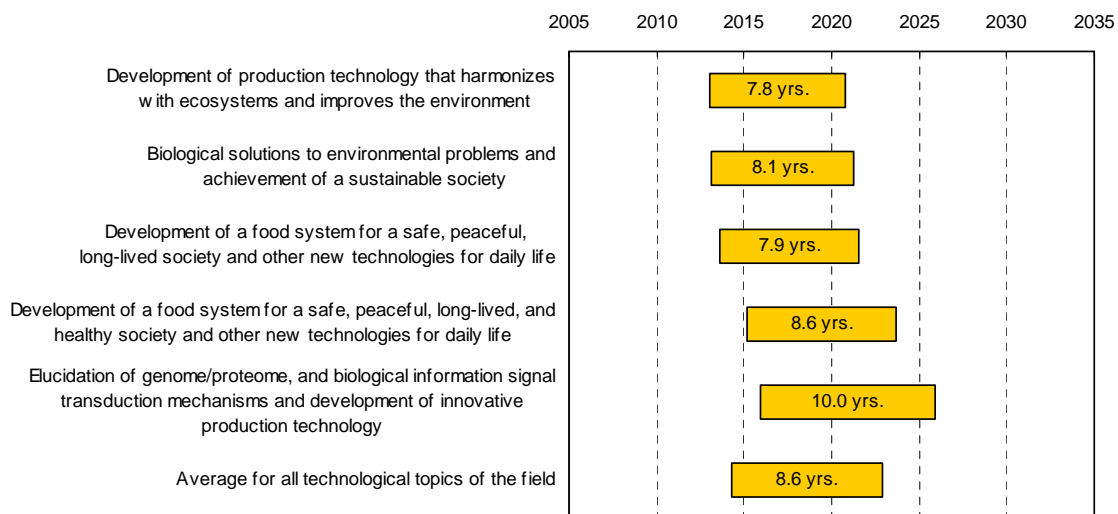
*Responses were indexed on a 100-point scale.

D. Time of realization

Distribution of realization time



Gap between technological realization and social application



Topics with short or long periods until social application

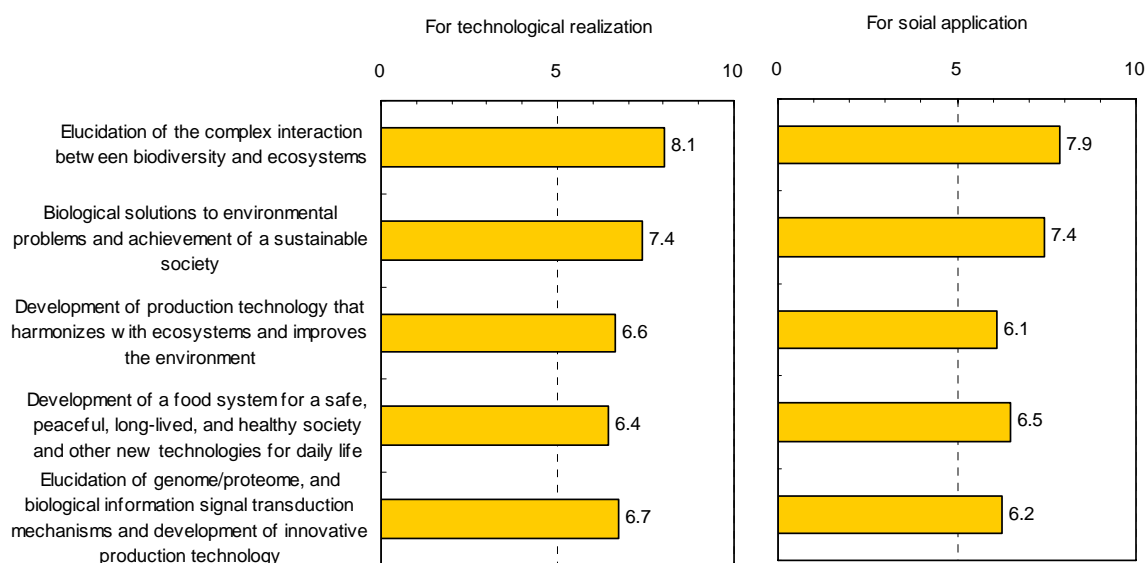
Topic	Year T*	Period*	Area
39: Crop production and greening in the strict environment, such as deserts, by using new plants enhanced/added salt, drought or cold tolerance.	2015	12	Elucidation of genome/ proteome, and biological information signal transduction mechanisms and development of innovative production technology
45: Growth regulation of crop/tree based on the knowledge of the mechanism about biosynthesis, transport, and receptor-mediated signaling by regulators in plants.	2019	12	Elucidation of genome/ proteome, and biological information signal transduction mechanisms and development of innovative production technology
18: Technology to restore coastal environments such as marine forests and tidal flats based on elucidation of material cycling systems that connect land, river, and coastal areas.	2015	11	Development of production technology that harmonizes with ecosystems and improves the environment
40: Modeling of all process about the rice plant growth based on the complete elucidation of gene functions and interaction of transcripts.	2017	11	Elucidation of genome/ proteome, and biological information signal transduction mechanisms and development of innovative production technology
43: Prevention of infection disease based on the knowledge of the immune system and its regulatory factors of fish.	2016	11	Elucidation of genome/ proteome, and biological information signal transduction mechanisms and development of innovative production technology
46: Genetically engineered plants in which artificially introduced genes do not spread over the environment because of the special timing/site expression of genes.	2014	11	Elucidation of genome/ proteome, and biological information signal transduction mechanisms and development of innovative production technology
Topic	Year T*	Period*	Area
23: Systems that utilize wearable computers (ultra-small PCs that can be worn on the body) to enable computer and internet use even during farm work, to serve as automatic input systems for production record data and as navigation systems that advise on use of inputs, pest control, and so on.	2011	4	Development of production technology that harmonizes with ecosystems and improves the environment
09: Widespread use of low-price agriculture, forestry, and fisheries materials (multi-films for outdoor cultivation, fishing tackle, etc.) and containers that use biodegradable materials.	2009	5	Solving environmental problems with biology and achieving a recycling-oriented society
17: Robots that selectively harvest fruit according to quality and ripeness and automatically sort them.	2012	6	Development of production technology that harmonizes with ecosystems and improves the environment
31: Home freshness-sensing devices to detect the freshness of foods.	2012	6	Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life
02: Technology to estimate long-term changes in resource amounts in order to appropriately manage true sardines and other important fisheries resources.	2015	7	Elucidation of the complex interaction between biodiversity and ecosystems
20: Sensor networks that monitor environmental and biological data in fields, barns, ponds, and so on in real time for the early detection of abnormalities in livestock, such as pest outbreaks and avian influenza and other infections.	2013	7	Development of production technology that harmonizes with ecosystems and improves the environment
24: Food manufacturing that avoids causing allergic reactions by using allergen measurement technology.	2014	7	Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life

Topic	Year T*	Period*	Area
26: Foods and diets especially for the elderly that prevent declines in antioxidant, brain, and mastication functions and that use food to support a healthy aging society.	2013	7	Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life
30: Forest treatment methods based on physiological elucidation of the comfort-increasing effects of forests and wood.	2013	7	Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life
32: Prevention, diagnosis, and treatment technology through the complete elucidation of BSE onset.	2013	7	Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life

*Year T: Time of technological realization Period: Period until social application (years)

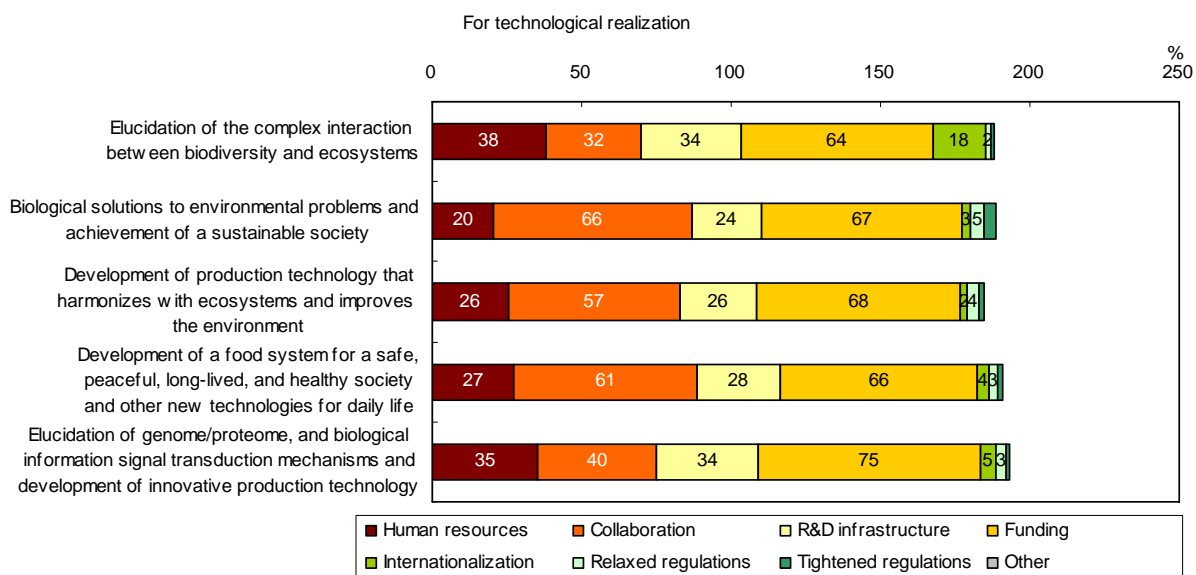
E. Effective measures that should taken by government

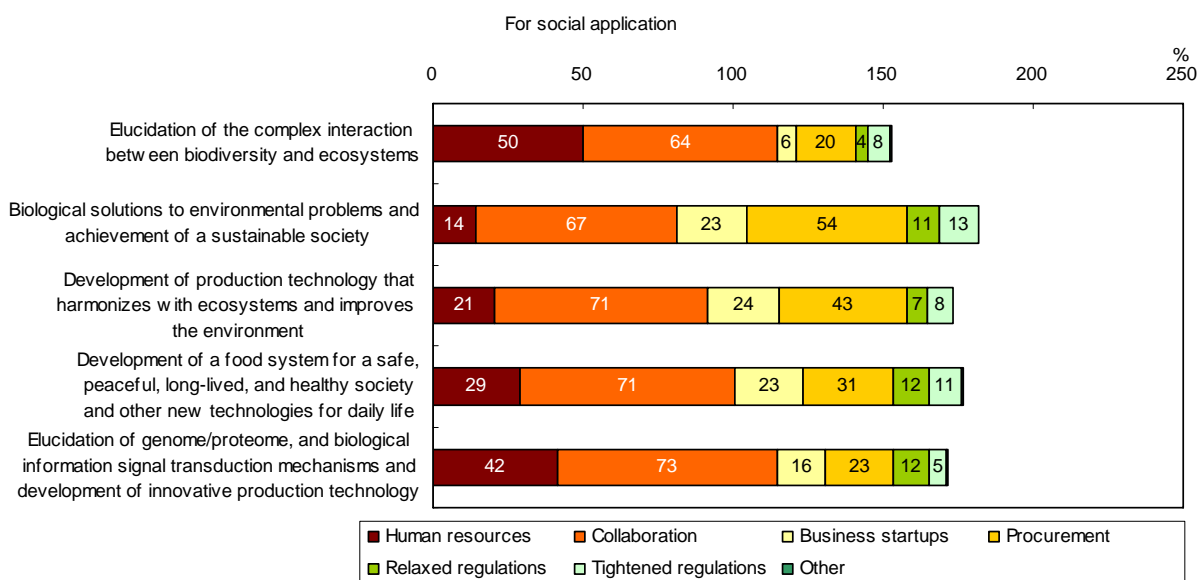
Necessity of government involvement



*Responses were indexed on a 10-point scale

Effective measures





F. Time-line of topics

Technological realization

Year	Topic
2009	09: Widespread use of low-price agriculture, forestry, and fisheries materials (multi-films for outdoor cultivation, fishing tackle, etc.) and containers that use biodegradable materials.
2011	13: Manufacturing technology for reusable wood compound materials through advances in technology to compound wood and non-wood materials. 23: Systems that utilize wearable computers (ultra-small PCs that can be worn on the body) to enable computer and internet use even during farm work, to serve as automatic input systems for production record data and as navigation systems that advise on use of inputs, pest control, and so on.
2012	17: Robots that selectively harvest fruit according to quality and ripeness and automatically sort them. 19: Production system technology artificially seed eels in mass quantities, raise them, and ship them. 31: Home freshness-sensing devices to detect the freshness of foods.
2013	07: Completely control pine wilt in Japan. 12: Technology to ferment alcohol or methane from wood biomass through the development of highly-efficient lignin decomposition. 16: Biological crop protection methods (phage, plant activators, natural enemies, pheromones, allelopathy, etc.) that reduce use of synthetic chemical pesticides and fertilizers. 20: Sensor networks that monitor environmental and biological data in fields, barns, ponds, and so on in real time for the early detection of abnormalities in livestock, such as pest outbreaks and avian influenza and other infections. 26: Foods and diets especially for the elderly that prevent declines in antioxidant, brain, and mastication functions and that use food to support a healthy aging society. 28: Sensor network technology that monitors foods from production to table with DNA chips, spectrum sensors, and other sensors in order to prevent contamination with harmful substances, bacteria, and so on. 30: Forest treatment methods based on physiological elucidation of the comfort-increasing effects of forests and wood. 32: Prevention, diagnosis, and treatment technology through the complete elucidation of BSE onset. 35: Production of transformed livestock with secreted antibacterial proteins, blood coagulation factor and other physiologically active substances in milk 38: Industrial production of useful substances such as medicines through the utilization of insect cell cultures and other transformants.
2014	04: Systems that utilize remote sensing technology to periodically provide useful data on agriculture, forestry, and fisheries resources for all climate zones and topographies in order to estimate agricultural product harvests, forest biomass, and real-time ocean environment data. 06: Understand genetic geographic classification through molecular markers to analyze regional differentiation and genetic diversity of the world's major commercial tree types.

Year	Topic
	<p>14: Technology to effectively remove dioxins and heavy metals from soil by utilizing plants and microorganisms.</p> <p>15: Achievement of low costs agriculture and forestry and rural communities oriented towards zero emissions by using local agricultural and forestry resources, organic waste, and other sources of biomass energy.</p> <p>21: Cultivation of ultrahigh-yield soy beans through varieties that produce large numbers of root nodes.</p> <p>22: Production technology for food and drugs that utilize the physiology of unused microorganisms from the deep ocean.</p> <p>24: Food manufacturing that avoids causing allergic reactions by using allergen measurement technology.</p> <p>25: Functional foods tailored to individual physical characteristics to prevent lifestyle disease.</p> <p>27: Precision taste analysis robots that sense taste and other properties and analyze them.</p> <p>37: Improvement and farming of new organisms for fisheries with advantageous characteristics (e.g., environmental tolerance and resistance to disease) by applying DNA markers and other genome technology.</p> <p>41: Production of aquaculture varieties fixed preferred properties (disease resistance, high growth) through chromosomal manipulation cloning.</p> <p>42: Production of livestock cloned from somatic cells based on elucidation of epigenetic and other nuclear genetic information reprogramming mechanism</p> <p>46: Genetically engineered plants in which artificially introduced genes do not spread over the environment because of the special timing/site expression of genes.</p>
2015	<p>01: Technology to assess the impact of global climate change and environmental changes on an ocean-wide scale in particular on changes in the amount of large migratory fish resources such as salmon and tuna.</p> <p>02: Technology to estimate long-term changes in resource amounts in order to appropriately manage true sardines and other important fisheries resources.</p> <p>08: Elucidation of the mechanisms by which nonpathogenic microorganisms (endophytes) become established inside plants and how they influence plant growth.</p> <p>11: Widespread use of biomass energy fuel cells.</p> <p>18: Technology to restore coastal environments such as marine forests and tidal flats based on elucidation of material cycling systems that connect land, river, and coastal areas.</p> <p>29: Food crop safety assessment systems that utilize proteomics and metabolics.</p> <p>33: Risk management technology for harmful chemicals (endocrine disruptors, heavy metals, etc.) based on elucidation of their long-term impacts on human beings, crops, livestock, and ecosystems.</p> <p>36: Prevention of diseases, recovery of homeostasis, improvement of feeding and milk production control based on elucidation of immune system and endocrine mechanisms of adenohipophysys</p> <p>39: Crop production and greening in the strict environment, such as deserts, by using new plants enhanced/added salt, drought or cold tolerance.</p>
2016	<p>03: Technology to assess various species living in a one mass through school detection systems that enable accurate measurement of fish length and differentiation of fish species.</p> <p>10: Creation of biomass production crops of greater than 50 tons/hectare/year (dry).</p> <p>43: Prevention of infection disease based on the knowledge of the immune system and its regulatory factors of fish.</p>
2017	<p>40: Modeling of all process about the rice plant growth based on the complete elucidation of gene functions and interaction of transcripts.</p>
2019	<p>05: Systems that use global sensor networks to monitor major element and material cycles in agriculture, forestry, and fisheries ecosystems.</p> <p>45: Growth regulation of crop/tree based on the knowledge of the mechanism about biosynthesis, transport, and receptor-mediated signaling by regulators in plants.</p>
2027	<p>44: Communication technology between human and livestock utilized sensing of the neuro-transmission in the brain.</p>

Social application

Year	Topic
2014	<p>09: Widespread use of low-price agriculture, forestry, and fisheries materials (multi-films for outdoor cultivation, fishing tackle, etc.) and containers that use biodegradable materials.</p>
2015	<p>23: Systems that utilize wearable computers (ultra-small PCs that can be worn on the body) to enable computer and internet use even during farm work, to serve as automatic input systems for production record data and as navigation systems that advise on use of inputs, pest control, and so on.</p>

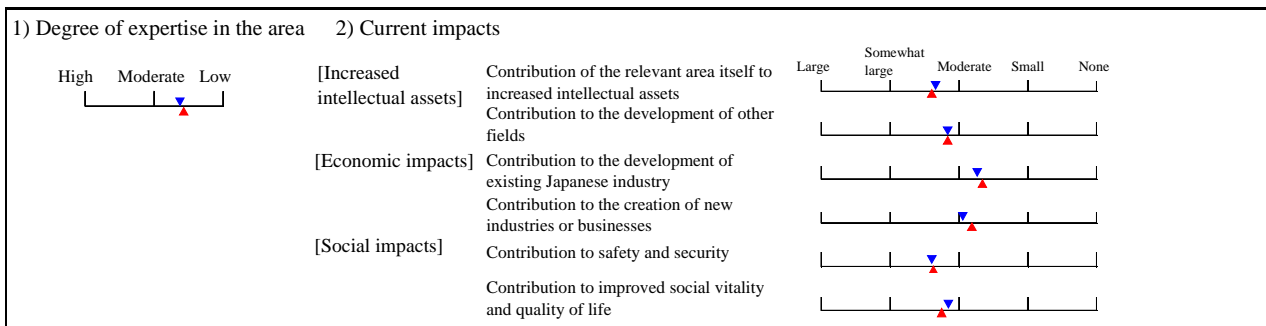
Year	Topic
2018	34: Formation of positive understanding and consensus on genetically engineered plants and foods. 17: Robots that selectively harvest fruit according to quality and ripeness and automatically sort them. 31: Home freshness-sensing devices to detect the freshness of foods.
2019	13: Manufacturing technology for reusable wood compound materials through advances in technology to compound wood and non-wood materials.
2020	19: Production system technology artificially seed eels in mass quantities, raise them, and ship them. 20: Sensor networks that monitor environmental and biological data in fields, barns, ponds, and so on in real time for the early detection of abnormalities in livestock, such as pest outbreaks and avian influenza and other infections. 26: Foods and diets especially for the elderly that prevent declines in antioxidant, brain, and mastication functions and that use food to support a healthy aging society. 30: Forest treatment methods based on physiological elucidation of the comfort-increasing effects of forests and wood. 32: Prevention, diagnosis, and treatment technology through the complete elucidation of BSE onset.
2021	07: Completely control pine wilt in Japan. 16: Biological crop protection methods (phage, plant activators, natural enemies, pheromones, allelopathy, etc.) that reduce use of synthetic chemical pesticides and fertilizers. 24: Food manufacturing that avoids causing allergic reactions by using allergen measurement technology. 35: Production of transformed livestock with secreted antibacterial proteins, blood coagulation factor and other physiologically active substances in milk 38: Industrial production of useful substances such as medicines through the utilization of insect cell cultures and other transformants.
2022	02: Technology to estimate long-term changes in resource amounts in order to appropriately manage true sardines and other important fisheries resources. 12: Technology to ferment alcohol or methane from wood biomass through the development of highly-efficient lignin decomposition. 14: Technology to effectively remove dioxins and heavy metals from soil by utilizing plants and microorganisms. 15: Achievement of low costs agriculture and forestry and rural communities oriented towards zero emissions by using local agricultural and forestry resources, organic waste, and other sources of biomass energy. 25: Functional foods tailored to individual physical characteristics to prevent lifestyle disease. 28: Sensor network technology that monitors foods from production to table with DNA chips, spectrum sensors, and other sensors in order to prevent contamination with harmful substances, bacteria, and so on.
2023	01: Technology to assess the impact of global climate change and environmental changes on an ocean-wide scale in particular on changes in the amount of large migratory fish resources such as salmon and tuna. 04: Systems that utilize remote sensing technology to periodically provide useful data on agriculture, forestry, and fisheries resources for all climate zones and topographies in order to estimate agricultural product harvests, forest biomass, and real-time ocean environment data. 21: Cultivation of ultrahigh-yield soy beans through varieties that produce large numbers of root nodes. 22: Production technology for food and drugs that utilize the physiology of unused microorganisms from the deep ocean. 41: Production of aquaculture varieties fixed preferred properties (disease resistance, high growth) through chromosomal manipulation cloning. 42: Production of livestock cloned from somatic cells based on elucidation of epigenetic and other nuclear genetic information reprogramming mechanism
2024	03: Technology to assess various species living in a one mass through school detection systems that enable accurate measurement of fish length and differentiation of fish species. 06: Understand genetic geographic classification through molecular markers to analyze regional differentiation and genetic diversity of the world's major commercial tree types. 11: Widespread use of biomass energy fuel cells. 27: Precision taste analysis robots that sense taste and other properties and analyze them. 29: Food crop safety assessment systems that utilize proteomics and metabolics. 33: Risk management technology for harmful chemicals (endocrine disruptors, heavy metals, etc.) based on elucidation of their long-term impacts on human beings, crops, livestock, and ecosystems. 37: Improvement and farming of new organisms for fisheries with advantageous characteristics (e.g., environmental tolerance and resistance to disease) by applying DNA markers and other genome technology.

Year	Topic
2025	36: Prevention of diseases, recovery of homeostasis, improvement of feeding and milk production control based on elucidation of immune system and endocrine mechanisms of adenohipophysis 46: Genetically engineered plants in which artificially introduced genes do not spread over the environment because of the special timing/site expression of genes.
2026	10: Creation of biomass production crops of greater than 50 tons/hectare/year (dry). 18: Technology to restore coastal environments such as marine forests and tidal flats based on elucidation of material cycling systems that connect land, river, and coastal areas.
2027	39: Crop production and greening in the strict environment, such as deserts, by using new plants enhanced/added salt, drought or cold tolerance. 43: Prevention of infection disease based on the knowledge of the immune system and its regulatory factors of fish.
2028	40: Modeling of all process about the rice plant growth based on the complete elucidation of gene functions and interaction of transcripts.
2029	05: Systems that use global sensor networks to monitor major element and material cycles in agriculture, forestry, and fisheries ecosystems.
2031	45: Growth regulation of crop/tree based on the knowledge of the mechanism about biosynthesis, transport, and receptor-mediated signaling by regulators in plants.
2036-	44: Communication technology between human and livestock utilized sensing of the neuro-transmission in the brain.

Appendix: Results of R1 and R2

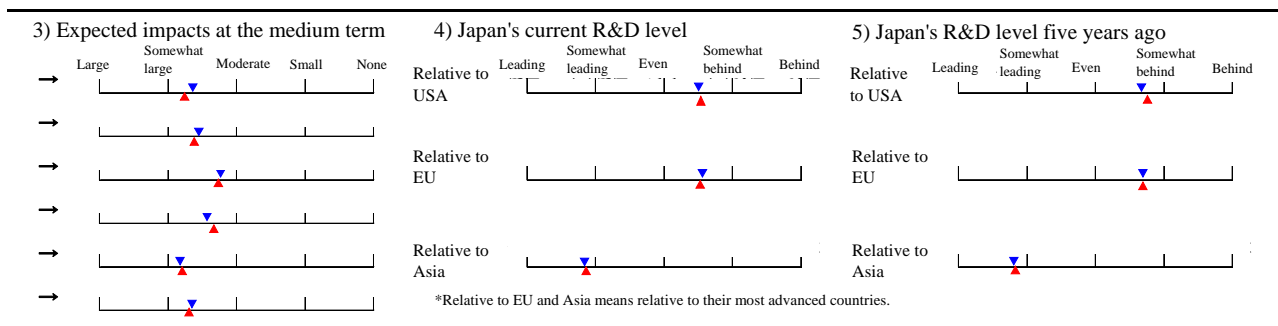
I. Elucidation of the complex interaction between biodiversity and ecosystems

1. Questions regarding the relevant area



2. Questions regarding topics

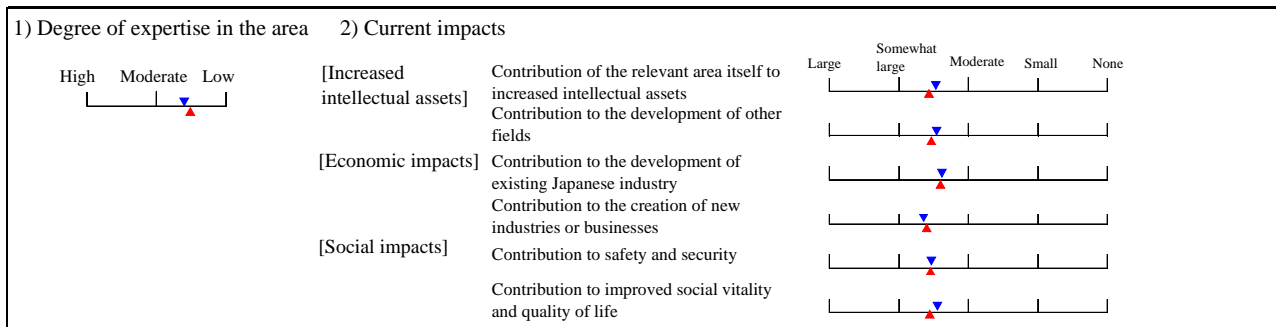
No	Topic	Questionnaire	Degree of expertise				Importance to Japan				Time of technological realization									
			High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know	
			Respondents (persons)													Will not be realized		Do not know		
			%				%									%				
1	Technology to assess the impact of global climate change and environmental changes on an ocean-wide scale in particular on changes in the amount of large migratory fish resources such as salmon and tuna.	1	120	7	13	80	-	78	58	39	3	0							4	19
		2	116	6	9	85	-	82	64	36	0	0							1	4
		E	7	100	0	0	-	93	86	14	0	0							0	0
2	Technology to estimate long-term changes in resource amounts in order to appropriately manage true sardines and other important fisheries resources.	1	110	8	14	78	-	82	65	33	2	0							3	16
		2	108	6	12	82	-	87	73	27	0	0							0	5
		E	6	100	0	0	-	100	100	0	0	0							0	0
3	Technology to assess various species living in a one mass through school detection systems that enable accurate measurement of fish length and differentiation of fish species.	1	90	9	12	79	-	60	31	51	16	2							2	17
		2	94	4	12	84	-	56	19	69	12	0							0	4
		E	4	100	0	0	-	69	50	25	25	0							0	0
4	Systems that utilize remote sensing technology to periodically provide useful data on agriculture, forestry, and fisheries resources for all climate zones and topographies in order to estimate agricultural product harvests, forest biomass, and real-time ocean	1	209	7	28	65	-	71	48	42	10	0							1	9
		2	178	3	24	73	-	74	50	47	3	0							1	2
		E	6	100	0	0	-	100	100	0	0	0							0	0
5	Systems that use global sensor networks to monitor major element and material cycles in agriculture, forestry, and fisheries ecosystems.	1	182	8	26	66	-	63	36	45	17	2							4	14
		2	168	5	20	75	-	63	29	67	3	1							2	3
		E	8	100	0	0	-	88	75	25	0	0							0	0
6	Understand genetic geographic classification through molecular markers to analyze regional differentiation and genetic diversity of the world's major commercial tree types.	1	143	11	22	67	-	54	22	52	24	2							3	10
		2	135	4	17	79	-	49	11	64	24	1							1	4
		E	5	100	0	0	-	45	0	80	20	0							0	0
7	Completely control pine wilt in Japan.	1	140	8	31	61	-	66	41	41	17	1							6	14
		2	142	6	27	67	-	67	39	52	7	2							6	7
		E	9	100	0	0	-	78	56	44	0	0							0	0
8	Elucidation of the mechanisms by which nonpathogenic microorganisms (endophytes) become established inside plants and how they influence plant growth.	1	151	15	19	66	-	52	18	53	28	1							1	14
		2	146	7	27	66	-	49	9	71	18	2							1	5
		E	10	100	0	0	-	63	30	60	10	0							0	0



Countries at the leading edge						Regarding technological realization										Time of social application					Regarding social application														
						Necessity of gov't involvement				Effective measures that should be taken by gov't											Necessity of gov't involvement				Effective measures that should be taken by gov't										
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	
(%)						(%)				(%)						(%)					(%)				(%)										
47	40	8	2	3	67	24	7	2	37	30	37	55	41	3	2	2							2	25	56	27	14	3	43	47	11	16	7	22	4
65	29	6	0	0	77	21	1	1	37	18	39	63	40	2	0	0							0	9	69	26	3	2	58	58	2	9	4	16	0
29	71	0	0	0	100	0	0	0	57	14	57	71	86	0	0	0							0	14	100	0	0	0	86	57	0	14	0	71	0
79	14	6	0	1	68	24	6	2	40	29	44	62	26	2	4	1							0	19	57	28	13	2	48	44	9	21	6	23	2
92	7	1	0	0	79	20	0	1	45	19	38	69	17	2	0	0							0	6	72	23	4	1	63	55	1	14	4	16	0
83	17	0	0	0	100	0	0	0	83	0	83	100	33	0	0	0							0	0	100	0	0	0	67	67	0	33	17	33	0
53	25	20	0	2	28	46	21	5	29	51	37	55	12	1	2	1							1	21	30	37	28	5	42	54	17	21	4	11	0
75	13	12	0	0	21	68	10	1	18	53	23	58	8	2	0	0							0	5	20	59	18	3	43	73	7	11	6	3	0
50	0	50	0	0	75	25	0	25	75	25	75	0	0	0	0	0							0	0	0	75	25	0	25	75	25	25	0	0	0
7	81	10	1	1	53	37	8	2	35	45	46	56	37	3	1	0							2	13	44	40	13	3	41	63	27	28	7	4	2
2	94	4	0	0	68	30	1	1	31	44	48	64	24	2	0	0							1	6	53	42	4	1	49	75	11	22	4	1	1
0	100	0	0	0	100	0	0	0	33	67	67	67	50	0	0	0							0	0	100	0	0	0	33	83	17	50	0	0	0
7	72	20	0	1	45	39	13	3	44	38	48	55	39	4	2	0							5	16	39	41	14	6	51	58	24	30	9	8	1
2	89	8	0	1	63	33	3	1	39	29	46	60	26	2	0	0							3	4	43	49	7	1	54	72	10	18	3	2	1
13	87	0	0	0	75	25	0	0	50	50	63	50	50	0	0	0							0	0	62	38	0	0	38	88	0	38	13	13	0
13	62	24	0	1	27	45	24	4	42	26	37	54	37	6	2	0							5	15	21	49	23	7	46	55	13	20	12	12	1
4	89	6	0	1	23	61	14	2	48	13	31	65	19	2	2	0							3	4	16	61	22	1	54	66	10	9	2	4	2
0	100	0	0	0	40	60	0	0	80	20	40	80	40	0	0	0							0	0	60	40	0	0	60	80	20	20	0	40	0
91	2	5	0	2	47	36	14	3	39	46	32	51	2	7	8	1							8	19	44	38	14	4	30	39	13	48	9	17	2
97	1	2	0	0	66	28	4	2	34	54	19	60	2	4	4	1							5	10	58	36	5	1	30	52	5	53	6	12	1
100	0	0	0	0	67	22	0	11	88	25	13	63	13	0	0	0							11	0	75	25	0	0	38	25	13	63	0	25	0
18	63	17	0	2	18	47	30	5	45	33	33	67	8	2	1	1																			
8	84	7	0	1	15	61	21	3	56	22	26	74	4	1	1	0																			
0	100	0	0	0	50	40	10	0	80	50	50	80	10	0	10	0																			

II. Biological solutions of environmental problems and achievement of a sustainable society

1. Questions regarding the relevant area

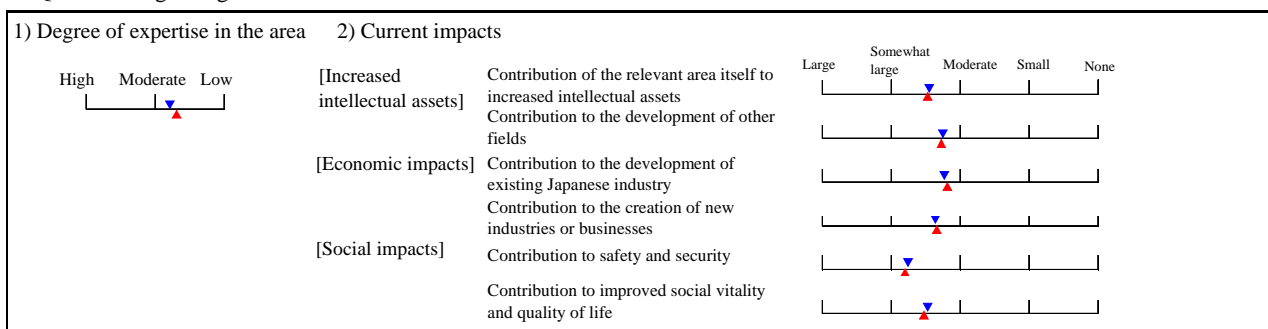


2. Questions regarding topics

No	Topic	Questionnaire	Degree of expertise				Importance to Japan				Time of technological realization											
			Respondents (persons)				Index				Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know				
			High	Moderate	Low	None	High	Moderate	Low	None												
			(%)				(%)				(%)											
9	Widespread use of low-price agriculture, forestry, and fisheries materials (multi-films for outdoor cultivation, fishing tackle, etc.) and containers that use biodegradable materials.	1	202	10	30	60	-	71	44	50	6	0								1	5	
		2	185	5	25	70	-	70	41	57	2	0									1	0
		E	9	100	0	0	-	67	33	67	0	0										0
10	Creation of biomass production crops of greater than 50 tons/hectare/year (dry).	1	165	13	28	59	-	62	35	43	21	1									10	17
		2	163	8	31	61	-	58	23	66	10	1									6	3
		E	13	100	0	0	-	73	54	31	15	0										15
11	Widespread use of biomass energy fuel cells.	1	151	7	22	71	-	68	42	44	13	1									4	9
		2	143	1	17	82	-	70	46	44	9	1									1	1
		E	2	100	0	0	-	50	0	100	0	0										0
12	Technology to ferment alcohol or methane from wood biomass through the development of highly-efficient lignin decomposition.	1	154	10	25	65	-	58	29	46	24	1									3	8
		2	140	6	19	75	-	59	22	68	10	0									0	1
		E	9	100	0	0	-	66	38	49	13	0										0
13	Manufacturing technology for reusable wood compound materials through advances in technology to compound wood and non-wood materials.	1	111	8	23	69	-	57	25	52	23	0									1	7
		2	112	4	14	82	-	54	16	66	18	0									0	0
		E	4	100	0	0	-	75	50	50	0	0										0
14	Technology to effectively remove dioxins and heavy metals from soil by utilizing plants and microorganisms.	1	209	13	27	60	-	74	51	44	5	0									2	9
		2	186	10	22	68	-	80	62	35	2	1									1	1
		E	19	100	0	0	-	92	83	17	0	0										0
15	Achievement of low costs agriculture and forestry and rural communities oriented towards zero emissions by using local agricultural and forestry resources, organic waste, and other sources of biomass energy.	1	210	16	26	58	-	79	62	35	3	0									3	9
		2	190	9	27	64	-	88	77	21	1	1									1	1
		E	17	100	0	0	-	88	82	12	0	6										6

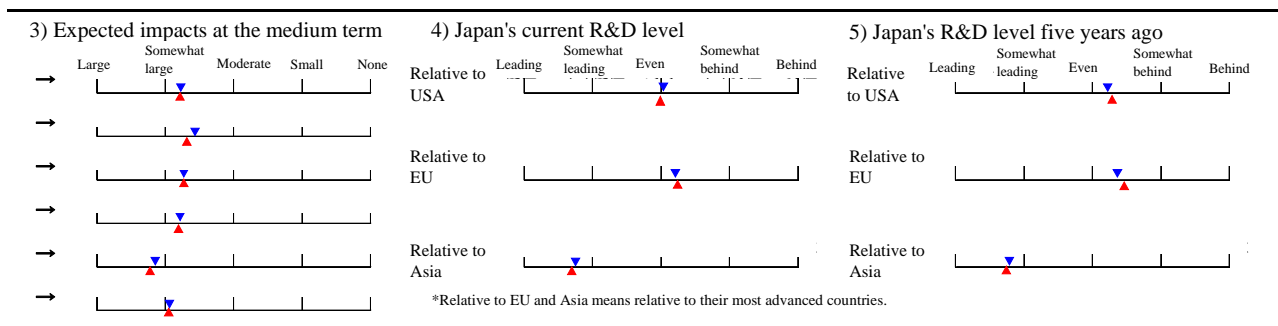
III. Development of production technology that harmonizes with ecosystems and improves the environment

1. Questions regarding the relevant area



2. Questions regarding topics

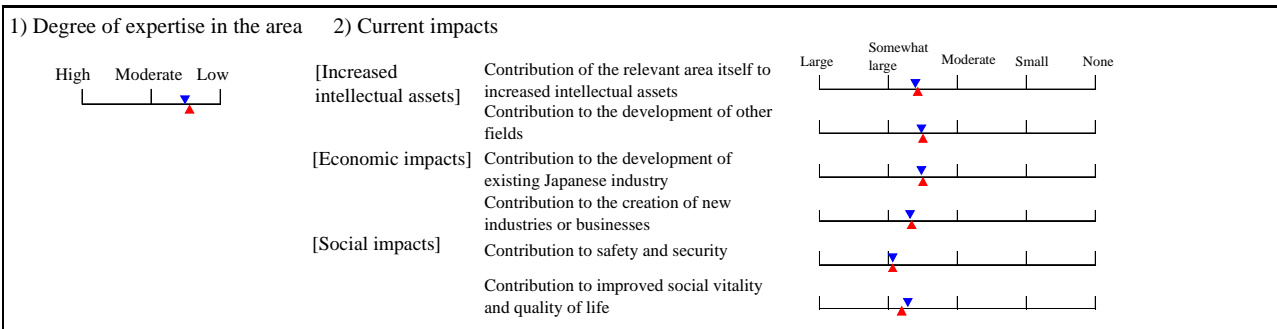
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise					Importance to Japan					Time of technological realization						
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know
				(%)					(%)					(%)						
16	Biological crop protection methods (phage, plant activators, natural enemies, pheromones, allelopathy, etc.) that reduce use of synthetic chemical pesticides and fertilizers.	1	201	22	25	53	-	70	43	51	5	1							1	9
		2	184	18	21	61	-	74	48	50	1	1							1	1
		E	34	100	0	0	-	86	73	24	3	0							0	0
17	Robots that selectively harvest fruit according to quality and ripeness and automatically sort them.	1	170	9	28	63	-	47	15	48	32	5							4	5
		2	159	6	21	73	-	47	8	65	27	0							1	1
		E	9	100	0	0	-	53	11	78	11	0							0	0
18	Technology to restore coastal environments such as marine forests and tidal flats based on elucidation of material cycling systems that connect land, river, and coastal areas.	1	137	13	20	67	-	74	52	42	6	0							2	7
		2	136	6	17	77	-	83	66	31	2	1							0	2
		E	8	100	0	0	-	100	100	0	0	0							0	0
19	Production system technology artificially seed eels in mass quantities, raise them, and ship them.	1	115	10	18	72	-	49	17	47	33	3							2	8
		2	115	6	9	85	-	47	9	62	28	1							0	1
		E	7	100	0	0	-	79	57	43	0	0							0	0
20	Sensor networks that monitor environmental and biological data in fields, barns, ponds, and so on in real time for the early detection of abnormalities in livestock, such as pest outbreaks and avian influenza and other infections.	1	160	13	21	66	-	69	43	44	12	1							4	6
		2	138	6	19	75	-	73	48	48	3	1							1	2
		E	8	100	0	0	-	81	62	38	0	0							13	0
21	Cultivation of ultrahigh-yield soy beans through varieties that produce large numbers of root nodes.	1	152	13	27	60	-	51	20	48	28	4							6	12
		2	160	13	18	69	-	51	14	67	15	4							4	2
		E	20	100	0	0	-	58	20	70	10	0							5	5
22	Production technology for food and drugs that utilize the physiology of unused microorganisms from the deep ocean.	1	146	7	23	70	-	58	29	49	20	2							0	17
		2	140	2	21	77	-	55	17	69	14	0							0	3
		E	3	100	0	0	-	100	100	0	0	0							0	0
23	Systems that utilize wearable computers (ultra-small PCs that can be worn on the body) to enable computer and internet use even during farm work, to serve as automatic input systems for production record data and as navigation systems that advise on use of inputs, pest control, and so on.	1	165	11	28	61	-	54	25	44	27	4							1	5
		2	167	7	19	74	-	54	15	71	13	1							0	0
		E	12	100	0	0	-	73	50	42	8	0							0	0



Countries at the leading edge						Regarding technological realization											Time of social application					Regarding social application															
						Necessity of gov't involvement				Effective measures that should be taken by gov't												Necessity of gov't involvement				Effective measures that should be taken by gov't											
Japan	USA	EU	Asia	Other		High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other		
(%)						(%)					(%)											(%)					(%)										
21	30	47	1	1	32	53	13	2	45	46	42	65	8	13	12	0								1	9	32	49	16	3	35	52	30	48	28	27	1	
9	24	67	0	0	25	71	3	1	39	57	26	73	4	8	5	1									1	1	27	69	2	2	23	68	16	63	17	20	1
12	15	73	0	0	38	62	0	0	47	59	44	82	9	18	6	0									0	0	44	53	0	3	30	67	36	64	33	21	0
72	20	5	1	2	8	37	41	14	19	56	30	54	6	5	1	1									5	7	7	31	45	17	20	57	35	44	12	3	0
94	6	0	0	0	4	45	45	6	7	79	15	61	0	1	0	0									2	1	4	34	58	4	8	76	24	42	3	0	0
89	11	0	0	0	11	56	22	11	13	75	0	50	0	0	0	0									0	0	11	33	56	0	11	67	33	33	0	0	0
37	24	37	0	2	55	37	7	1	47	48	42	65	8	12	8	1									1	11	56	35	8	1	41	53	16	41	16	29	2
44	10	46	0	0	77	20	3	0	41	50	30	72	4	4	6	0									0	2	79	19	2	0	39	74	5	43	5	26	1
17	0	83	0	0	100	0	0	0	71	29	57	71	14	0	29	0									0	0	100	0	0	0	43	71	14	43	0	57	0
93	3	1	1	2	16	36	37	11	32	39	28	59	8	3	2	1									0	15	8	29	44	19	27	38	44	37	12	8	0
99	0	1	0	0	7	50	38	5	23	53	12	70	1	2	0	0									0	1	2	30	60	8	12	52	56	32	3	2	0
100	0	0	0	0	43	57	0	0	43	57	14	86	0	0	0	0									0	0	29	29	42	0	14	43	57	57	0	14	0
39	42	17	1	1	39	41	17	3	35	51	45	64	18	10	6	0									3	9	37	44	16	3	36	62	30	44	11	20	1
40	58	2	0	0	42	53	5	0	26	65	30	71	5	3	2	0									2	2	34	60	5	1	20	84	13	49	5	10	0
29	71	0	0	0	57	43	0	0	29	43	43	86	0	0	0	0									13	0	43	43	14	0	14	86	14	43	14	0	0
37	49	9	1	4	17	40	34	9	32	27	30	73	9	5	2	1									6	14	14	34	40	12	35	40	20	38	16	5	6
24	75	1	0	0	10	65	21	4	31	25	24	79	2	3	0	1									5	5	7	51	35	7	30	58	10	46	7	1	2
50	45	5	0	0	15	65	15	5	42	16	32	79	5	11	0	0									0	10	11	62	16	11	47	41	12	47	12	0	0
39	50	8	0	3	22	47	25	6	39	49	50	61	11	11	1	0									1	21	19	34	36	11	34	59	46	25	25	3	1
20	80	0	0	0	10	68	19	3	21	48	47	65	5	3	1	0									1	4	8	47	41	4	19	77	35	18	12	2	0
33	67	0	0	0	67	33	0	0	67	67	33	100	0	0	0	0									0	0	67	33	0	0	100	67	33	100	0	0	0
54	37	8	0	1	19	40	33	8	30	71	30	55	4	9	2	0									4	8	19	35	36	10	27	59	38	49	16	9	1
76	23	1	0	0	9	67	23	1	16	80	20	57	0	6	1	0									2	1	9	50	39	2	13	79	29	47	5	5	0
92	8	0	0	0	33	42	25	0	17	83	25	50	0	8	0	0									0	0	34	33	33	0	8	83	50	42	0	0	0

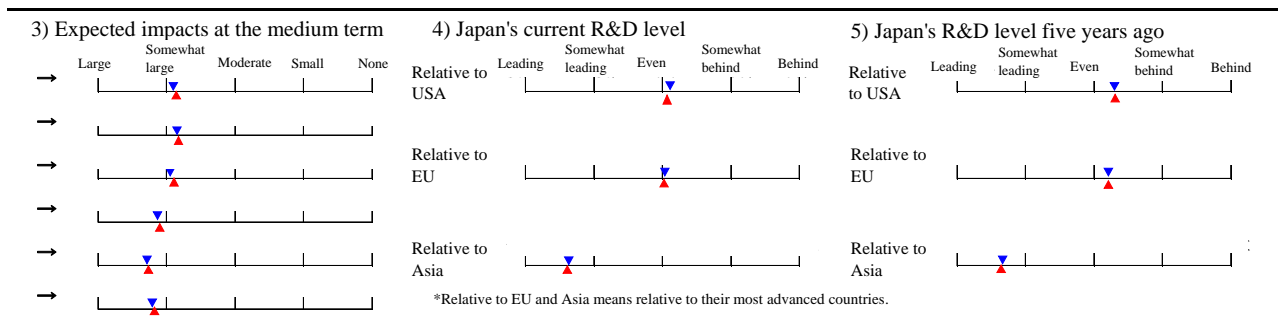
IV. Development of a food system for a safe, peaceful, long-lived, and healthy society and other new technologies for daily life

1. Questions regarding the relevant area

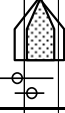
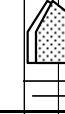


2. Questions regarding topics

No	Topic	Questionnaire	Degree of expertise				Importance to Japan				Time of technological realization												
			Respondents (persons)				Index	High			Moderate	Low	Already realized	2006-2010		2011-2015		2016-2025		2026-2035		2036-	
			High	Moderate	Low	None		High	Moderate	Low	None	Will not be realized		Do not know									
(%)				(%)				(%)		(%)		(%)		(%)		(%)							
24	Food manufacturing that avoids causing allergic reactions by using allergen measurement technology.	1	150	9	25	66	-	66	37	54	8	1									3	10	
		2	147	4	22	74	-	60	23	73	3	1									1	3	
		E	6	100	0	0	-	83	67	33	0	0									0	0	
25	Functional foods tailored to individual physical characteristics to prevent lifestyle disease.	1	166	11	30	59	-	66	39	50	10	1									4	10	
		2	158	4	28	68	-	59	22	71	6	1									2	1	
		E	7	100	0	0	-	71	43	57	0	0									0	0	
26	Foods and diets especially for the elderly that prevent declines in antioxidant, brain, and mastication functions and that use food to support a healthy aging society.	1	151	9	32	59	-	74	52	42	6	0									3	5	
		2	145	6	19	75	-	78	58	35	6	1									0	1	
		E	8	100	0	0	-	94	87	13	0	0									0	0	
27	Precision taste analysis robots that sense taste and other properties and analyze them.	1	123	11	19	70	-	37	7	38	46	9									3	11	
		2	144	5	14	81	-	34	2	34	58	6									2	6	
		E	7	100	0	0	-	43	14	29	57	0									0	0	
28	Sensor network technology that monitors foods from production to table with DNA chips, spectrum sensors, and other sensors in order to prevent contamination with harmful substances, bacteria, and so on.	1	161	11	27	62	-	59	31	45	21	3									3	8	
		2	165	3	22	75	-	56	18	71	11	0									1	1	
		E	5	100	0	0	-	65	40	40	20	0									0	0	
29	Food crop safety assessment systems that utilize proteomics and metabolics.	1	130	16	23	61	-	57	29	45	23	3									5	11	
		2	124	6	25	69	-	54	16	70	13	1									1	0	
		E	8	100	0	0	-	66	38	49	13	0									0	0	
30	Forest treatment methods based on physiological elucidation of the comfort-increasing effects of forests and wood.	1	128	4	18	78	-	44	12	45	38	5									5	10	
		2	121	2	19	79	-	44	7	56	35	2									3	2	
		E	3	100	0	0	-	67	33	67	0	0									0	0	
31	Home freshness-sensing devices to detect the freshness of foods.	1	138	12	21	67	-	36	7	37	42	14									5	8	
		2	149	5	18	77	-	32	3	27	61	9									4	1	
		E	8	100	0	0	-	47	13	49	38	0									0	0	



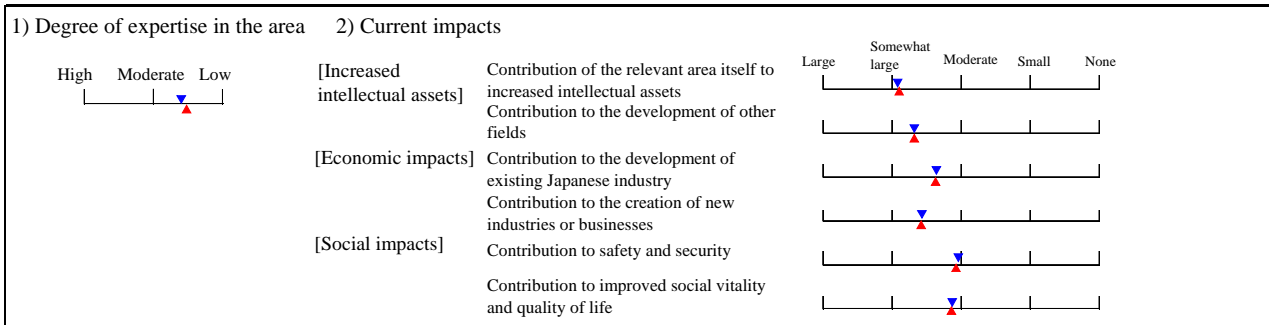
Countries at the leading edge						Regarding technological realization										Time of social application					Regarding social application															
						Necessity of gov't involvement				Effective measures that should be taken by gov't											Necessity of gov't involvement				Effective measures that should be taken by gov't											
Japan	USA	EU	Asia	Other		High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	
(%)						(%)				(%)						(%)					(%)				(%)											
35	48	17	0	0	30	47	20	3	33	57	42	57	8	11	4	0								3	9	27	45	22	6	28	57	36	34	16	16	1
19	80	1	0	0	15	73	11	1	23	72	25	66	4	4	1	0								0	5	15	66	18	1	17	75	24	33	15	8	0
0	100	0	0	0	67	33	0	0	33	67	17	50	33	17	0	0								0	0	50	50	0	0	50	67	33	17	17	33	0
33	53	13	1	0	28	46	22	4	32	64	38	57	8	14	2	1								4	9	23	43	28	6	24	61	36	32	30	13	0
19	79	2	0	0	11	70	18	1	12	80	25	60	3	7	1	0								3	2	12	64	23	1	10	75	33	25	28	6	0
0	100	0	0	0	42	29	29	0	0	57	14	57	0	14	0	0								0	0	29	57	14	0	0	57	14	14	43	0	0
42	42	14	1	1	31	44	22	3	42	58	35	56	8	11	2	1								1	6	27	38	31	4	31	64	39	39	27	7	1
60	38	2	0	0	18	71	11	0	23	79	17	67	4	5	1	0								0	1	15	68	17	0	15	76	26	42	16	2	0
87	13	0	0	0	49	38	13	0	13	50	13	63	0	0	0	0								0	0	38	49	13	0	38	63	13	25	13	0	0
61	30	9	0	0	9	27	45	19	34	48	37	57	5	4	2	1								4	16	9	20	43	28	24	68	43	37	9	2	0
84	16	0	0	0	3	26	61	10	14	65	14	65	0	2	1	1								3	6	1	21	63	15	12	79	37	21	2	0	0
100	0	0	0	0	14	14	72	0	0	57	0	57	0	0	0	0								0	0	14	14	72	0	14	71	29	14	0	0	0
37	50	12	0	1	32	38	25	5	33	56	46	59	9	8	7	1								3	11	31	33	27	9	29	61	34	46	16	22	0
22	76	1	0	1	16	66	17	1	18	73	26	69	5	1	2	0								2	2	19	56	23	2	12	78	23	45	9	17	0
0	100	0	0	0	40	40	20	0	40	80	20	40	0	0	0	0								0	0	40	20	40	0	20	60	40	40	0	0	0
12	68	17	0	3	23	46	26	5	33	42	47	60	7	4	4	1								3	14	26	39	28	7	29	57	32	35	10	17	3
3	92	5	0	0	12	73	14	1	18	55	39	73	2	3	1	0								2	0	12	71	15	2	14	79	19	38	4	13	0
0	100	0	0	0	49	38	13	0	50	63	75	50	13	13	0	0								0	0	42	29	29	0	71	57	43	57	14	14	0
27	13	57	0	3	12	36	40	12	41	42	33	52	7	8	0	0								4	16	11	32	41	16	44	51	27	31	17	4	0
14	4	81	0	1	6	43	46	5	37	47	21	61	2	3	0	0								3	3	4	31	59	6	41	71	14	21	5	0	1
34	33	33	0	0	33	67	0	0	67	33	33	67	0	0	0	0								0	0	33	67	0	0	33	100	0	0	0	0	0
69	21	6	0	4	3	22	49	26	17	60	28	49	3	8	2	0								5	14	5	22	42	31	18	48	49	28	12	8	1
88	5	6	0	1	1	13	70	16	8	81	10	48	1	3	2	0								6	1	2	15	65	18	10	67	56	16	4	5	0
87	13	0	0	0	14	14	72	0	0	86	0	71	0	0	0	0								13	0	13	25	62	0	0	75	50	38	0	0	0

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization										
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know			
				(%)				(%)					(%)										
32	Prevention, diagnosis, and treatment technology through the complete elucidation of BSE onset.	1	148	7	20	73	-	77	60	32	5	3									3	7	
		2	144	2	19	79	-	89	79	16	4	1										1	1
		E	3	100	0	0	-	100	100	0	0	0										0	0
33	Risk management technology for harmful chemicals (endocrine disruptors, heavy metals, etc.) based on elucidation of their long-term impacts on human beings, crops, livestock, and ecosystems.	1	195	8	29	63	-	79	60	35	4	1									2	11	
		2	185	5	22	73	-	93	85	14	1	0									1	1	
		E	9	100	0	0	-	100	100	0	0	0									0	0	
34	Formation of positive understanding and consensus on genetically engineered plants and foods.	1	205	26	29	45	-	78	61	27	10	2											
		2	192	19	29	52	-	90	80	17	2	1											
		E	36	100	0	0	-	92	86	11	0	3											

Countries at the leading edge					Regarding technological realization										Time of social application					Regarding social application														
					Necessity of gov't involvement				Effective measures that should be taken by gov't											Necessity of gov't involvement				Effective measures that should be taken by gov't										
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)						(%)					(%)														
19	14	67	0	0	65	26	6	3	49	37	50	65	28	5	10	0		1	10	66	22	8	4	48	47	14	47	11	31	1				
7	4	89	0	0	87	10	2	1	54	29	55	73	14	2	2	1		1	1	87	10	2	1	60	60	3	50	6	24	1				
0	0	100	0	0	100	0	0	0	67	0	67	100	67	0	0	0		0	0	100	0	0	0	100	33	0	100	0	33	0				
14	47	39	0	0	64	28	7	1	50	43	49	64	20	5	12	1		1	13	62	27	11	0	47	52	16	34	10	37	2				
3	68	29	0	0	87	11	2	0	62	34	45	78	7	2	4	0		0	3	88	10	2	0	53	71	6	37	6	27	1				
0	67	33	0	0	100	0	0	0	56	11	56	100	11	0	0	0		0	0	100	0	0	0	56	67	0	56	11	44	0				
																		6	12	64	23	10	3	58	42	11	14	33	22	10				
																		2	8	79	16	3	2	76	55	7	8	37	14	2				
																		6	6	80	11	3	6	82	61	18	21	39	15	0				

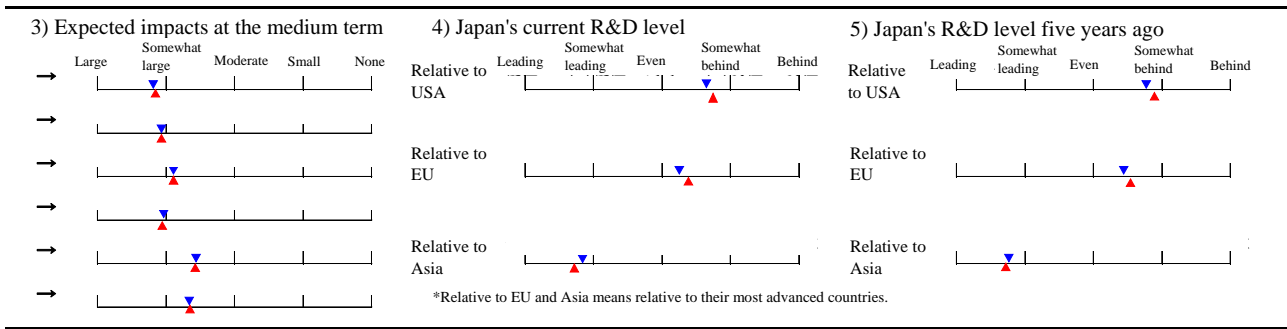
V. Elucidation of genome/proteome, and biological information signal transduction mechanisms and development of innovative production technology

1. Questions regarding the relevant area



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan				Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know	
				(%)				(%)				(%)									
35	Production of transformed livestock with secreted antibacterial proteins, blood coagulation factor and other physiologically active substances in milk	1	97	7	29	64	-	46	13	51	31	5								4	9
		2	116	2	22	76	-	47	6	69	25	0								0	3
		E	2	100	0	0	-	75	50	50	0	0								0	0
36	Prevention of diseases, recovery of homeostasis, improvement of feeding and milk production control based on elucidation of immune system and endocrine mechanisms of adenohypophysis	1	82	9	24	67	-	44	11	46	38	5								2	16
		2	99	3	17	80	-	45	5	65	30	0								0	0
		E	3	100	0	0	-	67	33	67	0	0								0	0
37	Improvement and farming of new organisms for fisheries with advantageous characteristics (e.g., environmental tolerance and resistance to disease) by applying DNA markers and other genome technology.	1	123	17	24	59	-	60	31	50	16	3								2	12
		2	131	7	22	71	-	57	18	73	9	0								0	2
		E	9	100	0	0	-	78	56	44	0	0								0	0
38	Industrial production of useful substances such as medicines through the utilization of insect cell cultures and other transformants.	1	130	10	23	67	-	59	30	50	17	3								1	9
		2	141	2	28	70	-	56	15	79	6	0								1	1
		E	3	100	0	0	-	100	100	0	0	0								0	0
39	Crop production and greening in the strict environment, such as deserts, by using new plants enhanced/added salt, drought or cold tolerance.	1	179	26	24	50	-	55	25	49	23	3								3	10
		2	175	15	29	56	-	56	18	68	13	1								1	2
		E	27	100	0	0	-	65	30	70	0	0								0	0
40	Modeling of all process about the rice plant growth based on the complete elucidation of gene functions and interaction of transcripts.	1	155	25	22	53	-	65	42	38	18	2								4	10
		2	153	14	21	65	-	72	47	47	5	1								3	2
		E	21	100	0	0	-	81	62	38	0	0								0	0
41	Production of aquaculture varieties fixed preferred properties (disease resistance, high growth) through chromosomal manipulation cloning.	1	107	13	21	66	-	56	26	50	20	4								2	12
		2	115	7	15	78	-	50	9	73	18	0								1	4
		E	8	100	0	0	-	56	25	50	25	0								13	0
42	Production of livestock cloned from somatic cells based on elucidation of epigenetic and other nuclear genetic information reprogramming mechanism	1	81	9	25	66	-	50	16	53	28	3								0	11
		2	92	1	22	77	-	47	4	78	17	1								0	2
		E	1	100	0	0	-	100	100	0	0	0								0	0



Countries at the leading edge	Regarding technological realization											Time of social application					Regarding social application														
	Necessity of gov't involvement					Effective measures that should be taken by gov't						2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied		Do not know		Necessity of gov't involvement					Effective measures that should be taken by gov't					
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure						Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	(%)	(%)	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement
4	68	26	0	2	19	41	31	9	32	50	37	60	10	15	5	1			6	17	22	34	34	10	25	54	34	27	33	14	2
0	96	3	1	0	6	70	23	1	17	64	15	72	4	8	2	0			2	4	7	56	34	3	19	79	22	21	23	9	0
0	100	0	0	0	50	50	0	0	0	50	0	100	0	0	0	0			0	0	50	50	0	0	0	100	50	0	0	0	0
3	77	19	0	1	16	44	35	5	33	40	43	64	12	8	0	0			1	20	15	38	37	10	41	58	27	27	13	6	1
1	97	2	0	0	6	69	25	0	23	47	28	71	3	3	1	0			0	3	5	57	37	1	36	77	10	14	11	4	0
33	67	0	0	0	33	67	0	0	0	100	33	100	0	0	0	0			0	0	0	100	0	0	67	67	0	33	0	0	0
39	48	11	1	1	29	46	22	3	41	45	46	66	11	7	0	0			2	12	21	46	28	5	38	64	37	36	17	8	3
33	64	3	0	0	19	69	12	0	35	47	41	76	3	2	1	1			0	6	9	74	16	1	31	80	20	32	8	4	1
56	44	0	0	0	67	33	0	0	56	33	67	100	11	0	0	0			0	0	56	33	11	0	67	56	22	78	0	11	0
36	56	8	0	0	29	41	23	7	34	53	37	63	9	11	2	1			2	15	20	41	31	8	31	59	43	27	28	11	0
20	79	1	0	0	11	78	11	0	29	66	25	74	2	5	1	0			1	2	8	74	17	1	25	78	40	19	20	6	0
33	67	0	0	0	67	33	0	0	33	67	0	100	33	0	0	0			0	0	33	67	0	0	0	100	67	33	33	0	0
26	63	9	1	1	34	45	17	4	42	36	37	62	39	11	0	1			3	16	34	45	16	5	47	52	28	35	19	4	4
11	86	1	1	1	28	63	8	1	47	36	24	74	25	6	2	1			2	5	27	62	9	2	51	73	20	38	10	2	1
15	81	4	0	0	41	59	0	0	41	41	30	81	22	7	0	0			0	0	44	49	7	0	52	70	26	59	19	0	0
73	25	1	0	1	44	35	16	5	43	33	48	73	22	5	0	1			5	17	33	32	25	10	47	53	21	26	15	2	6
91	9	0	0	0	59	35	5	1	47	26	44	78	7	3	0	0			7	7	36	45	16	3	53	75	10	23	7	1	1
76	24	0	0	0	71	29	0	0	71	29	38	86	5	5	0	0			0	10	53	33	14	0	81	76	19	33	10	0	0
57	32	9	0	2	29	41	26	4	38	42	40	67	3	8	3	0			6	14	28	32	36	4	35	53	33	30	18	12	1
78	18	4	0	0	15	69	16	0	27	45	29	77	1	2	0	0			4	5	9	55	34	2	36	72	20	20	12	8	0
75	25	0	0	0	37	38	25	0	50	50	50	88	13	0	0	0			13	0	38	13	49	0	38	50	25	50	25	25	0
17	48	35	0	0	25	44	27	4	31	33	46	64	8	13	6	0			1	20	27	40	28	5	33	42	25	29	23	10	4
7	82	11	0	0	7	81	11	1	22	33	45	67	0	1	1	0			1	2	7	77	15	1	38	73	9	20	10	8	0
100	0	0	0	0	100	0	0	0	100	100	100	100	0	100	0	0			0	0	100	0	0	0	100	100	100	100	100	0	0

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan				Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be realized	Do not know	
				(%)				(%)				(%)									
43	Prevention of infection disease based on the knowledge of the immune system and its regulatory factors of fish .	1	100	6	20	74	-	62	34	50	13	3								1	18
		2	104	4	13	83	-	57	16	78	6	0								1	3
		E	4	100	0	0	-	81	75	0	25	0								25	0
44	Communication technology between human and livestock utilized sensing of the neuro-transmission in the brain.	1	72	7	17	76	-	37	12	28	46	14								13	25
		2	89	2	9	89	-	31	3	25	61	11								10	15
		E	2	100	0	0	-	50	0	100	0	0								0	0
45	Growth regulation of crop/tree based on the knowledge of the mechanism about biosynthesis, transport, and receptor-mediated signaling by regulators in plants.	1	145	25	23	52	-	56	23	56	21	0								1	14
		2	145	16	28	56	-	58	19	76	5	0								1	4
		E	23	100	0	0	-	73	45	55	0	0								0	0
46	Genetically engineered plants in which artificially introduced genes do not spread over the environment because of the special timing/site expression of genes.	1	151	28	28	44	-	69	47	38	12	3								5	10
		2	159	18	25	57	-	78	58	37	4	1								2	2
		E	28	100	0	0	-	86	74	22	4	0								0	4

Countries at the leading edge						Regarding technological realization										Time of social application						Regarding social application														
						Necessity of gov't involvement				Effective measures that should be taken by gov't												Necessity of gov't involvement				Effective measures that should be taken by gov't										
Japan	USA	EU	Asia	Other		High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006-2010	2011-2015	2016-2025	2026-2035	2036-	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	
(%)						(%)				(%)						(%)						(%)														
47	39	13	1	0	32	45	19	4	43	36	49	66	9	7	1	0								1	18	27	45	22	6	40	55	26	28	14	10	2
67	24	9	0	0	17	78	5	0	38	29	42	75	3	1	0	0								1	4	12	76	10	2	46	72	9	24	4	4	0
50	50	0	0	0	50	50	0	0	50	50	50	100	0	0	0	0								0	0	50	25	25	0	75	50	0	75	0	25	0
0	82	16	0	2	14	32	36	18	42	37	46	60	13	0	2	4								14	32	14	22	39	25	52	44	27	25	4	6	6
0	98	2	0	0	5	23	60	12	37	26	36	71	1	0	3	0								17	16	2	24	60	14	62	60	10	16	0	3	0
0	100	0	0	0	50	50	0	0	50	50	50	100	0	0	0	0								0	0	0	50	50	0	50	100	50	50	0	0	0
11	75	12	0	2	25	48	23	4	42	31	42	75	12	5	2	0								4	17	19	42	30	9	52	46	20	26	13	5	3
2	96	2	0	0	17	73	8	2	54	23	36	82	4	4	1	1								4	8	13	69	14	4	60	66	11	21	7	1	1
4	96	0	0	0	35	61	4	0	52	4	39	100	4	4	0	0								0	0	22	78	0	0	61	65	4	26	9	0	0
12	77	10	0	1	43	37	17	3	41	40	48	70	12	10	8	2								5	17	41	35	19	5	38	44	17	30	36	23	8
1	98	1	0	0	56	38	4	2	44	39	43	78	5	7	3	0								3	10	50	43	4	3	42	69	11	24	34	15	1
0	96	4	0	0	71	29	0	0	50	36	36	93	7	11	4	0								0	11	68	32	0	0	39	64	11	36	50	4	4