

Chapter 3

Characteristics of the Agricultural and Forestry Industries in the Soma Area and Damage Sustained as a Result of the Great East Japan Earthquake

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Abstract This chapter is organized about the characteristics of the agricultural and forestry industries in the Soma area (the cities of Soma and Minamisoma, the town of Shinchi, and the village of Iitate) and the damage sustained as a result of the Great East Japan Earthquake, by using the statistics published by the country and municipalities and related documentation. The earthquake and tsunami wrought serious damage on agriculture and agriculture- and forestry-related communal facilities in the Soma area. At the Fukushima Daiichi nuclear power station, the hydrogen explosions triggered by the earthquake and tsunami damaged reactor buildings, and large quantities of radionuclides were dispersed over a wide area. Following the accidents at the nuclear plant, two communities in the Soma area—the village of Iitate and part of the city of Minamisoma—were designated as evacuation zones. To bring an end to these consequences of the radioactive contamination as soon as possible, the city authority is implementing radiation-related measures.

Keywords Soma area • Great East Japan Earthquake

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3.1 Characteristics of the Agricultural and Forestry Industries in the Soma Area Before the Great East Japan Earthquake

3.1.1 Characteristics of the Soma Area

The Soma area in Fukushima Prefecture comprises the cities of Soma and Minamisoma, the town of Shinchi, and the village of Iitate, located in the northeast of the prefecture. Soma, Minamisoma, and Shinchi are on the Pacific coast, and Iitate is inland in the Abukuma Highlands, an area benefiting from abundant natural assets. In terms of climate, the seasonal winds that blow from the Japan Sea are cut off by the Abukuma mountains, so, in contrast to much of Japan’s northeastern Tohoku region, the Pacific coastal area in particular receives comparatively little snowfall in winter, making it a pleasant location in which to live.

Figure 3.1 shows the economies of the municipalities that make up the Soma area. Total economic output by municipality ranges from highest to lowest as follows: Minamisoma, 250,111 million yen; Soma City, 146,521 million yen; Shinchi, 41,083 million yen; Iitate, 12,781 million yen. Averaged across the municipalities of Fukushima Prefecture as a whole, primary industry accounts for 2.1 % of total economic output, secondary industry accounts for 27.9 %, and tertiary industry for 69.6 %. In Minamisoma and Shinchi the distribution is similar, but in these two municipalities tertiary industry accounts for a higher percentage of economic output than in Fukushima Prefecture as a whole, with the electricity, gas, and water utility industries accounting for a particularly high share. In the city of Soma, on the other hand, secondary industry accounts for a higher percentage (48.7 %) of economic output than tertiary industry (47.4 %), with manufacturing accounting for a particularly high percentage (42.6 %) of the total economic output. In Iitate, primary industry commands a relatively high share (14.4 %) of the total economic output, although its share is still less than that of the secondary or tertiary industries. Agriculture’s share of Iitate’s total output is relatively high at 13.7 %, and agriculture could therefore be described as one of the village’s key industries.

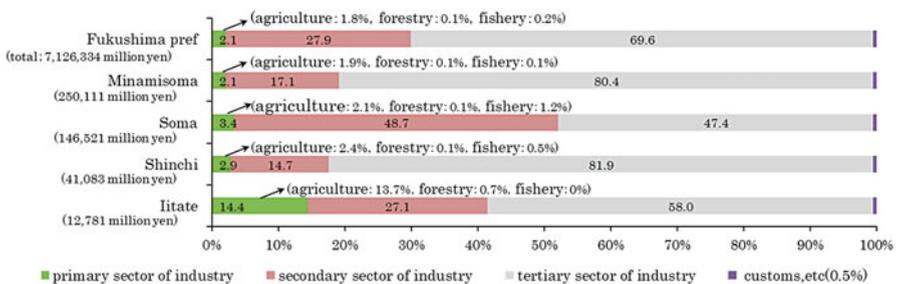


Fig. 3.1 Distribution of total economic output by municipality and economic sector in Fukushima Prefecture (fiscal 2010). (From Prefectural Accounts in Fukushima Prefecture for fiscal 2010)

3.1.2 Characteristics of the Agricultural and Forestry Industries in the Soma Area

Table 3.1 shows the area of cultivated land under management and the number of farm management entities in Fukushima Prefecture by area. The first observation from the table is that the Nakadori region accounts for the largest share (63,467 ha) of the total area of Fukushima Prefecture of cultivated land under management (121,488 ha). Nakadori is followed by the Aizu region (31,242 ha) and the Hamadori region (26,684 ha). By type, cultivated land in Fukushima Prefecture is made up of paddy fields (90,572 ha), non-paddy arable fields (25,057 ha), and land under permanent crops (5,859 ha). The area of cultivated land under management in the Soma area comprises 7,486 ha in Minamisoma, 3,123 ha in Soma city, 2,331 ha in Iitate, and 1,122 ha in Shinchi. In terms of land category, Minamisoma, Soma city, and Shinchi—coastal areas featuring extensive plains—have the prefecture’s highest ratios of paddy fields cultivated, with 84.1 %, 88.0 %, and 73.3 %, respectively. Iitate has a high ratio of non-paddy arable field area under cultivation (49.5 %) because it is located on a plateau. Fukushima Prefecture as a whole has 71,091 farming entities that own cultivated land, and by district the breakdown is Nakadori 42,528 ha, Hamadori 14,577 ha, and Aizu 13,917 ha. Overall, approximately 90 % of farming entities that own cultivated land in Fukushima Prefecture own paddy fields and non-paddy arable fields.

Table 3.2 depicts the Soma area’s forestland by form of ownership. Overall, Fukushima Prefecture has 971,694 ha of forest. Within the Soma area, the forest is divided among the municipalities as follows: Minamisoma 21,947 ha, Iitate 17,531 ha, Soma City 10,143 ha, and Shinchi 1,636 ha; the Soma area as a whole accounts for approximately 5.3 % of Fukushima Prefecture’s forested land. By form of ownership, forest under the jurisdiction of the Japanese government’s Forestry Agency (national forest) accounts for the highest share across Fukushima Prefecture as a whole with 41.6 %. In the Soma area, 58 % of Iitate’s forest is under the jurisdiction of the Forestry Agency; the percentages of private forest owned by individuals and others are high in Shinchi (67.1 %), Minamisoma (42.1 %), and Soma City (41.3 %).

Next, we examine the changes in the number of hectares managed by the Soma area’s farming and forestry entities between 2005 and 2010 (Table 3.3). In terms of farming entities, across Fukushima Prefecture as a whole, the number of relatively small operations managing less than 3 ha decreased during the 5 years whereas the number of entities managing 5 ha or more increased. Entities managing 20 to 30 ha and 30 to 50 ha in particular show a marked increase in number, indicating that the prefecture’s farming entities are on the whole increasing the size of their operations. In the Soma area, the number of farming entities managing less than 5 ha generally decreased whereas the number of entities managing 5 ha or more increased.

Table 3.1 Area of cultivated land under management and number of farming entities in Fukushima Prefecture (fiscal 2010)

		Area of cultivated land under management	Paddy fields	Non-paddy arable fields	Fruit orchards	Management entities of cultivated land	Management entities of paddy fields	Management entities of non-paddy fields	Management entities of fruit orchards
Fukushima Prefecture	Number	121,488	90,572	25,057	5,859	71,091	67,956	61,236	9,353
	Percentage	100	74.6	20.6	4.8	100	95.6	86.1	13.2
Nakadori	Number	63,467	43,269	15,269	4,935	42,528	40,330	36,295	7,381
	Percentage	100	68.2	24.1	7.8	100	94.8	85.3	17.4
Aizu	Number	31,242	26,427	4,244	572	13,917	13,494	12,586	1,287
	Percentage	100	84.6	13.6	1.8	100	97.0	90.4	9.2
Hamadori	Number	26,684	20,828	5,505	354	14,577	14,064	12,288	678
	Percentage	100	78.1	20.6	1.3	100	96.5	84.3	4.7
Soma area	Number	7,486	6,293	1,139	54	3,052	2,954	2,616	106
	Percentage	100	84.1	15.2	0.7	100	96.8	85.7	3.5
Soma	Number	3,123	2,748	312	64	1,278	1,243	1,038	77
	Percentage	100	88.0	10.0	2.0	100	97.3	81.2	6.0
Shinchi	Number	1,122	822	275	25	530	489	492	59
	Percentage	100	73.3	24.5	2.2	100	92.3	92.8	11.1
Iitate	Number	2,331	1,173	1,155	4	763	720	694	18
	Percentage	100	50.3	49.5	0.2	100	94.4	91.0	2.4

Source: Census of Agriculture and Forestry 2010

Note: Numerical value of Fukushima Prefecture and the total value of each region does not match because unpublished data exist

Table 3.2 Soma area's forests by municipality and form of ownership (fiscal 2010) (unit: ha, percentage)

	Total	National forest					Public forest					Private					Center for forestry and agriculture development							
		Forestry agency	Othe	Prefecture	Public corporation	City	Property ward	Company	Temples and shrines	Joint holding	Individual	Forestry agency	Othe	Prefecture	Public corporation	City		Property ward	Company	Temples and shrines	Joint holding	Individual		
Fukushima Prefecture	Number	971,694	4,621	10,776	15,842	42,243	24,275	25,969	4,228	140,918	286,079	12,396												
	Percentage	100	0.5	1.1	1.6	4.3	2.5	2.7	0.4	14.5	29.4	1.3												
Minami soma	Number	21,947	136	485	15	277	54	240	48	2,638	9,237	45												
	Percentage	100	0.6	2.2	0.1	1.3	0.2	1.1	0.2	12.0	42.1	0.2												
Soma	Number	10,143	-	307	-	99	14	813	9	1,907	4,186	51												
	Percentage	100	-	3.0	-	1.0	0.1	8.0	0.1	18.8	41.3	0.5												
Shinchi	Number	1,636	-	102	-	118	-	33	1	247	1,097	29												
	Percentage	100	-	6.2	-	7.2	-	2.0	0.1	15.1	67.1	1.8												
Iitate	Number	17,531	12	12	531	501	-	438	17	575	5,183	19												
	Percentage	100	0.10	0.1	3.0	2.9	-	2.5	0.1	3.3	29.6	0.1												

Source: Statistical yearbook of Fukushima Prefecture (127th)

Table 3.3 Farm and forestry management entities in the Soma area by number (no.) of hectares under management (2010) (unit: number of company (entity), percentage)

	Farm management entities	Less than 1 ha	1–1.5 ha	1.5–2 ha	2–3 ha	4–5 ha	5–10 ha	10–20 ha	20–30 ha	30–50 ha	50–100 ha	100 ha or more
Fukushima prefecture	2005	81,791	15,534	9,375	9,436	5,367	2,057	429	55	20	16	2
	2010	71,654	13,583	8,421	8,727	5,399	2,417	607	109	45	27	1
	Increase/decrease	-12	-13	-10	-8	1	18	41	98	125	69	-50
Minami soma	2005	3,708	683	575	662	404	150	46	6	4	0	0
	2010	3,086	584	445	552	352	153	70	15	7	3	-
	Increase/decrease	-17	-14	-23	-17	-13	2	52	150	75	-	-
Soma	2005	1,573	297	243	287	183	74	25	1	-	-	-
	2010	1,285	218	195	244	168	82	31	4	-	-	-
	Increase/decrease	-18	-27	-20	-15	-8	11	24	300	-	-	-
Shinchi	2005	687	159	97	57	36	21	5	2	-	-	-
	2010	536	126	79	57	30	21	7	3	3	1	-
	Increase/decrease	-22	-21	-19	0	-17	0	40	50	-	-	-
Iitate	2005	928	220	146	153	74	22	8	2	-	7	-
	2010	771	151	113	115	80	36	13	7	1	9	-
	Increase/decrease	-17	-31	-23	-25	8	64	63	250	-	29	-

Fukushima prefecture	2005	7,189	62	2,705	2,192	1,226	366	249	152	104	12	12
	2010	4,929	73	1,714	1,472	912	271	181	112	82	10	13
	Increase/decrease	-31	18	-37	-33	-26	-26	-27	-26	-21	-17	8
Minami soma	2005	249	3	84	73	50	16	5	9	2	1	1
	2010	210	4	59	72	44	14	7	6	2	-	-
	Increase/decrease	-16	33	-30	-1	-12	-13	40	-33	0	-	-
Soma	2005	326	-	171	93	36	8	8	5	2	-	-
	2010	307	-	155	86	42	8	6	6	2	-	-
	Increase/decrease	-6	-	-9	-8	17	0	-25	20	0	-	-
Shinchi	2005	12	-	6	3	1	-	1	1	-	-	-
	2010	2	x	x	x	x	x	x	x	x	x	x
	Increase/decrease	-83	-	-	-	-	-	-	-	-	-	-
Iitate	2005	84	-	26	28	16	7	4	2	-	1	-
	2010	107	2	34	35	21	9	3	2	-	1	-
	Increase/decrease	27	-	31	25	31	29	-25	0	-	0	-

Source: Census of Agriculture and Forestry 2010

Note: '%' indicates the rate of increase or decrease from 2005 to 2010

Minamisoma, Shinchi, and Iitate show early signs that large farming entities managing 50 ha or more are starting to appear. Nonetheless, throughout Fukushima Prefecture and the Soma area, small- to medium-sized farming entities and entities managing less than 5 ha account for the majority.

Turning to forestry entities, the number in Fukushima Prefecture as a whole decreased dramatically (by 31 %) during the 5 years. Forestry entities managing less than 1,000 ha decreased in number overall, with the sole exception of small entities managing less than 3 ha, which maintained an 18 % increase. The same trend prevails in the Soma area also, revealing an apparent lack of new forestry entities to take over.

3.1.3 Changes in Farming and Forestry Entities and Output

Table 3.4 shows changes between 2005 and 2010 in the numbers of farming and forestry entities in the Soma area by type of management structure. From this table we see that the total number of farming entities decreased within Fukushima Prefecture and the Soma area, but the number of incorporated farming entities increased. Across the prefecture, cooperative corporations and joint-stock companies in particular rose in number. Within the Soma area, Minamisoma witnessed conspicuous growth in the number of farming entities becoming joint-stock companies. Despite this increase, however, the majority of farming entities in the Soma area remain individually operated or unincorporated.

Table 3.5 depicts the monetary values of the Soma area's agricultural output by product in fiscal 2008, and in fiscal 2011, the year of the earthquake. We observe from the table that in fiscal 2008 the product generating the highest output in terms of monetary value was rice, followed by vegetables. By municipality, Minamisoma (5.5 billion yen) and Shinchi (710 million yen) had the highest rice output in monetary terms. In the city of Soma, on the other hand, the output of vegetables was valued highest at 4.87 billion yen, with rice next at 2.41 billion yen. In the village of Iitate, located in a mountainous region, the outputs of rice (680 million yen) and beef cattle (640 million yen) were highest.

Data relating to agricultural output in fiscal 2011, the year of the Great East Japan Earthquake, are disclosed only for the city of Soma and the village of Iitate. In Soma, we see a dramatic drop not only in the city's overall agricultural output, but also in the output of its former staple products, rice and vegetables, as well as in other products. Similarly, in Iitate, the village's total agricultural output for fiscal 2011 was worth less than half of its fiscal 2008 value.

Table 3.4 Farm and forestry management entities in the Soma area by type of management structure (2005 and 2010) (unit: number of company (entity), percentage)

		Farm management entities										Forestry management entities												
		Incorporation					Company					Incorporation					Company							
																						Cooperative corporation		Co. Ltd
		Total	Corporation total	Cooperative corporation	Co. Ltd	Inc. Ltd	Total	Co. Ltd	Inc. Ltd	Total	Corporation total	Co. Ltd	Inc. Ltd	Total	Co. Ltd	Inc. Ltd	Total	Co. Ltd	Inc. Ltd	Total	Co. Ltd	Inc. Ltd	Forest cooperative	Other groups
Fukushima prefecture	2005	81,791	525	80	36	237	307	4	7,100	248	30	72	45	54	30	89								
	2010	71,654	616	109	307	4	4,853	178	67	67	1	4	41	37	9	76								
Minami soma	2005	3,708	26	1	2	14	248	9	1	1	4	1	2	0	1									
	2010	3,086	39	6	20	-	210	5	3	3	1	1	-	-	-									
Soma	2005	1,573	6	-	2	2	324	7	3	2	1	1	-	1	2									
	2010	1,285	9	1	4	-	306	7	3	-	1	1	1	1	1									
Shinchi	2005	687	4	-	-	4	-	-	-	-	-	-	-	-	-									
	2010	536	5	-	5	-	-	×	×	×	×	×	×	×	×									
Iitate	2005	928	13	10	-	1	83	8	-	-	-	1	5	-	1									
	2010	771	25	8	3	-	106	5	-	-	-	1	3	-	1									

Source: Census of Agriculture and Forestry 2010

Table 3.5 Monetary values of Soma area's agricultural output by product (fiscal 2008 and 2011) (unit: 10 million yen)

		Total	Rice	Vegetable	Fruits	Other crop cultivation	Beef cattle	Dairy cattle	Hog	Poultry
Fukushima prefecture	2008	1,003	550	172	21	11	84	56	50	×
Soma	2008	988	241	487	30	3	16	28	12	156
	2011	682	137	323	22	11	9	21	16	×
Shinchi	2008	193	71	68	10	–	0	7	–	×
Iitate	2008	362	68	42	0	1	64	17	×	×
	2011	140	38	57	9	16	–	5	–	×

Source: Statistic of gross values of production for agriculture in Fukushima Prefecture (2006 and 2011)

3.2 Damage to the Soma Area's Agricultural and Forestry Industries as a Result of the Great East Japan Earthquake

3.2.1 Loss of Life and Agricultural Damage Caused by the Tsunami

Approximately 1 h after the Great East Japan Earthquake on March 11, 2011, a tsunami reached the port of the city of Soma. The tsunami, which inundated the city relentlessly, reached a maximum wave height of 9.3 m. Along the Soma area coast, the tsunami smashed through the forest of trees more than 10 m tall that had been planted on the shoreline to protect against such an eventuality. At a stroke the water swallowed up streets full of homes and shops, fishing harbors, agricultural land, roads, and railroad tracks located in low-lying areas up to 2 km inland. Vast quantities of debris, and sludge from the ocean floor, were deposited in the communities damaged by the tsunami. In addition, the earthquake caused liquefaction and subsidence of land reclaimed through infilling or drainage throughout the Soma area. It was reported that land reclaimed by drainage in the city of Soma itself subsided by some 39 cm, and this subsidence caused flood damage whenever high waves, spring tides, or heavy rain occurred subsequently (Fig. 3.2).

What is more, a great many people in the Soma area lost their lives to the Great East Japan Earthquake and ensuing tsunami, and many others were deprived of the communities in which they had lived. As of 2013, a total of 1,700 people were known to have died in the Soma area as a result of the earthquake and tsunami, and the number of homes known to have been partially damaged or completely destroyed had reached approximately 9,500 (affecting some 4,600 families).

Meanwhile, at the Fukushima Daiichi nuclear power station operated by Tokyo Electric Power Company (TEPCO), the hydrogen explosions triggered by the earthquake and tsunami damaged reactor buildings, and large quantities of radionuclides



Fig. 3.2 Paddy fields and farming machinery damaged by the tsunami

Table 3.6 Farmland in the Soma area washed away or submerged by the Tsunami (2011) (units: ha, percentage)

	Area of cultivated land under management (2010)	Estimated damage area by the Tsunami	Percentage	Estimated damage area of paddy and non-paddy arable fields	
				Paddy	Non-paddy arable fields
Fukushima Prefecture	149,900	5,923	4	5,588	335
Minamisoma	8,400	2,722	32	2,643	80
Soma	3,910	1,311	34	1,251	60
Shinchi	1,330	433	33	428	5

Source: Ministry of Agriculture, Forestry and Fisheries (2011) Estimated areas of agricultural land damaged by washing away, flooding, etc., caused by the tsunami

were dispersed over a wide area. Following the accidents at the nuclear plant, two communities in the Soma area—the village of Iitate and part of the city of Minamisoma—were designated as evacuation zones. In addition, Iitate’s local government offices were forced to relocate to the city of Fukushima. At the same time, many residents who had lost their homes as a result of the earthquake and tsunami left the area in search of somewhere to live long term, such as temporary accommodation inside or outside Fukushima Prefecture, relatives’ homes, or rented apartments.

The earthquake and tsunami also wrought serious damage on agriculture in the Soma area. Table 3.6 shows the extent to which farmland in the Soma area was washed away or submerged by the tsunami. We see from the table that the estimated total area of farmland damaged in the prefecture as a whole was as much as 5,923 ha, of which 5,588 ha was paddy fields and 335 ha was non-paddy arable fields.

Within the Soma area, approximately 4,400 ha of farmland was damaged in the three tsunami-ravaged municipalities of Minamisoma, Soma City, and Shinchi.

In other words, approximately 80 % of all Fukushima Prefecture's farmland damaged by the tsunami was concentrated in the Soma area. Moreover, approximately 97 %, or 4,322 ha, of the tsunami-damaged farmland in the Soma area comprised paddy fields.

For farmers, machinery and equipment are indispensable assets for operating their farms. No statistics on damage to farming machinery and equipment are available, but it can be surmised that most of the farmers who lost their homes in the tsunami would have lost their machinery and equipment at the same time. Their immediate need was to reestablish their livelihood, yet they lacked the financial means to buy new machinery and equipment, and this contributed to dwindling motivation to resume farming.

Moreover, farmers faced another serious problem in the form of damage to agriculture- and forestry-related communal facilities.

Table 3.7 shows data on damage across Fukushima Prefecture as a whole, where the cost of damage to farmland and agricultural facilities was estimated to have reached approximately 27.3 billion yen. The damage caused by the earthquake and

Table 3.7 Damage to agriculture- and forestry-related communal facilities in Fukushima Prefecture (2011)

Agriculture			Forestry		
Classification	Number	Amount of damage (million yen)	Classification	Number	Amount of damage (million yen)
Damage of agriculture	300	2,110	Damage of forestry	735	2,362
Crops	101	805	Forest	11	265
Facility in farm	199	1,305	Forest product	39	146
Damage of farmland, watercourse, other	4,358	230,258	Facility	52	1,162
Farmland	1,283	93,507	Road	633	789
Watercourse	1,133	27,491	Damage of forestland	113	14,253
Road	894	2,966			
Reservoir	745	23,611	Forest land	103	10,681
Weir	59	3,125	Facility	10	3,572
Water pump	113	28,624			
Bridge	4	84			
Embankment	2	3,000			
Irrigation and drainage channel	105	22,431			
Coastal conservation facility	20	25,419			

Source: Fukushima Prefecture homepage: Damage of public facilities such as agriculture, forestry and fisheries (2013)

Note: It does not include damage caused by the Fukushima Daiichi nuclear disaster

tsunami included flooded farmland, collapsed reservoirs, ruptured irrigation and drainage channels, and destruction of drainage pump stations. Of the total estimated cost, more than 80 % related to damage in the Hamadori region. Even if the farmers' land, machinery, and equipment had escaped damage as a result of the tsunami, therefore, they would be unable to resume farming promptly unless irrigation facilities were restored.

In addition to damage to agricultural facilities, the damage to forestry-related communal facilities was also severe. In the Nakadori region in particular, 248 forest roads sustained damage including collapsed embankments and shoulders in 633 places overall. Other types of damage included mushroom bed logs falling from shelves at shiitake-growing facilities that operate within the forestry sector. The data shown do not include damage resulting from the nuclear accident, and it is anticipated that the cost of damage including that caused by the negative reputation will increase.

3.2.2 Contamination from Radionuclides in the City of Soma and Its Effects on Agriculture and Forestry

After the accident at the Fukushima Daiichi nuclear power station, the southerly wind blowing onto the Pacific coast in the southeast of the Tohoku region carried the radionuclides emitted from the power station toward the northwest, dispersing them all over Fukushima Prefecture. Consequently, high ambient radiation doses were measured in many of the Fukushima Prefecture municipalities. Most notably, ambient radiation doses exceeding 10 $\mu\text{Sv/h}$ were recorded within a 20-km radius of the power station in the towns of Naraha, Tomioka, Okuma, Futaba, and Namie.

In the city of Soma, the local authority measured ambient radiation doses in front of the city hall's branch office immediately after the disaster, recording a maximum dose of 1.73 $\mu\text{Sv/h}$. Although the doses gradually decreased thereafter, as of September 2013 there are still some scattered locations within Soma where the annual cumulative radiation dose exceeds 1 mSv. The local authority divided the city into a grid of 1-km squares to measure ambient radiation levels, and the results show that in June 2011 the average ambient radiation dose for the city of Soma as a whole was 0.74 $\mu\text{Sv/h}$. Of the eight districts comprising the city of Soma, the highest dose was 1.88 $\mu\text{Sv/h}$, recorded in the Tamano district adjacent to the village of Iitate. In addition, Yamakami district, located between Tamano district and Soma's city center, recorded a relatively high dose of 1.03 $\mu\text{Sv/h}$. In the tsunami-damaged districts of Iitoyo district, Nittaki district, and Isobe district on Soma's coast, the ambient radiation dose was around 0.40 $\mu\text{Sv/h}$, and the damage caused by radioactive contamination was relatively insignificant. Following the nuclear disaster the ambient radiation doses in all the districts of the city of Soma declined over time, decreasing to about half their original levels, but even now, two and a half years later, the dose in the district of Tamano district is still high, at 0.93 $\mu\text{Sv/h}$ (Table 3.8).

Table 3.8 Results of grid survey of ambient radiation doses in the city of Soma (unit: $\mu\text{Sv/h}$)

	2011		2012		2013	
	Soil	Asphalt pavement	Soil	Asphalt pavement	Soil	Asphalt pavement
Soma City	0.74	0.60	0.53	0.36	0.36	0.24
Nakamura district	0.49	0.36	0.32	0.23	0.23	0.16
Ono district	0.48	0.38	0.37	0.27	0.25	0.17
Iitoyo district	0.39	0.34	0.22	0.18	0.18	0.12
Hachiman district	0.72	0.57	0.51	0.34	0.36	0.22
Yamakami district	1.03	0.74	0.64	0.41	0.47	0.29
Nittaki district	0.55	0.46	0.37	0.27	0.29	0.20
Isobe district	0.38	0.28	0.27	0.19	0.20	0.14
Tamano district	1.88	1.70	1.56	1.00	0.93	0.60

Source: Soma City Homepage (Information about Radioactive)

Note: (1) The survey of year 2011 was conducted on 18th June, of 2012 was on 26th April until 7th May, of 2013 was on 26th April until 10th May

(2) Soma City divided the area into square of 1×1 km, and measured the air dose rates from 173 spots at 1-m height for 10 s long for 5 times

As a result of the accident at the Fukushima Daiichi nuclear power station, many Soma residents who had lost their homes also had to live with anxiety about the radiation. Meanwhile, others left the city voluntarily because they were worried about the possible effects of radiation on their children's health. As a result of the radionuclides dispersed into the atmosphere, steps were taken to halt shipments of Soma city's agricultural produce, including vegetables and beef cattle, and planting of rice crops for consumption was prohibited. Meanwhile, highly contaminated water was released into the sea, so that fishermen who had managed to overcome the tsunami damage enough to start rebuilding their livelihoods were forced to refrain from actually fishing.

To bring an end to these consequences of the radioactive contamination as soon as possible, the city authority is implementing the following radiation-related measures.

- (a) Holding information sessions in the city to enable the citizens to acquire accurate information about radioactivity.
- (b) Measuring radioactivity continuously across all Soma city's districts based on 1-km grid units to gauge radiation doses and identify "hotspots," and publishing the results promptly on the city's website and in its newsletter.
- (c) Continuously measuring radiation levels in 50 locations at each school in Soma to identify "mini-hotspots" and gain a detailed picture of radiation doses in the schools, and offering lectures about radiation to staff to enable them to communicate accurate information to the pupils.
- (d) Taking especially detailed grid-based measurements in the district of Tamano, where radiation doses were high, and decontaminating wherever necessary. The city authority is also holding seminars and training sessions on correct decontamination methods and offering health consultations and priority admis-

sion to temporary accommodation to alleviate people's concerns about the health risks of living in Tamano district.

- (e) Decontaminating with the help of local residents, using the radioactive substance decontamination manual in line with the city of Soma's decontamination plan released on December 28, 2011.
- (f) Setting up a decontamination project team to implement the decontamination plan within the city, revise the manual, and verify the benefits of decontamination. In addition, the city authority is putting in place a structure to devise and implement specific measures to prioritize protecting children from radiation exposure and maintaining their health. To this end it is setting up a special committee on health measures to discuss steps to safeguard citizens' health, and particularly the health of children.
- (g) Taking a variety of measures in conjunction with related agencies to dispel the negative reputation affecting agriculture, forestry, and fisheries produce, and associated processed products, as well as the industrial manufacturing and tourism industries. The city authority is also investigating the decreases in income that operators in the relevant industries have suffered as a result of negative reputation, and is sending a claim for the necessary amount of compensation to TEPCO.
- (h) The decontamination process produced waste in the form of earth and sand containing radionuclides that had to be stored where it would not endanger local citizens until it could be transported to the national government's interim storage facilities. The city authority therefore set up a temporary storage site at the industrial waste treatment plant within the city, and the earth and sand were stored there. The temporary storage site is monitored with careful attention to safety to prevent dispersal, outflow, or underground seepage of radionuclide.
- (i) Giving children up to the age of 15 and pregnant women "glass badges" to measure external radiation exposure for a 3-month period to safeguard the citizens' health, and particularly the health of children.
- (j) Testing ingredients before lunches are prepared at schools in the city that provide their own school lunches.
- (k) Installing machines in the city hall and district community centers to measure concentration of radionuclide, thereby alleviating citizen's health worries by helping them to decide whether it is safe to eat foodstuffs including vegetables and other agricultural and fish products cultivated at home. In addition, the city authority is taking measures to improve safety and peace of mind still further by deploying whole-body counters in the city's medical institutions to monitor internal radiation exposure properly and continuously, enabling citizens to manage their health.

As described, the Soma City authority is conducting an independent grid-based survey of ambient radiation doses, as well as real-time dosimeter monitoring, and surveys of ambient radiation at communal facilities within the city. In addition, surveys are currently being conducted at 68 ambient radiation monitoring posts established across Soma on April 1, 2012, by the Ministry of Education, Culture, Sports, Science and Technology. The measurement of ambient radiation levels at communal facilities takes place in six locations within the three districts of Ono district, Nakamura district, and Nittaki district. Doses at the temporary accommoda-

tion sites in the city of Soma are low, at around 0.1 $\mu\text{Sv/h}$. At elementary and junior high schools the ambient radiation dose varies from one district to another, but the doses at the Tamano elementary and junior high schools before they were decontaminated were high at 2.32 $\mu\text{Sv/h}$ and 2.41 $\mu\text{Sv/h}$, respectively. As children are most susceptible to the effects of radionuclides, Soma prioritizes their safety. To this end, the city authority decontaminated not only kindergartens and schools, but also other communal facilities frequently used by children, as well as the roads around them. As a result, the ambient radiation doses at most decontaminated elementary and junior high schools were reduced to around 0.1 $\mu\text{Sv/h}$. In many sports facilities, moreover, the doses are 0.5 $\mu\text{Sv/h}$ or lower.

3.2.3 Effects on Agriculture, Forestry, and Fisheries Products

Immediately after the nuclear disaster, Fukushima's prefectural authority was carefully monitoring the prefecture's produce for radionuclides and disclosing the relevant information. Monitoring is still continuing today, following upgrades to the devices and system used during fiscal 2012. This monitoring makes it possible to prohibit shipment of products that exceed the limits set for radionuclides, thereby preventing the products' distribution to the market. Table 3.9 shows radiation

Table 3.9 Results of tests to monitor radionuclide in Soma City's agriculture, forestry, and fisheries products (unit: percentage)

	2011			2012			2013		
	Above limit	Under limit	No detected	Above limit	Under limit	No detected	Above limit	Under limit	No detected
Vegetable	3	17	80	1	2	97	–	4	96
Fruit	19	28	53	–	29	71	–	44	56
Mt. vegetable and mushroom	58	24	18	19	58	23	7	86	7
Meat and chicken	2	27	71	–	5	95	–	3	97
Raw milk	25	50	25	–	–	–	–	–	–
Fish	25	48	27	6	45	49	1	28	71
Wild boar	100	–	–	100	–	–	100	–	–
Pheasant	100	–	–	100	–	–	–	–	–
Wild duck	–	100	–	–	100	–	–	100	–
Fertilizer (cow dung)	62	38	–	19	61	19	22	44	33

Source: Ministry of Health, Labour and Welfare (Survey of radionuclides in food)

Note: The above numbers are the numbers of agricultural products which exceeded the new limit, applied after 1st April 2012. The limit of vegetable, fruit, Mt. vegetable and mushroom, meat and chicken, fish, wild boar, pheasant, wild duck is 100 Bq/kg, raw milk is 50 Bq/kg, and fertilizer made from cow dung is 400 Bq/kg

monitoring results for the city of Soma's agricultural, forestry, and fisheries products from the time immediately after the nuclear disaster to the present. Immediately after the disaster a wide variety of products were found to contain radionuclide exceeding the new limit for non-dairy products of 100 Bq/kg. In particular, many fish and shellfish, edible wild plants and mushrooms, and fruits, as well as cattle manure compost, were found to exceed the limit.

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