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
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.
| Area of cultivated land under management | Paddy fields | Non-paddy arable fields | Fruit orchards | Management entities of cultivated land | 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                                | Minami Soma | Number                  | 7,486          | 6,293                                  | 1,139                                  | 54                                   | 3,052                                | 2,954                                | 2,616                                |
|                                          | 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                                |
|                                          | 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                                  |
|                                          | 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                                  |
|                                          | 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 |
|------------------|-------|-----------------|---------------|---------|-----------------------------------------------|
|                  | Number | Forestry agency | Other | Prefecture | Public corporation | City | Property ward | Company | Temples and shrines | Joint holding | Individual |                             |
| **Fukushima Prefecture** |       |                 |       |           |                |     |             |         |                    |               |           |                             |
| Number           | 971,694 | 404,345 | 4,621 | 10,776 | 15,842 | 42,243 | 24,275 | 25,969 | 4,228 | 140,918 | 286,079 | 12,396 |
| Percentage       | 100 | 41.6 | 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 | 8,772 | 136 | 485 | 15 | 277 | 54 | 240 | 48 | 2,638 | 9,237 | 45 |
| Percentage       | 100 | 40.0 | 0.6 | 2.2 | 0.1 | 1.3 | 0.2 | 1.1 | 0.2 | 12.0 | 42.1 | 0.2 |
| **Soma**         |       |                 |       |           |                |     |             |         |                    |               |           |                             |
| Number           | 10,143 | 2,757 | – | 307 | – | 99 | 14 | 813 | 9 | 1,907 | 4,186 | 51 |
| Percentage       | 100 | 27.2 | – | 3.0 | – | 1.0 | 0.1 | 8.0 | 0.1 | 18.8 | 41.3 | 0.5 |
| **Shinchi**      |       |                 |       |           |                |     |             |         |                    |               |           |                             |
| Number           | 1,636 | 8 | – | 102 | – | 118 | – | 33 | 1 | 247 | 1,097 | 29 |
| Percentage       | 100 | 0.5 | – | 6.2 | – | 7.2 | – | 2.0 | 0.1 | 15.1 | 67.1 | 1.8 |
| **Iitate**       |       |                 |       |           |                |     |             |         |                    |               |           |                             |
| Number           | 17,531 | 10,243 | 12 | 12 | 531 | 501 | – | 438 | 17 | 575 | 5,183 | 19 |
| Percentage       | 100 | 58.4 | 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         | 39,500   | 15,534   | 9,375  | 9,436  | 5,367   | 2,057    | 429      | 55       | 20      | 16               | 2               |
|                | 2010                    | 71,654         | 31,755   | 13,583   | 8,421  | 8,727  | 5,399   | 2,417    | 607      | 109      | 45      | 27                | 1               |
|                | Increase/decrease       | −12            | −20      | −13      | −10    | −8     | 1       | 18       | 41       | 98       | 125     | 69                | −50              |
| Minami soma    | 2005                    | 3,708          | 1,178    | 683      | 575    | 662    | 404     | 150      | 46       | 6        | 4      | 0                | 0               |
|                | 2010                    | 3,086          | 871      | 584      | 445    | 552    | 352     | 153      | 70       | 15       | 7      | 3                | −               |
|                | Increase/decrease       | −17            | −26      | −14      | −23    | −17    | −13     | 2        | 52       | 150      | 75     | −                | −               |
| Soma           | 2005                    | 1,573          | 463      | 297      | 243    | 287    | 183     | 74       | 25       | 1        | −      | −                | −               |
|                | 2010                    | 1,285          | 336      | 218      | 195    | 244    | 168     | 82       | 31       | 4        | −      | −                | −               |
|                | Increase/decrease       | −18            | −27      | −27      | −20    | −15    | −8      | 11       | 24       | 300      | −      | −                | −               |
| Shinchi        | 2005                    | 687            | 310      | 159      | 97     | 57     | 36      | 21       | 5        | 2        | −      | −                | −               |
|                | 2010                    | 536            | 203      | 126      | 79     | 57     | 30      | 21       | 7        | 3        | 3      | 1                | −               |
|                | Increase/decrease       | −22            | −35      | −21      | −19    | 0      | −17     | 0        | 40       | 50       | −      | −                | −               |
| Iitate         | 2005                    | 928            | 296      | 220      | 146    | 153    | 74      | 22       | 8        | 2        | −      | 7                | −               |
|                | 2010                    | 771            | 238      | 151      | 113    | 115    | 80      | 36       | 13       | 7        | 1      | 9                | −               |
|                | Increase/decrease       | −17            | −20      | −31      | −23    | −25    | 8       | 64       | 63       | 250      | −      | 29               | −               |
|                | 2005 | 2010 | Increase/decrease |
|----------------|------|------|-------------------|
| **Fukushima prefecture** |      |      |                   |
|                | 7,189| 4,929| −31               |
|                | 62   | 73   | 18                |
|                | 2,705| 1,714| −37               |
|                | 2,192| 1,472| −33               |
|                | 1,226| 912  | −26               |
|                | 366  | 271  | −26               |
|                | 249  | 181  | −27               |
|                | 152  | 112  | −27               |
|                | 104  | 82   | −26               |
|                | 12   | 10   | −21               |
|                | 12   | 13   | −17               |
| **Minami soma**  |      |      |                   |
| 2005           | 249  | 210  | −16               |
| 2010           | 33   | 4     | 33                |
| Increase/decrease | −30 | 12 | −37               |
|                | 73   | 72   | −12               |
|                | 50   | 44   | −13               |
|                | 16   | 14   | 40                |
|                | 5    | 7    | −33               |
|                | 2    | 6    | 0                 |
|                | 1    | 6    | −1                |
|                | 1    | 4    | −1                |
| **Soma**       |      |      |                   |
| 2005           | 326  | 307  | −6                |
| 2010           | −    | −    | −9                |
| Increase/decrease | −8 | 17 | −30               |
|                | 171  | 155  | −8                |
|                | 93   | 86   | 17                |
|                | 36   | 42   | 0                 |
|                | 8    | 8    | −25               |
|                | 5    | 6    | 20                |
|                | 2    | 6    | 0                 |
|                | −    | −    | −                 |
| **Shinchi**    |      |      |                   |
| 2005           | 12   | 6    | −83               |
| 2010           | −    | 6    | −                 |
| Increase/decrease | × | 3 | 83                |
|                | −    | 3    | −                 |
|                | ×    | 1    | −                 |
|                | ×    | 1    | −                 |
|                | ×    | 1    | −                 |
| **Iitate**     |      |      |                   |
| 2005           | 84   | 26   | 27                |
| 2010           | 107  | 34   | −                  |
| Increase/decrease | − | 31 | 27                |
|                | 28   | 35   | −25               |
|                | 16   | 21   | 0                 |
|                | 7    | 9    | 0                 |
|                | 4    | 3    | 0                 |
|                | 2    | 2    | −                 |

*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 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             | Incorporation                |
|                | Corporation total         | Corporation total           |
|                | Cooperative corporation   | Company Ltd                 |
|                | Company Ltd               | Inc. Ltd                    |
|                | Total                      | Total                       |
|                | percentage                 | percentage                  |
| Fukushima prefecture | 2005 81,791 525 80 36 237 7,100 | 2010 71,654 616 109 307 4 4,853 |
|                |                            | 2010 71,654 616 109 307 4 4,853 |
| Minami soma    | 2005 3,708 26 1 2 14 248 9 1 4 1 2 0 1 | 2010 3,086 39 6 20 – 210 5 3 1 – – – |
|                |                            | 2010 3,086 39 6 20 – 210 5 3 1 – – – |
| Soma           | 2005 1,573 6 2 2 324 7 3 2 1 – 1 2 | 2010 1,285 9 1 4 – 306 7 3 – 1 1 1 1 |
| Shinchi        | 2005 687 4 – – 4 – – 4 1 – – 1 – – 1 | 2010 536 5 – 5 – × × – × × × × |
|                |                            | 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 |
|                |                            | 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      |
|                 | 2011  | 682   | 137       | 323    | 22                     | 11          | 9            | 21  | 16      |
| Soma            | 2008  | 988   | 241       | 487    | 30                     | 3           | 16           | 28  | 12      |
|                 | 2011  | 193   | 71        | 68     | 10                     | –           | 0            | 7   | –       |
| Shinchi         | 2008  | 193   | 71        | 68     | 10                     | –           | 0            | 7   | –       |
|                 | 2011  | 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
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.

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 |
|--------------------------|-----------------------------------------------|-------------------------------------|------------|----------------------------------------------------------|
|                          | 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
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

| 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 μSv/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 μSv/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 μSv/h. Of the eight districts comprising the city of Soma, the highest dose was 1.88 μSv/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 μSv/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 μSv/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 μSv/h (Table 3.8).
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-

Table 3.8 Results of grid survey of ambient radiation doses in the city of Soma (unit: μSv/h)

|          | 2011 Soil | 2011 Asphalt pavement | 2012 Soil | 2012 Asphalt pavement | 2013 Soil | 2013 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                   |
| Itoyo 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

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(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 μSv/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 μSv/h and 2.41 μSv/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 μSv/h. In many sports facilities, moreover, the doses are 0.5 μSv/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    | 58   | 24   | 18    | 19   | 58  | 23   | 7        | 86   | 7         |
| and mushroom     |      |      |       |      |      |      |          |      |           |
| 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       | 62   | 38   | –     | 19   | 61  | 19   | 22       | 44   | 33        |
| (cow dung)       |      |      |       |      |      |      |          |      |           |

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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Bibliography

Agriculture, Forestry and Fisheries Department of Fukushima Prefecture (2013) Record of the Great East Japan Earthquake of Agriculture, Forestry and Fisheries in Fukushima prefecture (1st edn). https://www.pref.fukushima.lg.jp/sec/36005b/norinkikaku19.html

Ministry of Agriculture, Forestry and Fisheries, Basic statistical data related to agriculture, forestry and fisheries and the Great East Japan Earthquake- mainly Iwate, Miyagi, Fukushima Prefecture. http://www.maff.go.jp/j/tokei/joho/zusetu/zusetu.html

Ministry of Agriculture, Forestry and Fisheries, About the Great East Japan Earthquake-Correspond to the damage. http://www.maff.go.jp/j/kanbo/johoai/gai_taio/index.html. Soma city (2012), Soma city Revitalization Plan ver. 1.2 (in Japanese)

Monma T (2011) Sludge and debris were deposited in paddy: Challenge of research and restoration in Soma city. Shin-jitsugaku. Journal Tokyo University of Agriculture (in Japanese)

The Tohoku Regional Agricultural Administration Office (2013) Statistical yearbook of agriculture, forestry, and fisheries in Fukushima prefecture (59th) (from 2011 to 2012)