# March 2011 earthquake, tsunami and Fukushima nuclear accident impacts on Japanese agri-food sector

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## I. Introduction

On March 11, 2011 the strongest recorded in Japan earthquake off the Pacific coast of North-east of the country occurred (also know as Great East Japan Earthquake, 2011 Tohoku earthquake, and the 3.11 Earthquake) which triggered a powerful tsunami and caused a nuclear accident in one of the world's largest nuclear plant (Fukushima Daichi Nuclear Plant Station). It was the first disaster that included an earthquake, a tsunami, and a nuclear power plant accident.

The 2011 disasters have had immense impacts on people life, health and property, social infrastructure and economy, natural and institutional environment, etc. in North-eastern Japan and beyond [Abe, 2014; Al-Badri and Berends, 2013; Biodiversity Center of Japan, 2013; Britannica, 2014; Buesseler, 2014; FNAIC, 2013; Fujita et al., 2012; IAEA, 2011; IBRD, 2012; Kontar et al., 2014; NIRA, 2013; TEPCO, 2012; UNEP, 2012; Vervaeck and Daniell, 2012; Umeda, 2013; WHO, 2013; WWF, 2013]. We have done an assessment of major social, economic and environmental impacts of the triple disaster in another publication [Bachev, 2014].

There have been numerous publications on diverse impacts of the 2011 disasters including on the Japanese agriculture and food sector [Bachev and Ito, 2013; JA-ZENCHU, 2011; Johnson, 2011; Hamada and Ogino, 2012; MAFF, 2012; Koyama, 2013; Sekizawa, 2013; Pushpalal et al., 2013; Liou et al., 2012; Murayama, 2012; MHLW, 2013; Nakanishi and Tanoi, 2013; Oka, 2012; Ujiie, 2012; Yasunaria et al., 2011; Watanabe A., 2011; Watanabe N., 2013].

Most of the domestic information and publications have been in Japanese, which make it difficult for international public to get a full insight on the scales and diverse implications of disasters. What is more, most of the assessment focuses on the individual disaster (earthquake, tsunami, nuclear accident) and/or aspects of the impact (farming structures, material and economic damages, markets, health, displacement, environment, etc.) while there are few studies on the overall impacts of the tree disasters.

Furthermore, due to the scale of the disasters and affected agents, effects' multiplicities, spillovers, and long time horizon, the lack of "full" information and models of analysis, the overall impacts of 2011 disasters on Japanese agri-food chains is far from being completely evaluated.

The goal of this paper is to present the socio-economic impacts of the March 2011 earthquake, tsunami and the Fukushima nuclear disaster on the Japanese agriculture and food sector.

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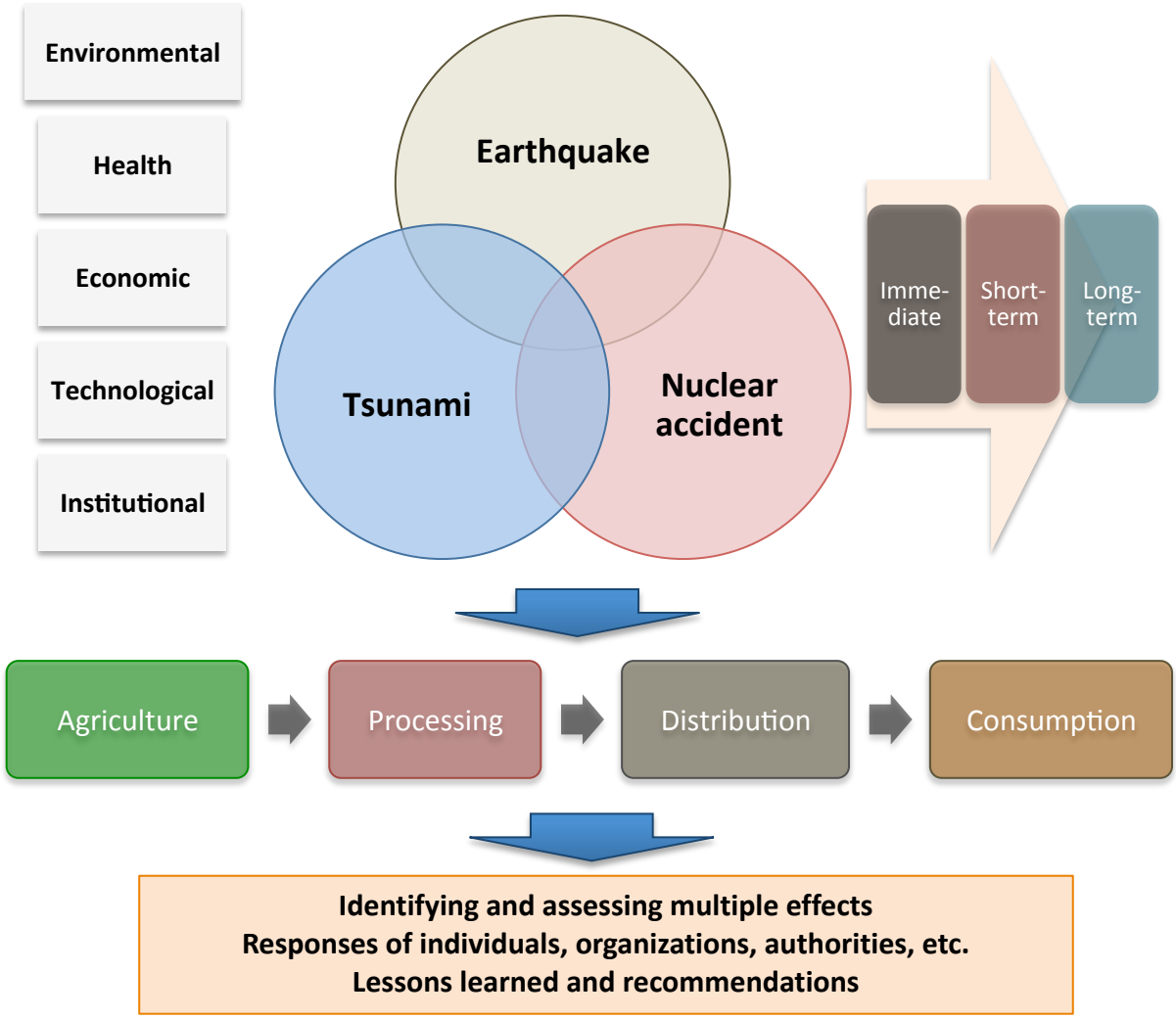
Individuals and households, farms and businesses, communities, material, biological and intellectual properties, institutional and natural environment, etc. all they have been affected by *one, two* or *three disasters* (earthquake, tsunami, nuclear accident) (Figure 1).

**Figure 1. Framework for analyzing impacts of 2011 triple disasters on Japanese agriculture and food chains**




Firstly, we have tried to identify and assess diverse impacts from the 2011 disasters on the Japanese agriculture and food chains. The analysis embraces:

- *Individual stages of the agri-food chain* - inputs supply, farming, storage, wholesaling, transportation, processing, distribution, retailing, and consumption;
- *Individual components of the agri-food chain* - natural resources, labor, biological assets, material assets, technology, production structure, finance, waste disposal, information, and management;
- *Different spacial scales* – local, regional, national, trans-national, and global.

Multiple effects from the 2011 disasters will be identified, described and "assessed" including:

- *Direct and indirect effects*;
- *Immediate, short-term, and long-term effects*;
- *Radiation, displacement, health, physiological, production, economic, technological, organizational, environmental, academic, institutional, and political effects;*
- *Expected, real, likely, perceived, and modeled effects.*

Next, we have tried to summarize responses of individuals, households, farms, businesses, communities, consumers, stakeholders, and authorities as well as assess the progress and challenges in post-disaster recovery and reconstruction.

Finally, we have tried to withdraw lessons from the Japanese experiences and suggest recommendations for improving public policies, and individual, business and collective actions for effective risk management.

Specification and assessment of individual effects has been associated with great difficulties because of their multiplicity, interdependency, synergy and multidirectional character, surround big uncertainty, shortage and controversy of data, large temporal and special scales, multiple agents with different perception, time horizon and interests involved, week methods of assessment and integration, etc. Therefore, we have tried to extend the uni-disciplinary and uni-sectoral analysis with multi and interdisciplinary approach and multisectoral study in order to better understand the overall impacts of the disaster on agri-food chain and its major components.

We have used a wide range of official governmental, farmers, industry and international organizations, and Tokyo Electric Power Company (TEPCO) data as well as information from publications in media, research and experts reports etc. In addition, we have carried out expert assessments and numerous in-deep interviews with leading experts in the areas, and representatives of the prefectural governments, farmers, food industries and non-governmental organizations, and affected farmers, business and consumers.

This paper contains thirteen parts: initially an overview of the three disasters and their displacement, health, economic, etc. effects is briefly presented; next analysis of affected farms and agricultural resources is made; third, the state of restoration of agricultural communities, lands, infrastructure and businesses is assessed; after that, impact on food industries is evaluated; next, radioactive contamination of agri-food products is analyzed; following that effects on agri-food markets, consumers and international trade is evaluated; after than effects on food regulation and inspection system is presented; next farms and agri-businesses damages from the Fukushima nuclear accident are assessed; following is the estimates on overall impact on farms and agricultural resources; after that overall impact on agricultural productions is evaluated; next overall impact on farm economy is analyzed; finally, lessons learned are summarized and recommendation suggested.

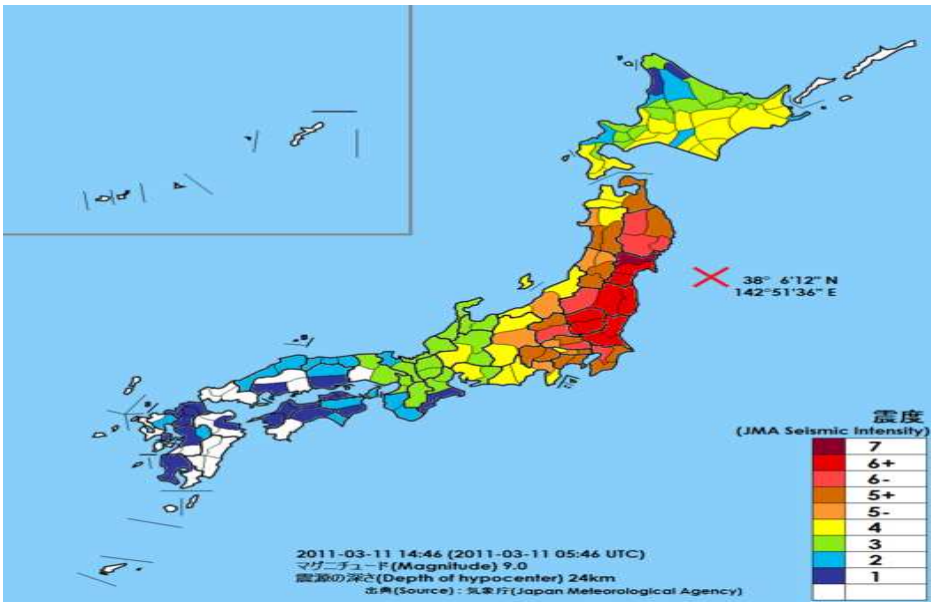
We would like to express our gratitude to the Japan Foundation for funding the project. We also want to thank all individuals and organizations providing valuable information and expertise as well as numerous participants in the expertise and interviews.

## II. Description of events and effects

On March 11, 2011 a mega thrust with a magnitude of 9.0 Mw occurred off the Pacific coast of Japan (Map 1). It was the most powerful earthquake ever recorded in or around Japan, and the forth most powerful earthquake in the world since 1900 [JMA, 2011].

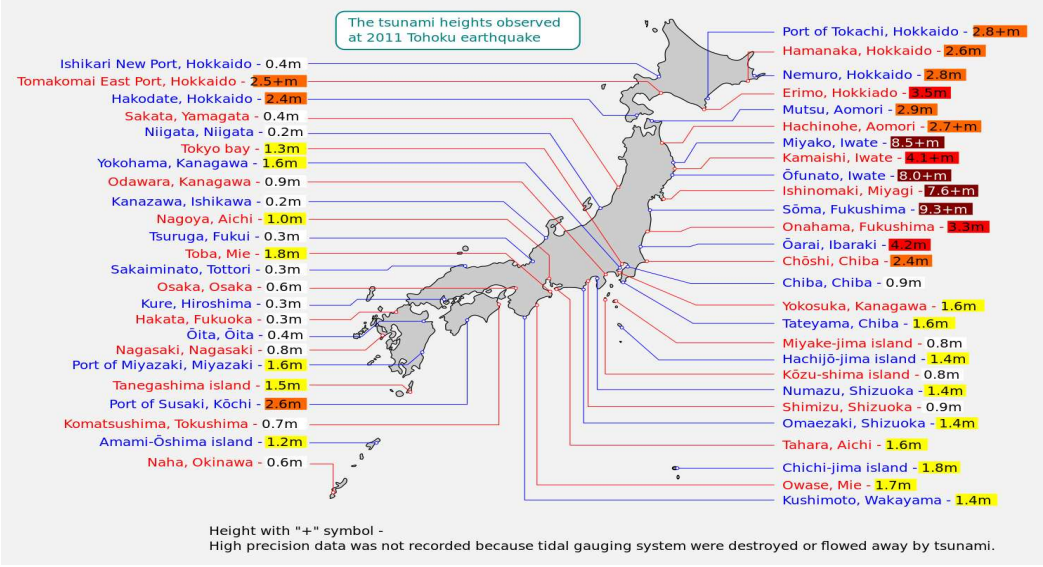
The earthquake triggered powerful tsunamis that spread over the wide area from Hokkaido to Okinawa (Map 2). According to estimates an extensive coastal area surpassing 400 km was hit by tsunami higher than 10 m that submerged plane areas more than 5 km inland [Mori et al, 2011].

**Map 1. Epicenter and seismic intensity of March 11, 2011 Earthquake**




Source: Japan Meteorological Agency

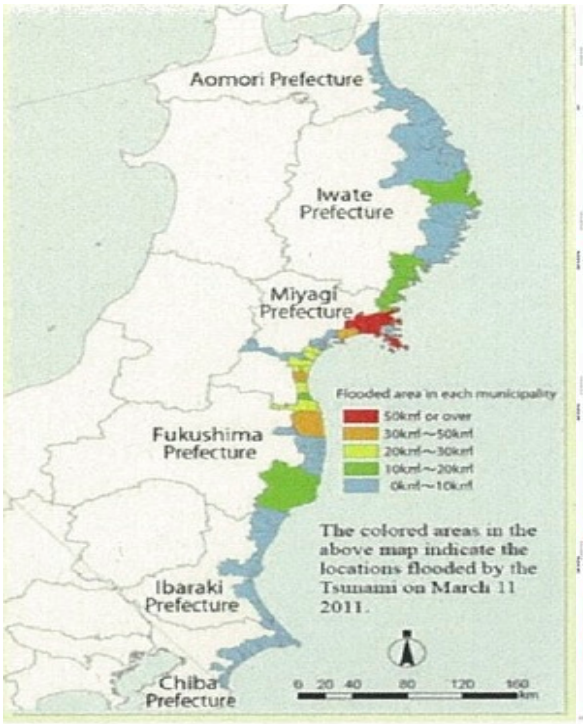
**Map 2. Great East Japan Earthquake observed tsunami heights in Japan**




Source: Japan Meteorological Agency

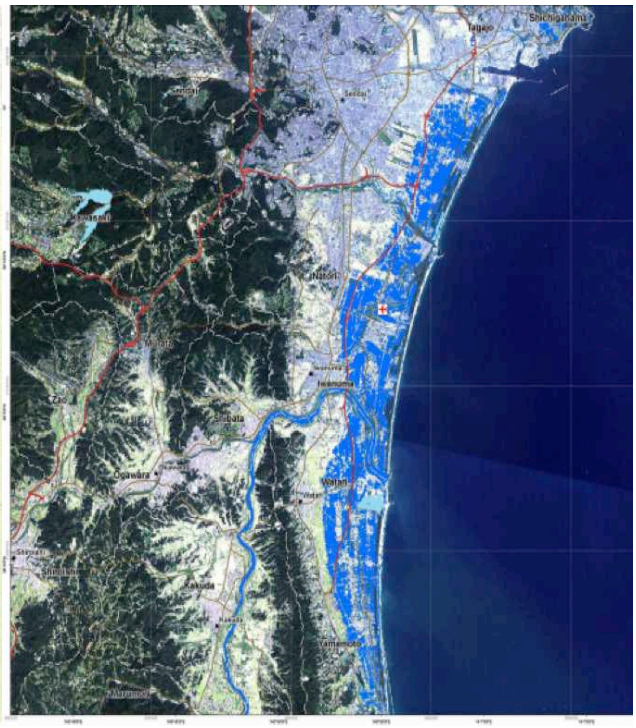
The tsunami inundated a total area of approximately 561 km$^2$ or 4.53% of the total territories of the six Northeastern prefectures of Honshu island [GIAJ, 2011]. The most affected was Miyagi prefecture where 16.3% of the territory was flooded by seawaters (Map 3 and Map 4).

**Map 3. Areas flooded by tsunami**




Source: JICA

**Map 4. Tsunami flooded areas of Sendai**



Source: U.S. Geological Survey

The earthquake and the tsunami caused a nuclear accident in one of the world's biggest nuclear power stations - the Fukushima Daiichi Nuclear Power Plant, Okuma and Futaba, Fukushima prefecture (Picture 1). The 14 meter high tsunami overwhelmed the plant's seawalls and damaged cooling systems and control rooms (Figure 1). Level 7 meltdowns occurred leading to releases of huge radioactivity into the environment [NISA, 2011].

According to the May 2012 nuclear power plant's estimates the cumulative radiation releases amounts 538.1 PBq of iodine-131, caesium-134 and caesium-137, out of which 520 PBq was released into the atmosphere between 12–31 March 2011 and 18.1 PBq into the ocean from 26 March – 30 September 2011 [TEPCO, 2012]. A total of 511 PBq of iodine-131 was released into both the atmosphere and the ocean, 13.5 PBq of caesium-134 and 13.6 PBq of caesium-137. Releases of other radioactive nuclides into air, groundwater and ocean such as strontium, plutonium-238, 239, 240, and 241 (120 GBq), and neptunium-239 (7.6 TBq) were also reported.

By November-December 2011 the emissions dropped from around 220 billion Bq immediately after the accident to 17 thousand Bq or about one-13 millionth the initial level.

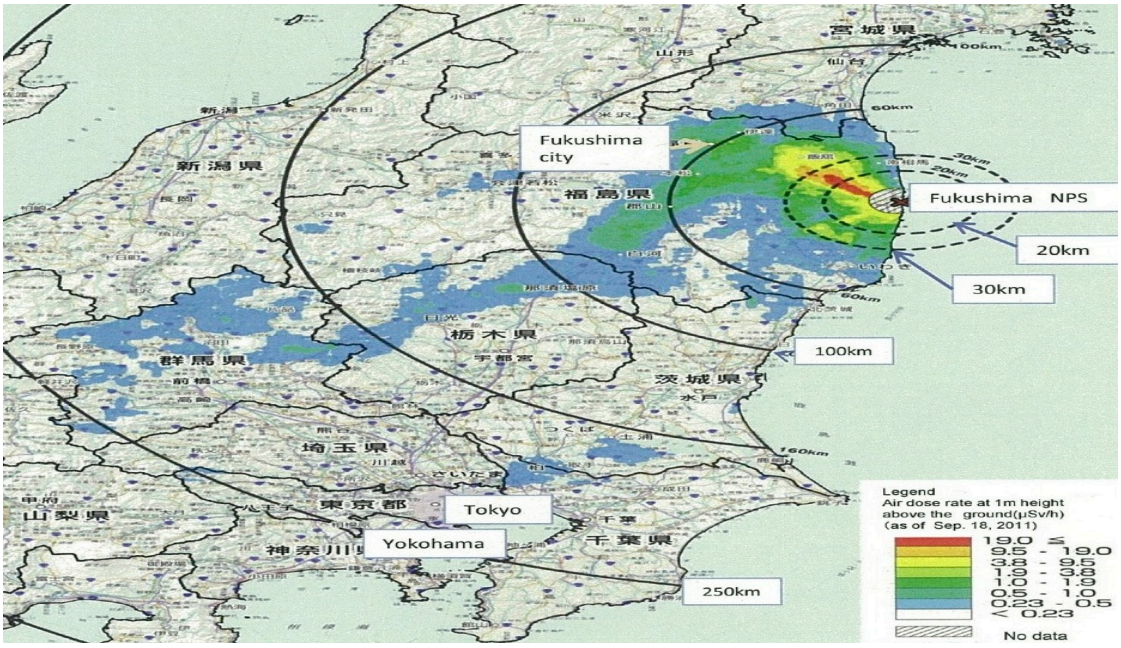
Since the accident there have been continued spills of contaminated water at the plant grounds and into the sea [TEPCO, 2013, 2014].

**Picture 1. Fukushima Daiichi Nuclear Plant**

Source: Tokyo Electric Power Company

Radioactive contamination from the nuclear plant has spread in the region and beyond though air, rains, dust, water circulations, wildlife, garbage disposals, transportation, and affected soils, waters, plants, animals, infrastructure, and population. High levels of radiation were detected in large areas surrounding the nuclear plant and beyond (Figure 3, Map 7). Besides, numerous anomalous "hot spots" have been discovered in areas far beyond the adjacent region [MEXT, 2012].

**Map 5. Radioactive pollution caused by Fukushima accident (September 18, 2011)**




Source: Ministry of Environment, 2014

The highest radioactive contamination has been within 20-30 km from the Fukushima nuclear power plant where the authorities have been implementing a 20 km (800 sq km) exclusion zone and other restricted areas since March 12, 2011.

Long-lived radioactive cesium have contaminated 30,000 sq km of the land surface of Japan while some 11,700 sq km is found to have radiation levels that exceeded Japan's allowable exposure rate of 1 mSV per year [MEXT, 2011].

The extent of radioactive contamination of air, waters and soils in Japan has been monitored and updating constantly [Nuclear Radiation Authority]. In Fukushima prefecture the radiation levels vary according to location (and even within the same locality because of numerous "hot spots"), it has been decreasing but it still higher than the levels before the disaster. In other prefectures the environmental radioactivity levels have been stable or decreased but mostly they are still higher than the period before the accident.

The March 2011 earthquake and resulting tsunami killed almost 15,900 people, injured more than 6100 and destroyed the lives of thousands more [National Police Agency, 2014]. The biggest number of victims is from Miyagi, Iwate and Fukushima prefectures where whole communities were wiped out by the powerful tsunami.

What is more, the official figure for disaster related deaths[2] has been growing reaching 3076 in 10 prefectures by the end of March 2014 [NHK World, May 6, 2014]. Many farmers from the affected areas and beyond who saw their businesses and livelihood destructed also suffered stress and anxiety [Murayama; Watanabe], and some took their lifes [The New York Times, March 29, 2011; CNN June 14, 2011].

Recent UN report pointed out that no deaths or serious illnesses have so far been reported from the radiation exposure from the nuclear accident. It concluded that no discernible increased incidence of radiation-related health effects (e.g. rate of cancer) are expected among exposed members of the public or their descendants" [The Japan News, April 3, 2014; NHK World, May 28, 2014].

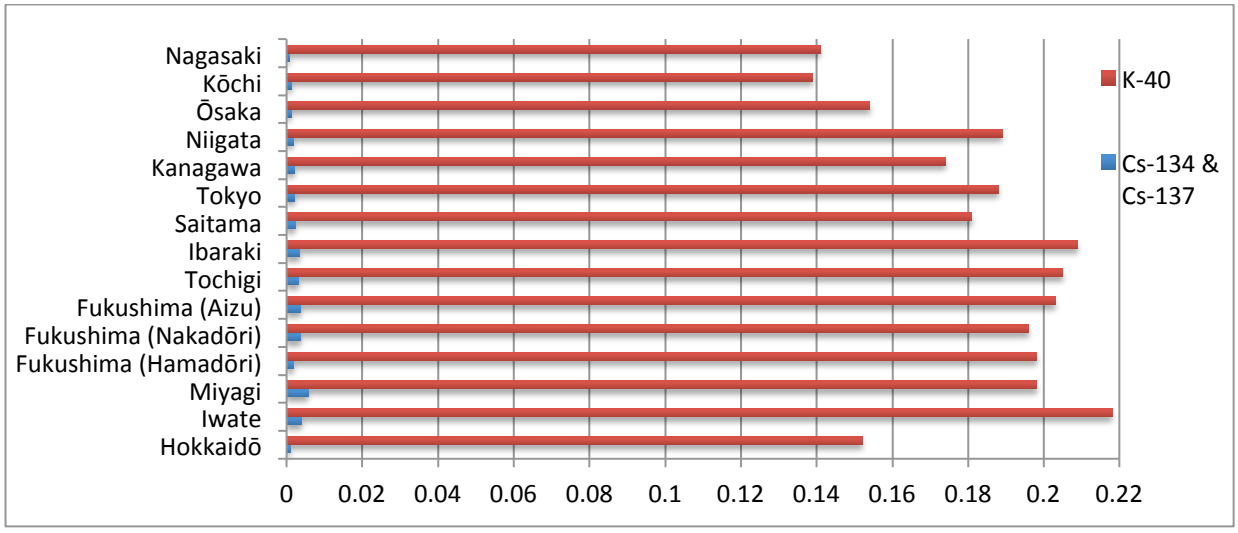
People living and working in different locations of affected regions have been exposed to diverse levels of radiation. For instance, surveys in most affected regions indicate that the annual radiation intakes from foods have been below 1 mSv/year and decreasing over time (Figure 2). In Fukushima prefecture (Nakadōri Area) the effective dose from radioactive cesium in foods has been decreasing constantly and it is less than 1% of the maximum allowed level (Figure 3).

According to large panel of experts the radiation uptake in such ranges is not harmful for the human health [MHLW]. Some publications demonstrate that the additional dose of Fukushima radionuclides received by consumers of Pacific Bluefin tuna for instance, can be estimated to result in two additional fatal cancer cases per 10,000,000 exposed people [Fisher et al., 2013].

What is more, it is believed that the health effects of the radiation release have been "primarily psychological rather than physical effects". Many consumers and producers alike "lose peace of mind" having food with (lower than official safety limit but nevertheless) radiation contamination.

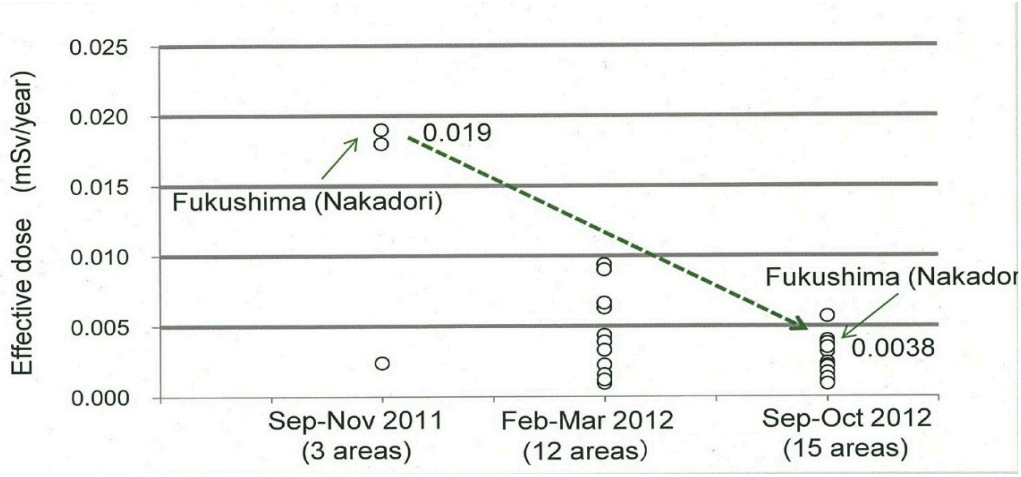
[2] include people who died as a result of having to change their environment and lifestyle, and live as evacuees away from home, family, business and community for a long period time.

**Figure 2. Estimation on annual dietary intake of radionuclides for September-October 2012 in Japan (mSv/year)**




Source: Ministry of Health, Labor and Welfare

**Figure 3. Evolution of effective dose from Cs-134 and Cs-137 in foods in Nakadori area of Fukushima**




Source: Ministry of Health, Labor and Welfare

Furthermore, people who have been evacuated have suffered from depression and other mental health effects [Brumfiel, 2013]. A survey indicates that 68% of evacuated households in Fukushima prefecture have one or more members with health problems such as lack of sleep or depression [NHK World, April 30, 2014].

The earthquake, tsunami and the nuclear accident caused a large evacuation involving some 470,000 (third day after the earthquake) and over 320,000 displaced persons on a longer-term basis [Reconstruction Agency, 2014]. The greatest number of evacuees and stranded persons were from Miyagi, Fukushima and Iwate prefectures where they accounted for 8.37%, 6.3% and 4.39% of the entire population.

On April 22, 2011, Fukushima Prefecture was divided into following areas (Map 6):

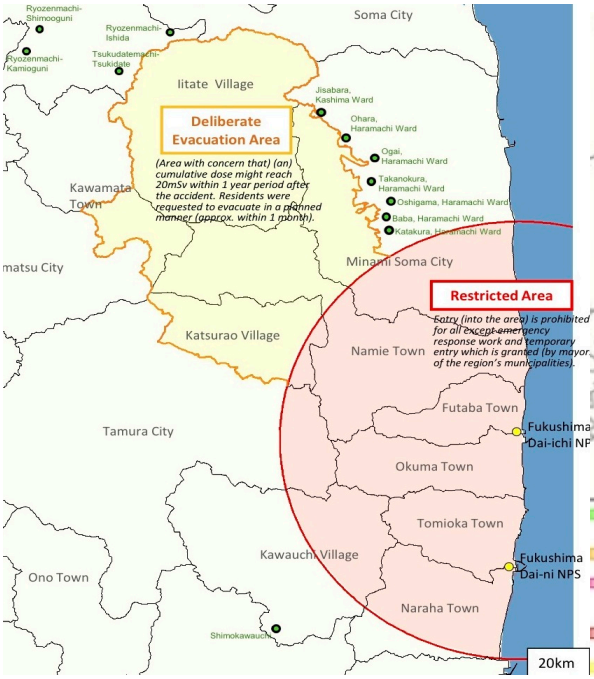
1) Restricted Area in 20 km radius around nuclear plant where entry is prohibited excluding those engaged in emergency response.

2) Deliberate Evacuation Area other than Restricted Area, where annual cumulative radiation dose was expected to reach 20 mSv per year. Overnight stay is prohibited but it is permitted to pass through, or to commute to workplace whose continued operation is approved by local administrators.

3) Evacuation prepared areas in case of emergency[3] - 20-30 km radius from Fukushima Daiichi Nuclear Power Plant where certain groups (pregnant women, with special needs) are not permitted.

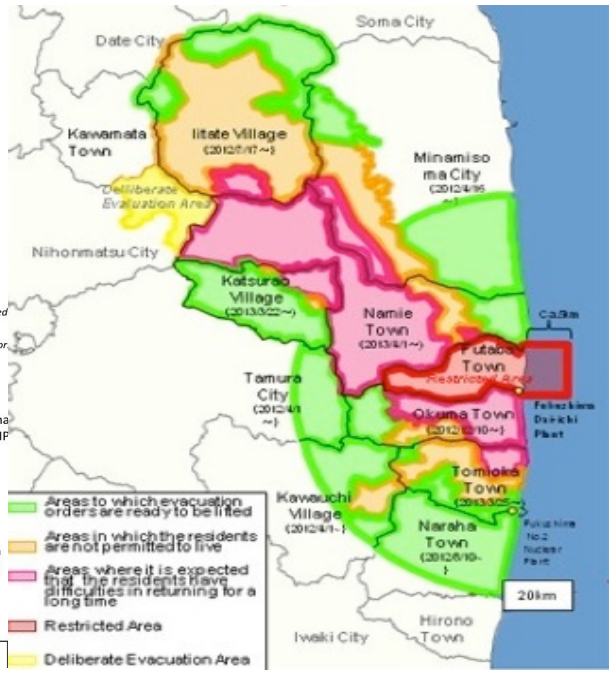
4) Specific Spots Recommended for Evacuation - sites with a cumulative dose of 20 mSv/y and above.

**Map 6. Restricted, Deliberate evacuation, and Specific spots areas (September 30, 2011)**




Source: Ministry of Economy, Trade and Industry, 2011

**Map 7. Present status of evacuation and restricted areas (March 30, 2014)[4]**




Source: Reconstruction Agency, 2014

In the end of 2011 the government decided to rearrange the areas to which evacuation orders have been issued into following categories (Map 7):

1) Areas to which evacuation orders are ready to be lifted - it is confirmed that the annual integral dose of radiation will definitely be below 20mSv. People can pass through the areas along main roads, return home temporarily (staying overnight is prohibited), and enter

[3] Lifted on September 30, 2011.

[4] On April 1, 2014 the evacuation order for a portion of Miyakoji District, Tamura City was lifted, which was the first complete lifting in the initial "no go zone" within a 20-km from the nuclear plant. On October 2014 the government lifted its evacuation advisory for the bulk of Kawauchi village within 20 km of the nuclear plant. The status of western part of the village also changed to a zone preparing for lifting of evacuation advisory.

the areas for the purpose of public benefit. They can also resume businesses such as manufacturing and conduct related maintenance, repair, or transport activities. Resuming farming depends on the degree of limitation on rice planting and the extent to which radiation has been removed from the ground. For hospitals, welfare facilities, or shops, work is limited to that for preparation for resuming businesses. People are not required in principle to take or carry out protection measures, such as screening or measures to control the radiation dose when they enter the areas temporarily.

2) Areas in which residents are not permitted to live – the annual integral dose of radiation is expected to be 20 mSv or more. People can temporarily return home in the areas (but staying overnight is prohibited), pass through the areas along main roads, and enter the areas for the purpose of public benefit, such as for repairing the infrastructure or conducting disaster prevention-related work. Entry is not recommended but allowed during daytime.

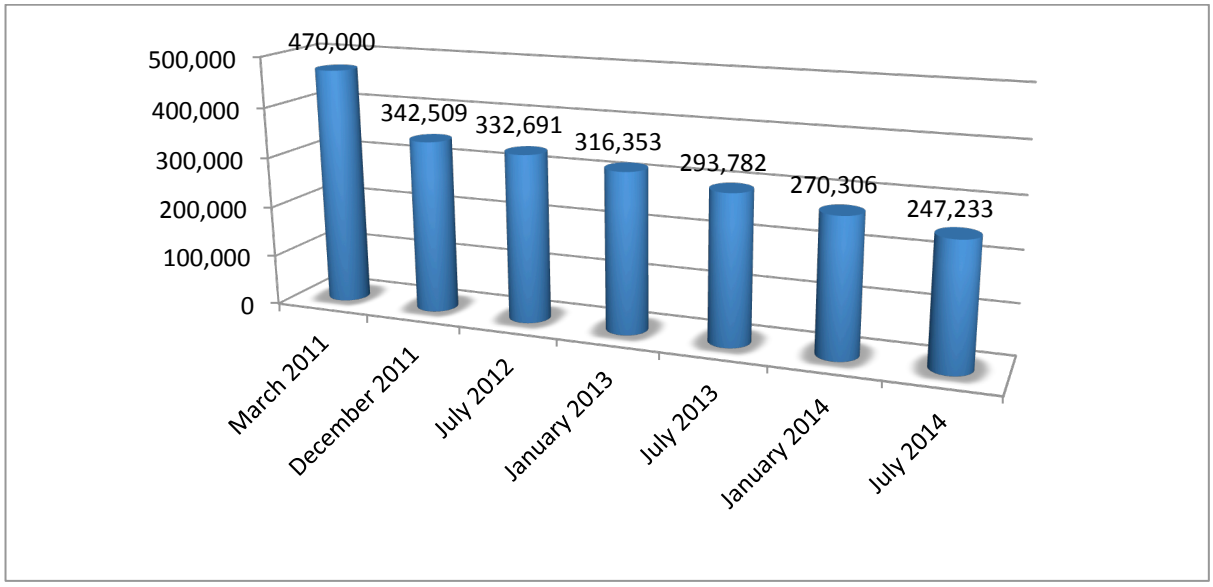
3) No entry areas - the annual integral dose of radiation is expected to be 20 mSv or more within five years and the current integral dose of radiation per year is 50 mSv or more. People are legally required to evacuate from the areas, for which physical barriers to entry such as barricades are placed at the boundaries of the area. People may temporarily return home to meet domestic needs and requirements as far as possible, while those who are in charge thoroughly screen people for radiation, control individual doses of radiation, and require the people entering the zone to wear protective gear.

4) Restricted area – 20 km radius from the Fukushima plant (other than areas 1, 2, 3).

5) Specific spots recommended for evacuation.

There are still more than 247,000 evacuated people[5] living in temporary housing and other makeshift facilities nationwide (Figure 4). What is more, a significant number of them live outside home prefectures – incuding 47,149 former Fukushima residents, 6,974 from Miyagi, and 1,513 from Iwate prefectures.

**Figure 4. Evolution of number of evacuees in post disaster years**




Source: Reconstruction Agency, National Police Unit

[5] 127,000 Fukushima prefecture residents, incuding 101,000 from the "Evacuation Order Area.

Major reasons for the slow progress of reconstruction and returning back of the evacuees have been: a slow pace of decontamination of lands, existing hotspots and restricted mobility in evacuated areas, difficulties of land acquisition for building cites, series difficulties in safe disposal of contaminated soil and debris, population fears regarding radiation hazards, lack of job opportunities, unrestored major services and infrastructure, problems for attracting bids from contractors, spikes in construction material prices and manpower shortages, absence of communities consensus for certain projects, uncertainty for future developments, etc. [The Japan News, March 4, March 11, April 3, April 4 and April 11, 2014; Hasegawa, 2013; Matanle, 2012; NHK World, March 11, May 8, May 29, 2014].

The March 2011 earthquake, tsunami and nuclear accident have caused immense damages in North-eastern Japan and beyond. The latest figure shows that 1,220,360 buildings in 20 prefectures have been damaged from the earthquake and tsunami, out of which 10.43% totally collapsed, 22.35% half destroyed, and the rest partially damaged, flooded or burned down [National Police Agency, 2014]. In addition, there were reports for numerous damaged roads, bridges, dikes, railways and landslides in 14 prefectures. The biggest property damages have been registered in Miyagi, Fukushima, Ibaraki, and Iwate prefectures.

The triple disaster has cased destruction of many businesses, which incurred big direct and indirect losses in certain sectors (manufacturing, energy, transport, agri-food etc.) and supply chains in Japan and worldwide [Fujita *et al.* 2012; Government of Japan, 2012; OECD, 2013; UFJ, 2011].

Furthermore, enormous amount of rubble and debris have been created by the earthquake and tsunami. In affected 239 municipalities of 13 prefectures the total amount of disaster debris is estimated to be about 20 million tons and tsunami deposits around 10 million tons [Reconstruction Agency, 2014].

What is more, the nuclear accident has contaminated huge areas of lands, property infrastructure, and debris in Fukushima and neighboring prefectures (Map 8). Heavily contaminated areas are located in 101 municipalities of 8 prefectures, and divided into: "Special Decontamination Area" (overlapping with Evacuation Order Area), where decontamination and waste management is done by the Government, and "Intensive Contamination Survey Area", overseen by local municipalities.

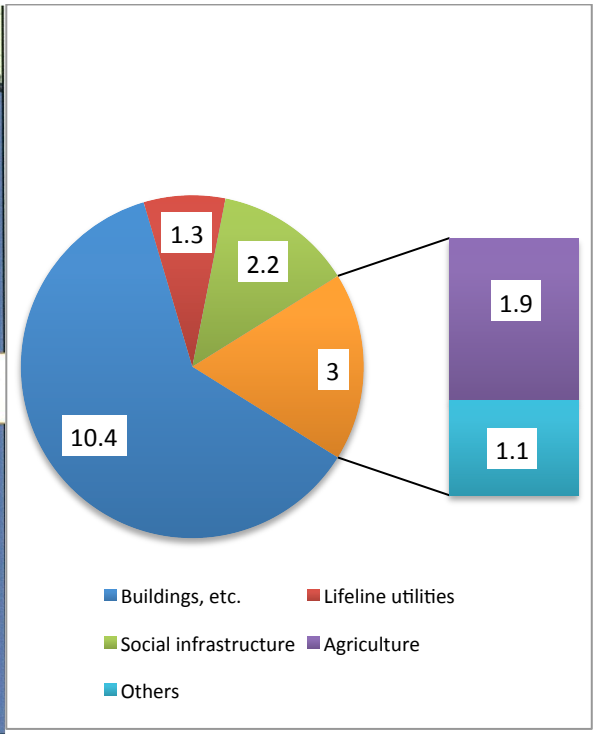
The initial official estimate for the direct economic losses from the March 2011 disaster was about 16.9 trillion yen ($210 billion USD) or 4% of the Gross Domestic Product of Japan (Figure 5). The greatest share of damages (61.5%) was for "Buildings, etc. (Housing, offices, plants, machinery, etc.)", followed by "Others (including agriculture, forestry and fisheries)" (17.7%), "Social infrastructure (river, road, harbors, drainage, and airport, etc.)" (13%) and "Lifeline utilities (water service, gas, electricity, and communication and broadcasting facilities" (7.7%). Anticipated damage in the sector "Agriculture" accounted for 11.24% of the total amount.

In March 2011 the Index of Industrial Production in the country and the most affected areas dropped considerably (Figure 6). Most of the damages have been concentrated in Fukushima, Iwate, and Miyagi prefectures where there was a significant destruction of the basic infrastructure and the economic activity [National Institute for Research Advancement, 2013].

**Map 8. Special decontamination (red) and Intensive contamination (yellow) areas**


Source: Ministry of Environment, 2014

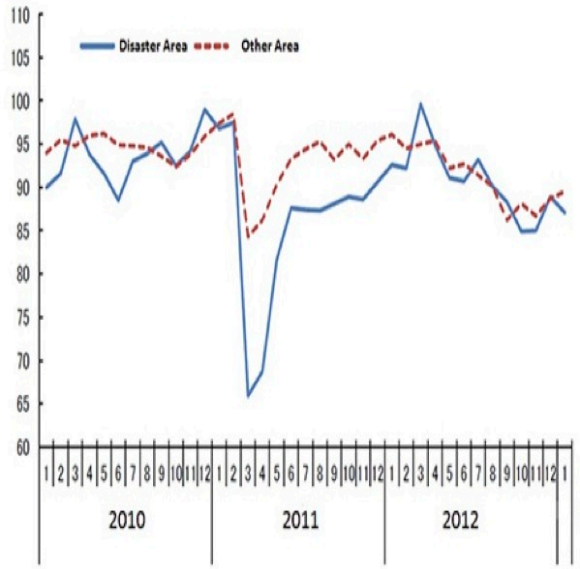
**Figure 5. Estimated economic damages of the March 2011 earthquake (trillion yens)**




Source: Cabinet Office of Japan, June 24, 2011

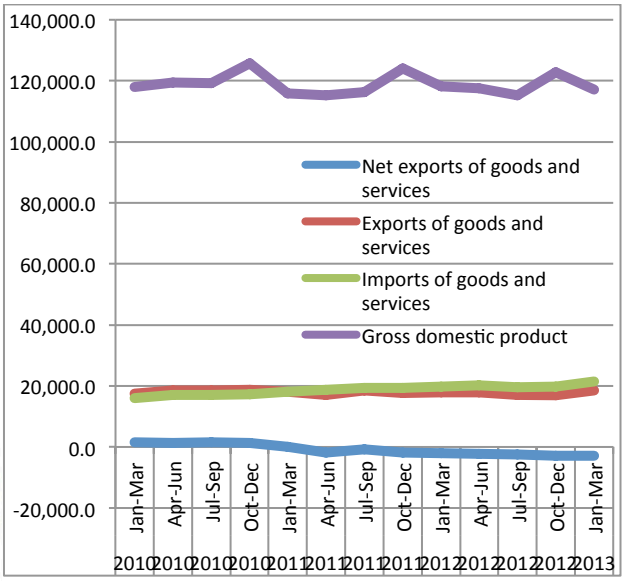
Macroeconomic impact of the March 2011 disaster has been also significant (Figure 7). Country's real Gross Domestic Product contracted almost 4% during January-March 2011 (comparing to 2010), and Japan has been experiencing a trade deficit as a result of the increased import.

**Figure 6. Index of industrial production**




Source: Reconstruction Agency, 2014

**Figure 7. Evolution of GDP, export and import**




Source: Statistics Bureau, MIAC, 2014

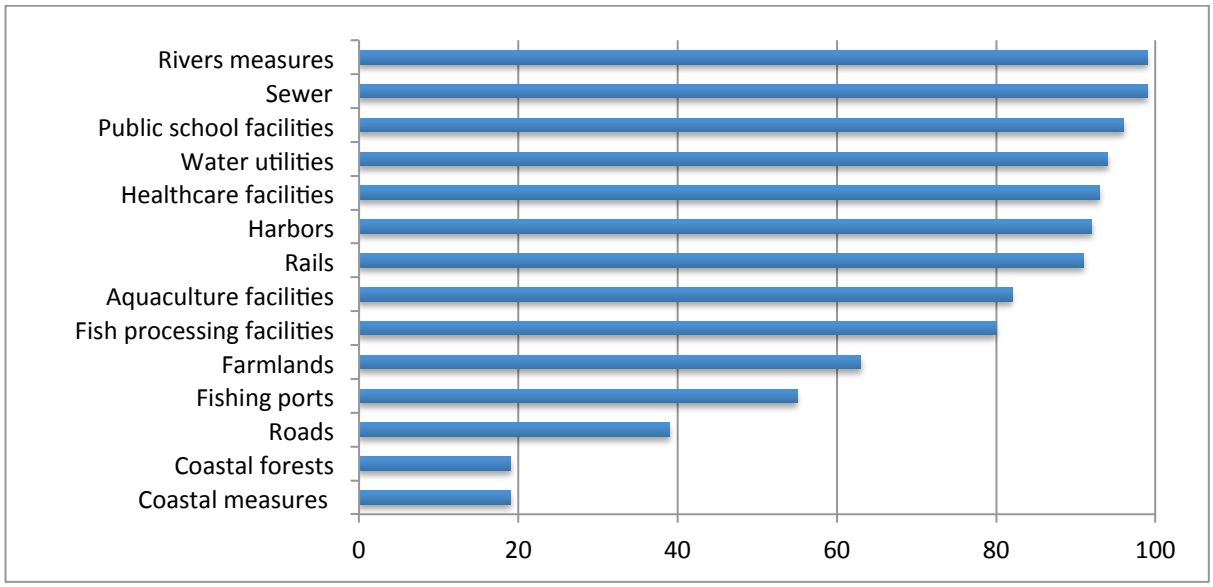
The share in Japan's GDP and population of Tohoku region and the three most affected prefectures is small - 8% and 4% accordingly [Statistics Bureau, 2012]. Besides, the disaster created a big demand for jobs, incentives for investments, and potential for economic growth associated with the recovery and reconstruction businesses (relief, rebuilding, decontamination, innovation etc.).

There has been also a huge government budget for recovery, reconstructions, compensations and development. Following the disaster, the Government approved two supplementary budgets of 6.14 trillion yens for relief and recovery, and launched a ten-year reconstruction program (for Fukushima, Miyagi and Iwate prefectures) of 25 trillion yens for the period 2011-2015 [Government of Japan, 2012; Reconstruction Agency, 2014].

Subsequently, there has been a a sizeable or complete recovery of damaged lifeline infrastructure in the months after the disaster – e.g. 96% of Electricity, 86% of Gas, 95% of LP Gas, 99% of Fixed line and Wireless phones, 100% of Mail delivery and Gas stations (as of October 2012), 98% of Water and 90% of healthcare facilities (as of March 2012) and 92% of public school facilities (as of March 2013) [Reconstruction Agency, 2014].

Similarly, there has been substantial progress in recovery and reconstruction of long-term infrastructures such as land, transportation networks, utilities, fish processing facilities, etc. (Figure 8).

**Figure 8. State of full-scale recovery and reconstruction of public infrastructure after Great East Japan Earthquake (July, 2014)***



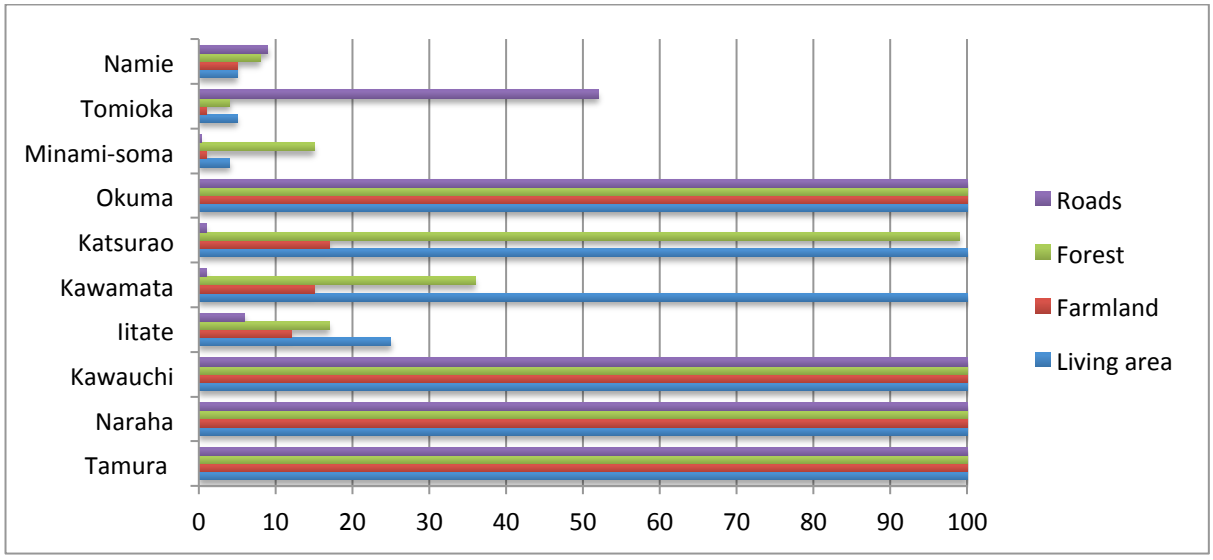

*farmland, healthcare, school, fish processing facilities (Mar 2014), Aquaculture facilities (Dec. 2012)
Source: Reconstruction Agency, 2014

In the three most affected prefectures there has been aunlike speed in the infrastructure recovery by individual cities, towns and villages [NIRA, 2013]. The later have been mostly associated with differences in the recovery of rail systems, treatment of debris, education and medical care.

For instance, in the Special Decontamination Area the progress of implementation of planned decontamination work differ substantially (Figure 9). Similarly, there is a

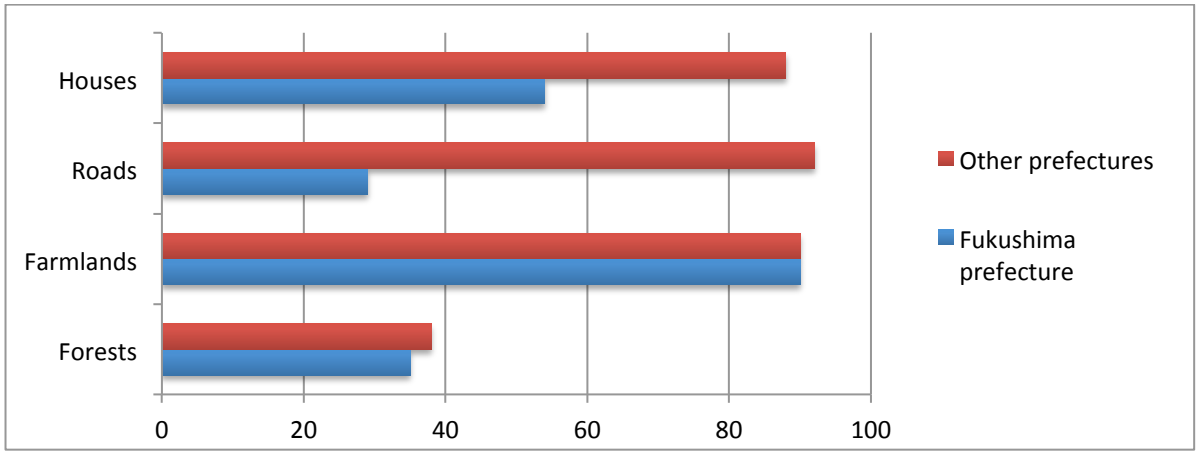
considerable difference in the progress of decontamination in Municipality Decontamination Areas[6] in Fukushima and other prefectures (Figure 10). Furthermore, while the decontamination of public facilities (administration facilities, schools, parks and sport facilities, etc.) has been entirely or largely completed reaching the end of full decontamination will likely take few more years [Reconstruction Agency, 2014].

**Figure 9. Progress in implementation of decontamination work in Special Decontamination Area by September 30, 2014 (per cent)**




Source: Ministry of Environment

**Figure 10. Progress of decontamination of Municipality Decontaminated Areas, as of March 2014 (percent)**



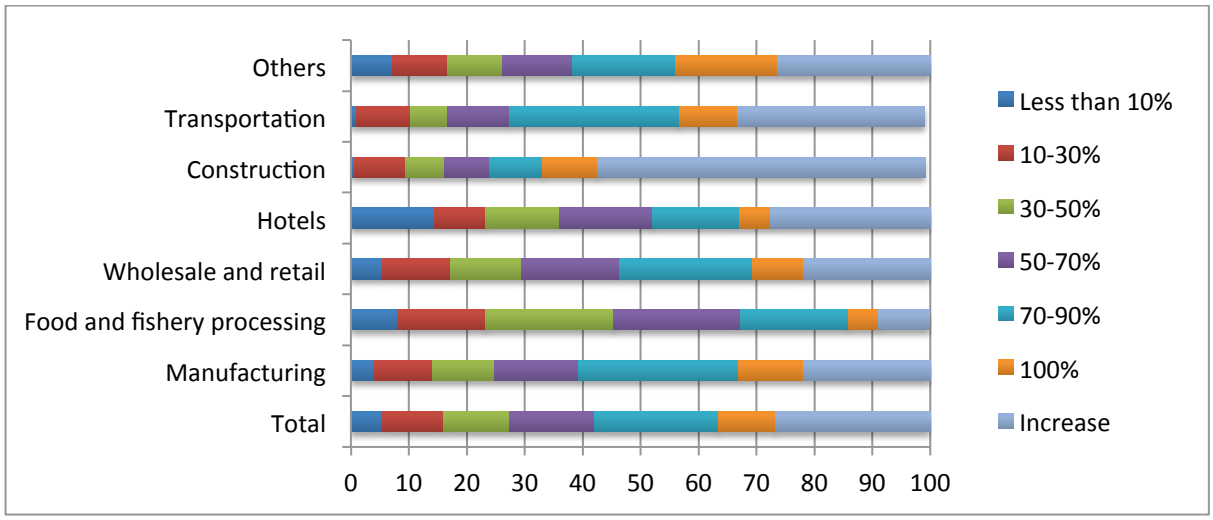

Source: Reconstruction Agency, 2014

There has been a constant recovery of sales of all industries in most affected prefectures (Figure 11), with a positive employment trend and ratio of job offers to jobseekers consistently higher than the national average since early 2012 [Reconstruction Agency, 2014]. However, the rate of post-disaster recovery has not bee similar in all sectors of affected

[6] responsibility of 94 municipalities in 8 prefectures [Reconstruction Agency, 2014].

industry. There is a fast and above pre-disaster recovery of construction industry. On the other hand, the recovery in wholesale, service, and food processing industries has been slower.

**Figure 11. Percent of sales recovery comparing to pre-disaster state in "Group subsidy recipients", July 2013**




Source: Reconstruction Agency, 2014

In Fukushima prefecture the overall progress has been lagging behind with regard to the recovery of economic activity, including production, consumption, and distribution (NIRA, 2013).

Furthermore, there has been a boom in technological innovations and the new sectors such as energy saving, renewable (solar, wind, biofuel) energy, nuclear safety, debris cleaning, processing and disposal, research and development, robotics, ITC, no-soil and solar sharing farming etc. with huge investments of leading players, numerous new comers, joint ventures, etc. [Asiaone News, June 26, 2013; JETRO, 2013; NHK World, June 12, 2012, June 30, July 8, July 25, 2014; The Japan Times, March 23, 2014].

The process of reconstructions has been associated with number of challenges such as: failure for timely evacuation from certain areas, slow response of authorities, lack of sufficient public information in the first stages of disasters, mistrust to public and private institutions, multiple displacements of many evacuees, divided communities and families, bad communication between different organizations, lack of financial resources, insufficient manpower and building materials, ineffective use of public funds, emotional conflicts between evacuees, insufficient and unequal compensation, substandard labor conditions for decontamination workers, increased number of criminal cases, numerous lawsuits against TEPCO and authorities, increasing costs and difficulties associated with decontamination and nuclear plant decommissioning, problems in finding temporary and permanent cites for storing radioactive waste, shortages of eclectic power, increasing energy supply costs, revisions in national energy, disaster prevention etc. policies, etc. . [Akiyama et al. 2012; Fukushima Minpo News, February 17, March 13, 2014; Hasegawa, 2013; The Japan News, March 4, March 6, March 11, March 12, March 27, April 4, 2014; The Japan Times, March 13, 2014; NHK World, March 13, June 12, 2014; Manoliu, 2014].

## III. Affected farms and agricultural resources

There have been a huge number of destructed agricultural communities, farms, and agricultural lands and properties from the March 2011 disasters (Picture 2).

**Picture 2. Minamisanriki (Shizugawa Ward) before and after 2011 tsunami**

Source: Tohoku Chiikizukuri

The total number of damaged Agricultural Management Entities[7] of different type (private farms, corporate entities, cooperatives, local public bodies, etc.) reached 37,700 or around 16% of all Agricultural Management Entities in the affected eight prefectures (Table 1).

The greatest part of damaged farms (45.6%) was in Fukushima prefectures where more than a third of farms were hurt by the earthquake, tsunami, or nuclear accident. The affected Agricultural Management Entities in Nagano, Nigata, Iwate and Miyagi prefectures also comprised a good portion of all entities in these prefectures.

Tsunami affected adversely almost 5% of all farms of the six coastal prefectures. Tsunami damaged Agricultural Management Entities account for about 27% of all damaged by the disasters entities (Table 14). The majority of the tsunami-damaged farms are located in Miyagi (59.4%) and Fukushima (26.9%) prefectures.

Reported area of agricultural land damaged by the 2011 disasters in the six coastal and six inland prefectures is around 24,500 ha (Table 2). More than 98% of the damaged agricultural lands were in the coastal regions. The mostly hit farmlands were in Miyagi and Fukushima, which represent accordingly 60.6% and 24.7% of the damaged agricultural lands in the coastal areas. Affected by the disasters farmlands in Miyagi and Fukushima prefectures amount almost to 11% and 4% of the total agricultural land in these prefectures.

[7] defined as entities engaged in or entrusted to conduct (consigned) agriculture production activities where the area and number of feed livestock of the production or operation are above a certain size - 30 ares of managed cultivated land; 15 ares of planted land for fields vegetables; 350 square meters of planted land for vegetables in facilities; 10 ares of planted land for fruits trees; 10 ares of planted land for fields flowers and ornamental plants; 250 square meters of lanted land for flowers and ornamental plants in facility; 1 milking cow; 1 fattening cattle; 15 pigs; 150 layers; 1000 broiler chickens shipped in a year; total sales of 500,000 yen of agricultural products [MAFF].

**Table 1. Number of damaged Agricultural Management Entities by 2011 earthquake (March 11, 2012)**

| Prefectures | Total number of Agricultural management entities* | Damaged agricultural entities | | Entities damaged by tsunami | |
|---|---|---|---|---|---|
| | | Number | Share, % | Number | Share, % |
| Aomori | 3,733 | 180 | 4.8 | 170 | 4.6 |
| Iwate | 35,321 | 7,700 | 21.8 | 480 | 1.4 |
| Miyagi | 47,574 | 7,290 | 15.3 | 6,060 | 12.7 |
| Fukushima | 50,945 | 17,200 | 33.8 | 2,850 | 5.6 |
| Ibaraki | 56,537 | 1,430 | 2.5 | 180 | 0.3 |
| Tochigi | 25,010 | 1,330 | 5.3 | - | - |
| Chiba | 17,224 | 1,220 | 7.1 | 430 | 2.5 |
| Nigata | 5,311 | 1,190 | 22.4 | - | - |
| Nagano | 312 | 210 | 67.3 | - | - |
| Total | 241,967 | 37,700 | 15.6 | 10,200 | 4.2 |

Source: Ministry of Agriculture, Forestry and Fisheries *subject to status confirmation

**Table 2. Area of damaged agricultural land by the 2011 earthquake (March 11, 2012)**

| Prefectures | Damaged agricultural land* | | Tsunami damaged agricultural land | | Share of completely restored agricultural land (%) | Share of restored tsunami damaged land (%) |
|---|---|---|---|---|---|---|
| | Area (ha) | % in total cultivated land | Area (ha) | % in damaged land | | |
| Aomori | 107 | 0.1 | 77 | 72 | 94.4 | 92.2 |
| Iwate | 1,209 | 0.8 | 725 | 60 | 22.2 | 3.9 |
| Miyagi | 14,558 | 10.7 | 14,341 | 98.5 | 33.3 | 32.5 |
| Fukushima | 5,927 | 3.9 | 5,462 | 92.1 | 9.3 | 4.1 |
| Ibaraki | 1,063 | 0.6 | 208 | 19.6 | 90.1 | 97.1 |
| Chiba | 1,162 | 0.9 | 663 | 57.1 | 100.0 | 100 |
| Total coastal | 24,026 | 2.7 | 21,476 | 89.4 | 32.9 | 27.3 |
| Yamagata | 1 | 0.0 | - | 0 | 100.0 | - |
| Tochigi | 198 | 0.1 | - | 0 | 98.0 | - |
| Gunma | 1 | 0.0 | - | 0 | 100.0 | - |
| Saitama | 39 | 0.0 | - | 0 | 100.0 | - |
| Niigata | 117 | 0.1 | - | 0 | 73.5 | - |
| Nagano | 95 | 0.1 | - | 0 | 69.5 | - |
| Total inland | 451 | 0.1 | - | 0 | 85.8 | - |
| Total | 24,477 | 1.6 | 21,476 | 87.7 | 33.8 | 27.3 |

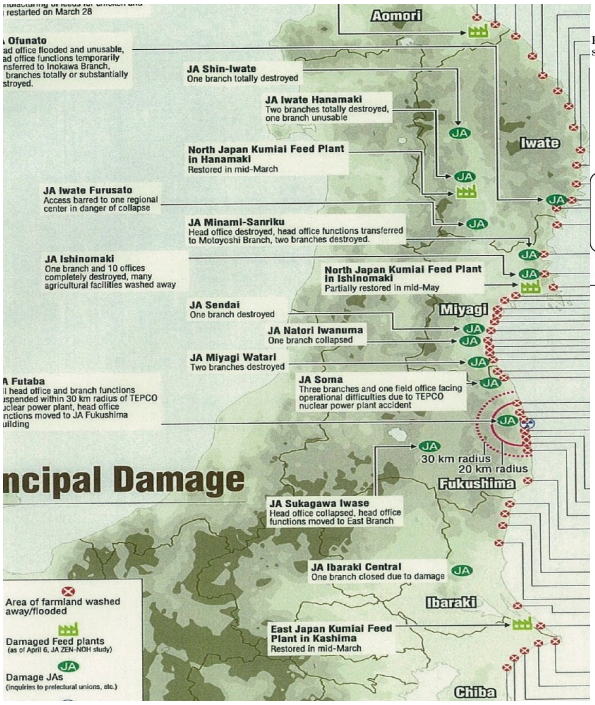
*includes tsunami-damaged land (to be restored) in Reconstruction Master Plan for Agriculture and Farming Villages), and other damaged land due to cracks, liquefaction, burial, sediment inflow, etc. as well as minimal tsunami-damaged land not included in Master Plan

Source: Ministry of Agriculture, Forestry and Fisheries

The tsunami damaged agricultural land account for more than 89% of the damaged farmland in coastal regions and the greatest portion of the damaged land in all but Ibaraki prefectures. Badly hit were 48 municipalities of the six Northeastern prefectures of the country (Map 9). Particularly huge areas of farmland were washed or flooded by tsunami in Minami-Soma city (2,722 ha), Watari town (2,711 ha), Yamamoto town (1,595 ha), and Soma

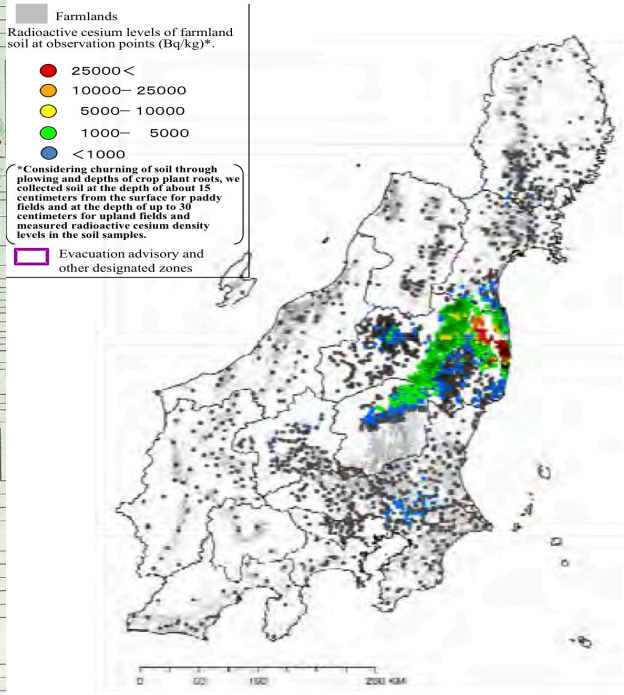
city (1,311 ha) of Fukushima prefecture, Sendai city (2,681 ha), Ishinomaki city (2,107 ha), Natori city (1,561 ha), Higashi-Matsushima city (1,495 ha), and Imanuma city (1,206 ha) of Miyagi prefecture, and Kasennuma city (1,032 ha) of Iwate prefecture [MAFF, 2014].

**Map 9. JA damages from 2011 disasters**




Source: JA ZENCHU, 2011

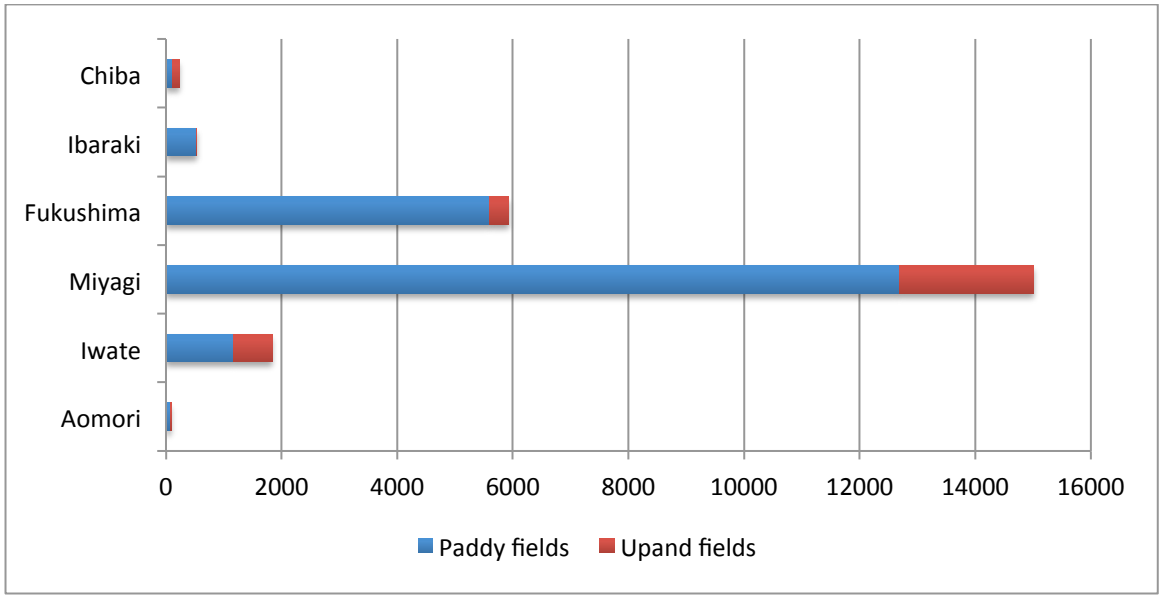
**Map 10. Farmland soil radiation (Mar. 23, 2012)**




Source: MAFF, 2012

More than 85% of the washed away or flooded by the tsunami farmlands were paddy fields (Figure 12). In most affected Miyagi and Fukushima prefectures the destroyed by the tsunami paddy fields accounted for 11.5% and 5.3% of all paddy fields in these prefectures.

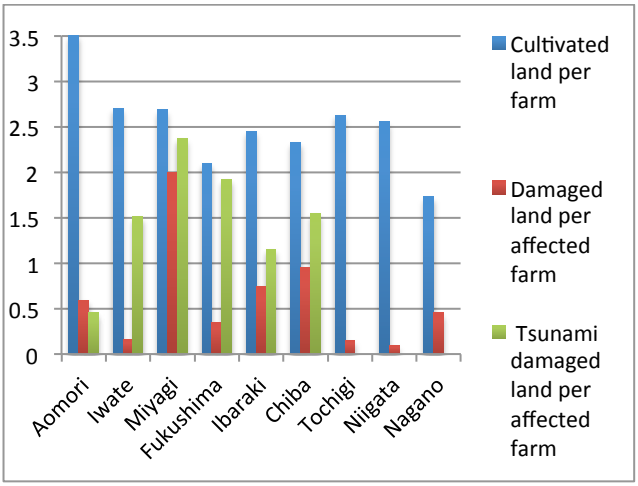
**Figure 12. Areas of farmlands washed away or flooded by March 2011 tsunami (ha)**




Source: Ministry of Agriculture, Forestry and Fisheries

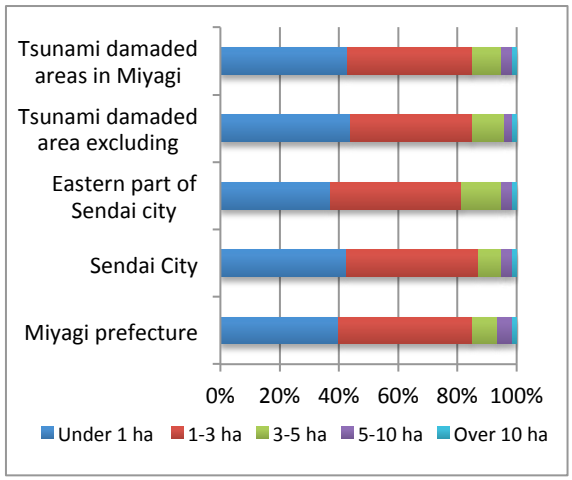
The average farms size in the affected by the 2011 disasters regions is 2.51 ha[8]. The average damaged-land per affected Agricultural Management Entities comprises a considerable portion of the average agricultural land under farm management in Miyagi, Chiba and Ibaraki prefectures (Figure 13). What is more, the average tsunami-damaged land per affected Agricultural Management Entities represents a significant part of the average farm size in all costal prefectures ranging from 12% (Aomori) up to 92% (Fukushima). Therefore, the 2011 disaster has enormously damaged the farmland, production capability and the entire economy of the (most) affected farms.

**Figure 13. Size of farms, damaged land and tsunami damaged land per affected AME in disaster regions (ha)**




Source: Ministry of Agriculture, Forestry and Fisheries

**Figure 14. Size of agricultural holdings in tsunami-damaged areas in Miyagi prefecture**




Source: Fuyuki 2013

The later is also confirmed by the detailed classification of the agricultural holdings in different parts of the most tsunami-damaged Miyagi prefecture where a significant portion of them are up to 1 ha and the majority bellow 3 ha (Figure 14).

In the three most strongly hit prefectures two-third of municipalities (85) has been damaged by the 2011 disaster, including 41.9% of them tsunami damaged [MAFF, 2014]. The biggest number of damaged municipalities has been in Fukushima prefecture (34, including 10 tsunami-damaged), followed by Miyagi (31, including 15 tsunami-damaged) and Iwate (20, including 11 tsunami-damaged).

According to the recent data almost 56% of the traditional agricultural hamlets[9] in Miyagi prefecture have been damaged by the March 2011 disasters, including 20.1% tsunami-damaged [MAFF, February 2014]. Particularly severely have been hit Tagajo, Higashimatsushima, Kawasaki-cho, Yamamoto-cho, Matsushima-machi, Shichigahama town, Rifu-cho, Yamato-cho, Osato-cho, Tomiya Town, Ohira village and Onagawa, where every one of the agricultural communities has been damaged by the disasters.

In other two most affected prefectures Iwate and Fukushima the share of damaged traditional agricultural hamlets is 35.8% and 27,7%, including 7.4% and 4.1% tsunami-

[8] including both unaffected and damaged Agricultural Management Entities.

[9] Shuraku – this is ancient agricultural community organization still vital in Japan. In the three most affected prefectures there are 10,737 agricultural hamlets, including 3,652 in Iwate, 2,797 in Miyagi and 4,288 in Fukushima [MAFF, 2014].

damaged. Harshly affected by the disasters have been Fukushima's Kagamiishi Town, Izumizaki village, Nakajima Village, Yabuki-machi, Naraha Town, Tomioka, Kawauchi Village, Okuma-machi, Futaba-cho, Namie-machi, Katsurao Village and Iitate, where each agricultural community has been damaged.

There have been registered damages in 36,092 places including: damaged agricultural land in 18,186 areas, damaged agricultural facilities (mainly storage reservoirs, drains, pumps, shore protection facilities for agricultural land) in 17,317 points, damaged coastal protection facilities for agricultural land in 139 points, and damaged facilities for daily life in farming villages (mainly community sewerage) in 450 points [MAFF, 2014]. For instance, type and locations of the principle damages for the Agricultural Cooperatives are shown on Map 9.

The biggest number of places with damaged lands was registered in Iwate (73.9%), Fukushima 10%) and Miyagi (8.3%) prefectures [MAFF, 2014]. The number of points with damaged agricultural facilities etc. was biggest in Miyagi (27.7% of total), Fukushima (22%), Iwate (21.4%), Chiba (13%) and Ibaraki (10.6%) prefectures; with damaged coastal farmland protection facilities in Miyagi (74.1%), Fukushima (14.4%) and Iwate (10.8%) prefectures; and with damaged rural community facilities in Fukushima (31.8%), Miyagi (24.1%), Ibaraki (21.7%) and Iwate (9.3%) prefectures.

Furthermore, there has been radioactive contamination of farmlands from the nuclear accident's fallout (Map 10). Recent survey in the most affected regions shows that contamination with cesium of paddy fields ranges from 67 up to 41,400 Bq/kg and other lands (arable, meadows, permanent crops) from 16 to 56,600 Bq/kg (Table 3). Most heavily contaminated farmlands are in Fukushima prefecture where 3.6% of all samples (including 4% of the paddy fields and 2.9% of other lands) are above 5000 Bq/kg.

**Table 3. Share of contaminated with Cs farmlands, as of December 28, 2012 (percent)**

| Prefectures | Paddy fields | | | | | Other farmlands | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | range (Bq/kg) | 0-500 | 500-1000 | 1000-5000 | > 5000 | range (Bq/kg) | 0-500 | 500-1000 | 1000-5000 | > 5000 |
| Miyagi | 72-1,310 | 61.9 | 28.6 | 9.5 | 0 | 110-860 | 50 | 50 | 0 | 0 |
| Fukushima | 50-41,400 | 39 | 16.1 | 40.8 | 4 | 40-56,600 | 34.3 | 21.2 | 41.6 | 2.9 |
| Ibaraki | | 0 | 0 | 0 | 0 | 230-560 | 50 | 50 | 0 | 0 |
| Tochigi | 110-1,040 | 50 | 41.7 | 8.3 | 0 | 62-2,630 | 66.7 | 11.1 | 22.22 | 0 |
| Gunma | 85-170 | 100 | 0 | 0 | 0 | 49-560 | 95 | 5 | 0 | 0 |
| Chiba | 67-120 | 100 | 0 | 0 | 0 | < 16-190 | 100 | 0 | 0 | 0 |
| Total | 67-41,400 | 43.2 | 17.8 | 35.6 | 3.4 | 16-56,600 | 46.2 | 19.2 | 32.4 | 2.2 |

Source: Ministry of Agriculture, Forestry and Fisheries

There has been also enormous destruction of livestock, fruit trees and crops in affected by the disasters regions. The total crop and livestock damages from the 2011 earthquake are estimated to worth 14.2 billion yen [MAFF, 2012]. In Aomori, Iwate and Miyagi prefectures alone the registered livestock damages include 187 dairy heads (171 drowned and 16 crushed or starved), 458 beef cattle (466 drowned and 12 crushed or starved), 5,850 hogs (4,037 drowned and 1,813 crushed or starved), and 4,549,620 poultry (174,800 drowned and 4,374820 crushed or starved) [Tohoku Agricultural Administration Office, 2011].

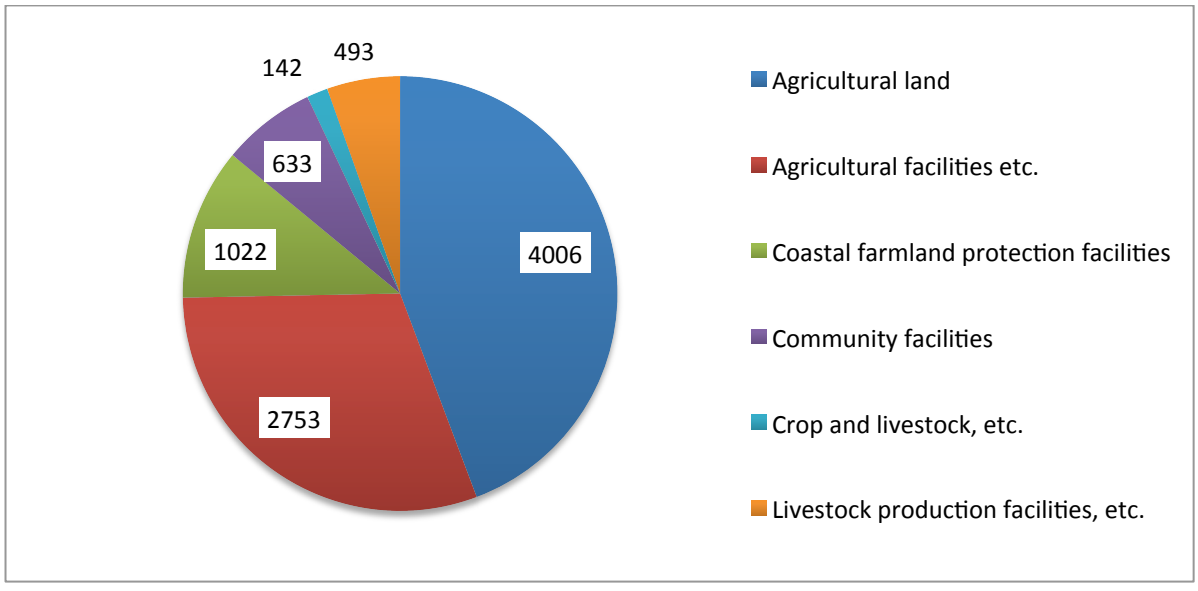
Damages on farms have been particularly big in areas around the Fukushima nuclear plant, where most agricultural land, livestock and crops were heavily contaminated and

destructed [Koyama, 2012, 2013; Watanabe, 2013]. In the most affected evacuation areas farming activity has been suspended or significantly reduced, and majority of livestock and crops destroyed. For instance, in JA Soma the damaged area from the nuclear accident reaches 5,439 ha and the damaged farmlands is 4,155 ha [Nagashima, 2013]. Consequently, in the evacuation area the number of farms decreased from 364 to 101 and the livestock heads from 4864 to 2261.

According to the officials the number of farm households in the evacuation zones was 5400 and the farming area 11,000 ha, including 73.3% of paddy fields, 25.6% of uplands, and 1.1% permanent crops [Fukushima Prefectural Government, March 2012]. That comprises 8% of the total number of farmers and 9% of the farming area in Fukushima prefecture in 2010. The numbers of beef cattle in the evacuation areas was 10,836, of milk cows 1,980 and of pigs 40,740, accounting respectively for 15%, 12% and 22% of the overall numbers of livestock in 2011. The estimate figure for chickens was 1,589 or 30% of the total number in the prefecture in 2009.

The official estimate for the inflicted damage on agriculture by the 2011 earthquake is 904.9 billion yen[10] (Figure 15). The biggest share of the damages is for agricultural land (44.3%) and agricultural facilities (30.4%), followed by the coastal farmland protection facilities (11.3%), community facilities (7%), agricultural livestock etc. (mainly country elevators, agricultural warehouses, PVC greenhouses, livestock bams, compost depos) (5.4%), and agricultural crop and livestock etc. (1.6%).

**Figure 15. Damages to agriculture from 2011 earthquake as of July 5, 2012 (100 million yen)**



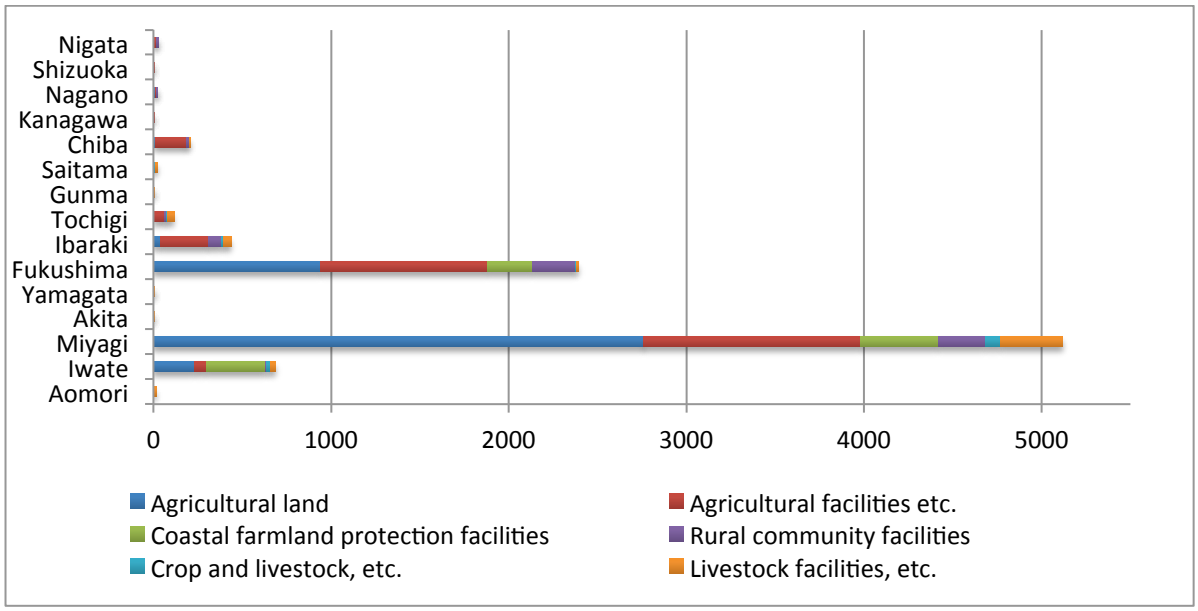

Source: Ministry of Agriculture, Forestry and Fisheries

[10] Damage to Sector Agriculture, Forestry and Fisheries (2,426.8 billion yen) is 18 times as large as for 2004 Nigata Chuetsu Easrtquake and about 27 times bigger than for 1995 Great Hanshin Easrtquake [MAFF, 2013].

The biggest portion of the damage worth on agricultural land was in Miyagi (69%), Fukushima (23.6%) and Iwate (5.8%) prefectures; on agricultural facilities, etc. in Miyagi (44.4%), Fukushima (34%), Ibaraki (9.9%) and Chiba (6.3%) prefectures; on coastal farmland protection facilities in Miyagi (42.5%), Iwate (32.4%) and Fukushima (24.8%) prefectures; on rural community facilities in Miyagi (43.1%), Fukushima (38.7%) and Ibaraki (12%) prefectures. The bulk of damage on crop and livestock, etc. was in Miyagi (57.8%), Iwate (13.9%), Tochigi (7.2%), Ibaraki (6.9%), Fukushima (5.7%) and Saitama (4.4%) prefectures, while on livestock facilities, etc. in Miyagi (71.2%), Ibaraki (8.8%), Tochigi (7.1%), and Iwate (5.8%) prefectures.

The greatest amount of damage has incurred in Miyagi prefecture representing 56.5% of the total worth (Figure 16). The second most affected prefecture was Fukushima with 26.4% of the total damage. Iwate and Chiba prefectures have also incurred considerable damages - 7.8% and 4.8% of the total.

**Figure 16. Damages to agriculture in different prefectures from 2011 earthquake as of July 5, 2012 (100 million yen)**




Source: Ministry of Agriculture, Forestry and Fisheries

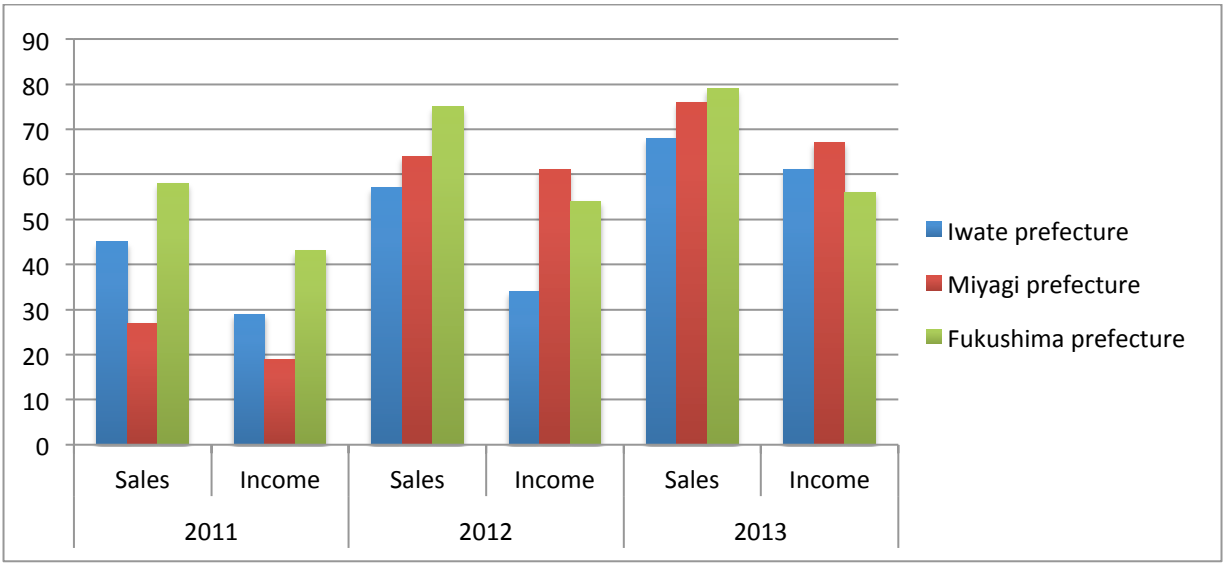
In Miyagi, Fukushima, Nagano and Iwate prefectures the damages on agricultural land take the greatest segment of registered prefectural amounts. In Kanagawa, Shizuoka, Gunma, Chiba, Yamagata, Ibaraki, Tochigi, Nagano, and Nigata damages on agricultural facilities etc. dominate. In Iwate prefecture most of the damages are on coastal farmland protection facilities. In Akita prefectures damages on rural community facilities are the largest. In Saitama and Yamagata crops and livestock losses are the biggest, while in Saitama and Aomori damage on livestock facilities etc. are the most important.

Some initial studies estimated the tsunami disaster losses in rice field in Miyagi and Fukushima prefectures to 1932.52 ha and 718.43 ha respectively, which are expected to cause a decrease in annual rice yield by 9,472.60 tons in Miyagi and by 2,939.10 tons in Fukushima, equivalent to a total annual loss of $US 1,411 millions [Liou et al., 2012]. Moreover, it was

estimated that such loss will be undoubtfully enlarged by several orders of magnitude when the contamination of nuclear radiation on the surrounding environment is considered.

A survey on the economic situation of agricultural management entities in the tsunami damaged areas have found out that in 2011 the sales revenues from agricultural products dropped by 68% comparing to 2010 and the agricultural income by 77% [Ministry of Agriculture, Forestry and Fisheries, 2013]. Farmers in Miyagi prefecture experienced the biggest decrease in sales and income, followed by the producers in Iwate and Fukushima prefectures (Figure 17).

**Figure 17. Evolution of agricultural sale and income of agricultural management entities in tsunami-damaged areas (2010=100)**



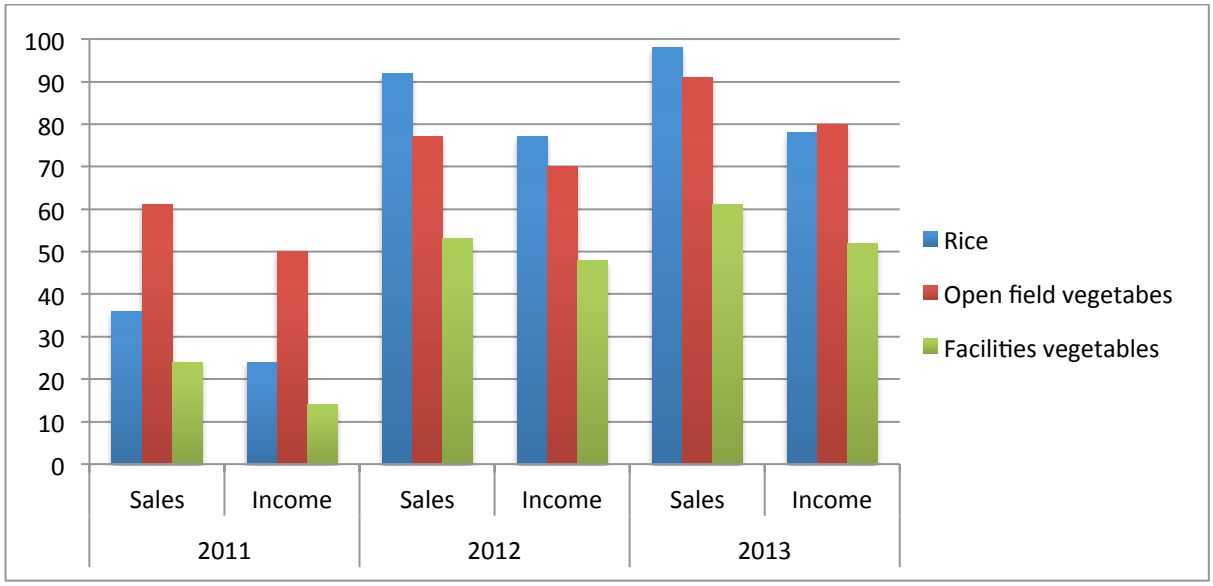

Source: Ministry of Agriculture, Forestry and Fisheries

Severe blows on sales and income were registered by producers in the three dominant type of farming in affected region as those specialized mainly in facilities vegetables saw the highest decrease in sales and income (86% and 76% accordingly), followed by the rice and open field vegetable producers (Figure 18).

There have been some improvements in sales and incomes in all areas but in 2013 they were still far bellow the 2010 level – 24% and 36% accordingly [MAFF, 2014]. The fastest recovery has been registered in Miyagi farms' sales and income (49% and 48% increase), followed by the Iwate (23% and 32% increase) and Fukushima (21% and 13% increase) producers' results. The slower growth of income compared to sales (in Iwate and Fukushima prefecture) was due to the higher costs associated with the post-disaster cleaning and rebuilding.

There has been a good progress in recovery of sales and income of rice and vegetable farms but in 2013 their levels was still considerable lower than in 2010. The fastest income growth was registered by the rice producers (54%) due to restoration of farmland and augmentation of sales (62%). The slower pace of post-disaster recovery in the facility grown vegetables was caused by the prolonged farmland restoration and the high (facility) rebuilding costs after the land restoration is complete and operation resumed [MAFF, 2014].

**Figure 18. Evolution of agricultural sale and income of agricultural management entities with different specialization in tsunami-damaged areas (2010=100)**




Source: Ministry of Agriculture, Forestry and Fisheries

In the first year after the disaster there was augmentation of the agricultural output value in 69.8% out of the 43 tsunami-damaged municipalities (Figure 56). In the rest of the affected municipalities there was no progress (11.6%) or even a reduction (18.6%) in the agricultural output, including in 58.3% of the damaged municipalities in Iwate prefecture, a half in Aomori prefecture, 26.7% in Miyagi prefecture, 16.7% in Ibaraki prefectures, and zero in Fukushima and Chiba prefectures [Ministry of Agriculture, Forestry and Fisheries, 2013].

In 2013 there was a further augmentation of the agricultural output value in 67.4% of the tsunami-damaged municipalities, a reduction in 25.6% of them, and no change in the rest 7% (Figure 56). There was a regression or no progress in agricultural output of 46.7% of the affected Miyagi municipalities, a third of damaged Fukushima and Ibaraki municipalities, a quarter of hit Iwate municipalities, and a fifth of destroyed Chiba municipalities [Ministry of Agriculture, Forestry and Fisheries, 2014].

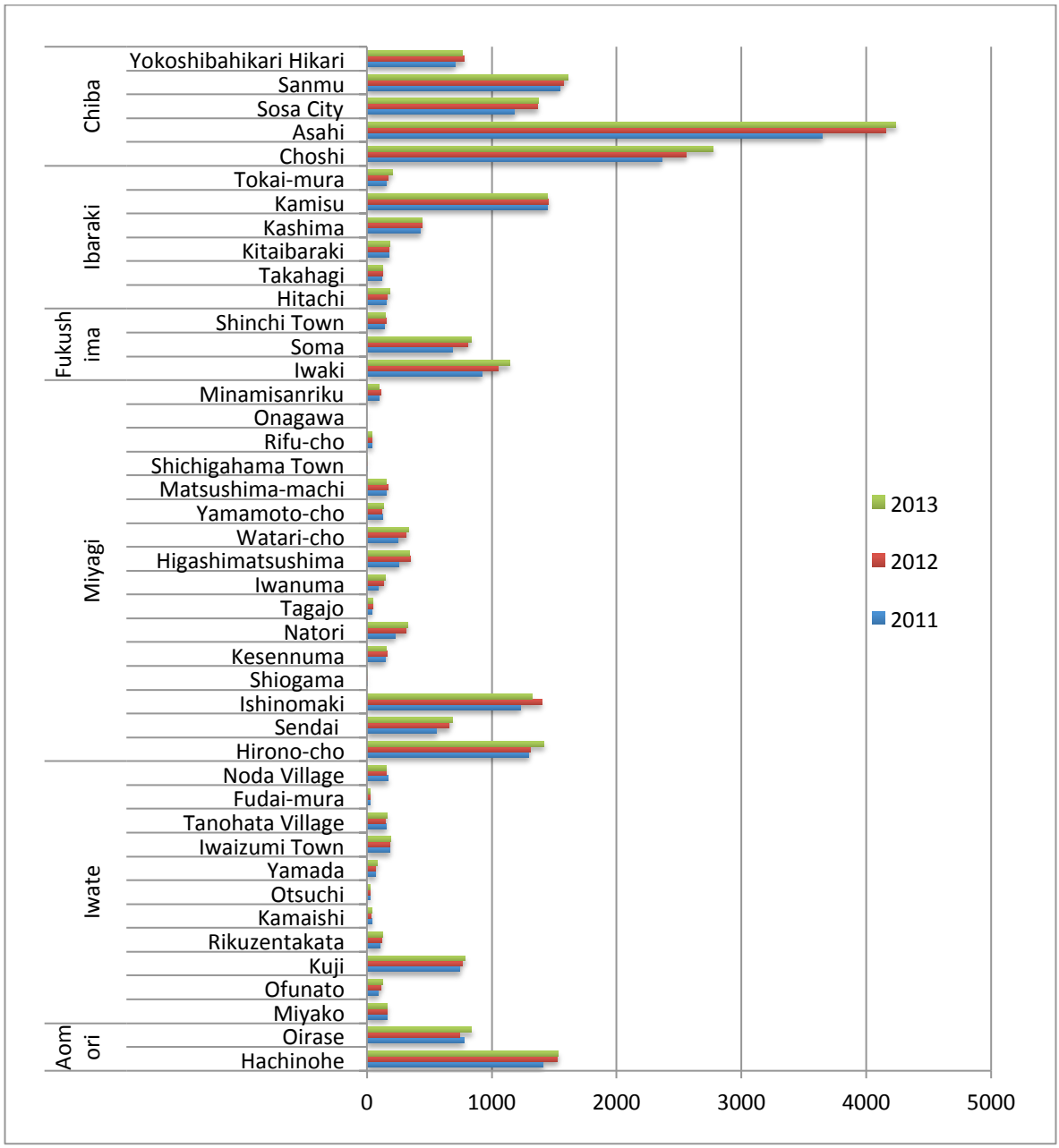
Individual municipalities differed substantially in terms of amount of damages, the 2011 production level, and the 2011-2013 sell-price levels. Therefore, the evolution of agricultural output value gives only a partial insight on the state of farming recovery in different municipalities[11].

There are official estimates on some of the damages from the Fukushima nuclear disaster as well. For instance, the total product damages from the accident accounts for 2,568 billion yen in Fukushima prefecture, out of which 41.9% are in the evacuated and restricted

[11] E.g. in 2012 there was no or very low output in Onagawa, Shiogama, and Shichigahama Town, Miyagi prefecture due to enormous tsunami destruction and farming suspension (no annual progression in the first two cases, and 80% reduction in the last one). On the other hand, a small output progression (0.8%) in Kamisu, Ibaraki prefecture expresses maintaining of a relatively high 2011 level.

areas (Table 4). These figures cover damage of products that cannot be sold, because of the restrictions on planning and distribution, and loss of the value caused by rumors.

**Figure 19. Evolution of agricultural output value in tsunami-damaged municipalities (10 million yen)**




Source: Ministry of Agriculture, Forestry and Fisheries

Nevertheless, above assessment does not include important "stock damage" (material funds, damage to production infrastructure, contamination of agricultural land, facilities for evacuation, and usage restrictions on machinery) as well as the loss of "society-related capital" (diverse tangible and intangible investments for creating production areas, brands, human resources, network structure, community, and cultural capital, ability to utilize resources and funds for many years). According to experts the later losses are quite difficult to measure and "compensate" [Koyama, 2013].

**Table 4. Agricultural product damages in areas affected by nuclear disaster in 2012**

| | Vegetables | Livestock | Fruit | Rice | Evacuated/restricted area total | Fukushima prefecture |
|---|---|---|---|---|---|---|
| Evacuated/restricted area share (%) | 42.4 | 68.0 | 48.9 | 35.9 | - | 100 |
| Evacuated/restricted area (100 million yen) | 225 | 346 | 135 | 371 | 1,077 | 2,568 |
| Evacuated/restricted area ratio (%) | 8.8 | 13.5 | 5.2 | 14.4 | 41.9 | 100 |

Source : Tohoku Department of Agricultural Administration, MAFF Statistics

Likely wise, much of the overall damages from the 2011 disasters on farmers livelihood and possessions, physical and mental health, environment, lost community relations etc. can hardly be expressed in quantitative (e.g. monetary) terms. Many farms livelihood and businesses have been severely destructed as a result of loss of life, injuries and displacement, and considerable damages on property (farmland, crops, livestock, homes, material assets, intangibles such as brands, good reputation, etc.), related infrastructure, and community and business relations.

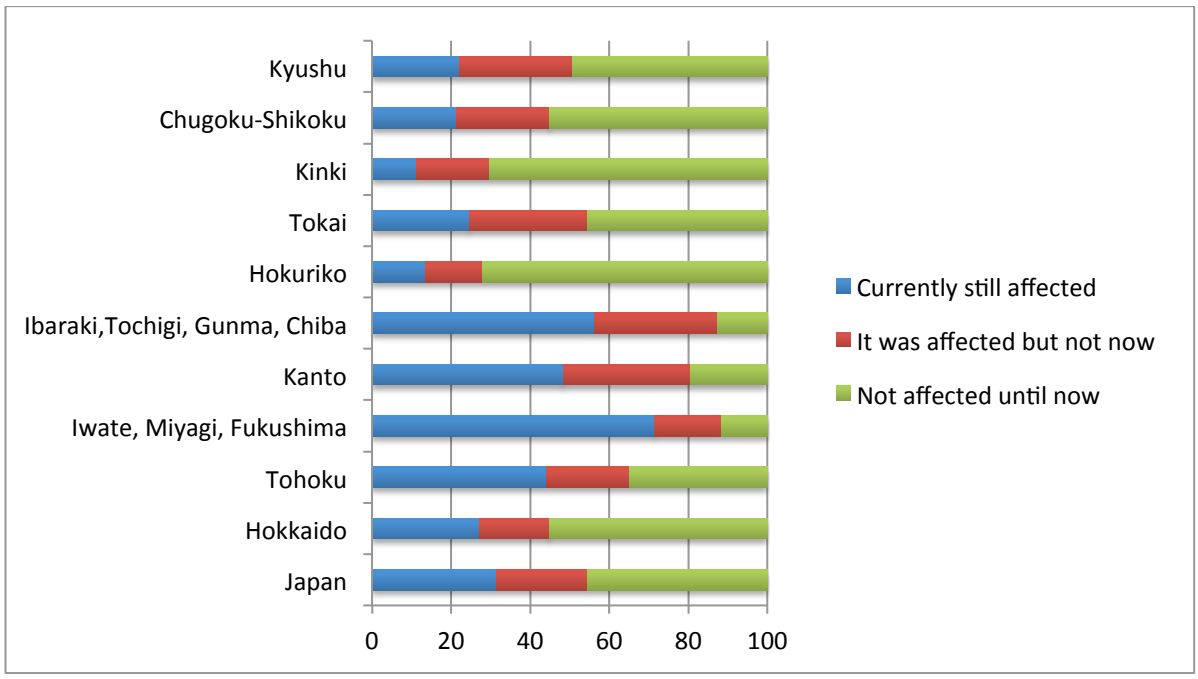
What is more, thousands of farmers in Fukushima and neighboring regions have been continuing to suffer enormously from the radioactive contamination of farmlands and agricultural products, the official and/or voluntary restrictions on production and shipments, and the declined markets and prices for their products (JA ZENCHU, 2012; Koyama 2013a, 2013b; Ujiie 2011 and 2012; Watanabe, 2011; Wataname 2013).

There has been a significant short and longer-term negative impact of the triple disaster on farm management entities in the most affected prefectures and beyond. According to a survey disaster affected negatively almost 55% of Japanese farms (Figure 20). A 2012 survey has found out that the most severely affected have been farmers in Tohoku and Kanto regions, and the least affected in Hokuriko and Kinki regions. In the worst hit Iwate, Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, and Chiba prefectures more than 88 89% of all farms "are still affected" or "were affected in the past" from the earthquake, tsunami and nuclear accident.

What is more, one year of the disaster 31.4% of the surveyed farms in the country reported adverse effect on their management by the disasters. More than 71% of farmers in Iwate, Miyagi, and Fukushima prefectures, and more than 56% of those in Ibaraki, Tochigi, Gunma, and Chiba prefectures continued to feel the adverse effects of the earthquake, tsunami and nuclear accident.

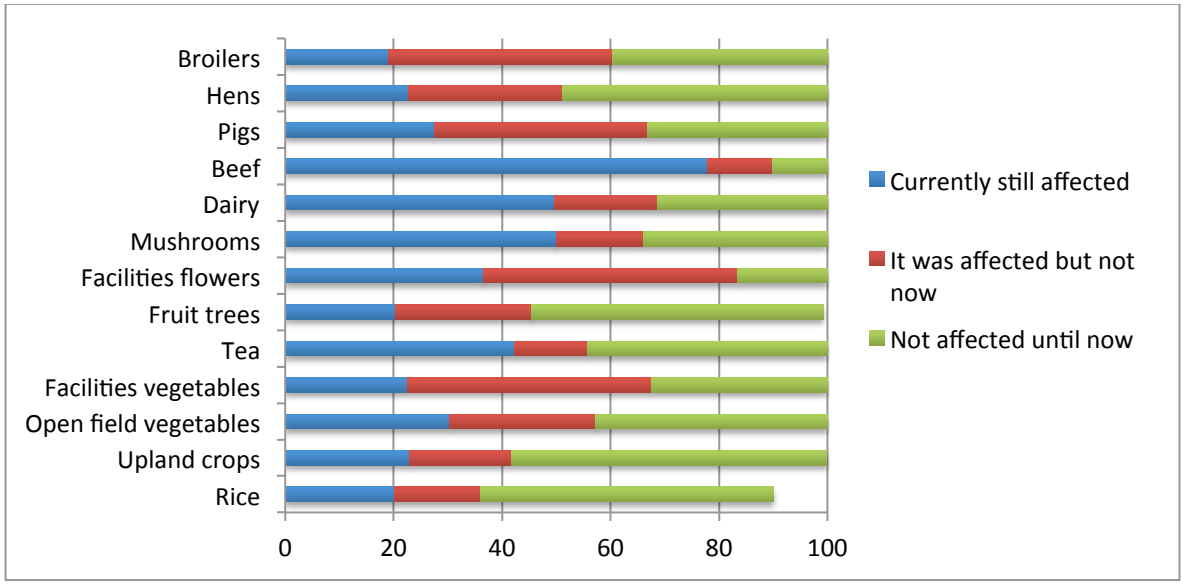
Among different sectors of agriculture the most farms have been affected by the disasters in beef and facility flowers production (Figure 21). Furthermore, one year after the disasters almost 78% of surveyed beef farmers, around a half of mushroom and dairy producers, more than 42% of tea and almost 37% of facility flower producers reported they are still feeling the adverse effects of the disasters.

**Figure 20. Adverse effect of Great East Japan Earthquake on farm management in different regions of Japan (March 2012)**




Source: Japan Finance Corporation

**Figure 21. Adverse effect of Great East Japan Earthquake on farm management in different subsectors of Japanese agriculture (March 2012)**




Source: Japan Finance Corporation

There is also huge differences in the most affected sectors in different regions of the country (Table 5). One year after disasters in Iwate, Miyagi, and Fukushima prefectures a great majority of farms in beef, dairy, mushroom, facility vegetables, fruit trees and rice

cultivation are still adversely affected by the earthquake, tsunami and nuclear accident. On the other hand, in Ibaraki, Tochigi, Gunma, and Chiba prefectures the negative impact lasted longer for the significant number of beef, mushroom, dairy, and open field vegetables producers.

**Table 5. Adverse effect of Great East Japan Earthquake on different subsectors in most affected regions (March 2012)**

| | Iwate, Miyagi, Fukushima | | | Ibaraki, Tochigi, Gunma, Chiba | | |
|---|---|---|---|---|---|---|
| | Currently still affected | It was affected but not now | Not affected until now | Currently still affected | It was affected but not now | Not affected until now |
| Rice | 64.2 | 18.9 | 16.9 | 44 | 24.5 | 31.4 |
| Upland crops | | | | 46.2 | 23.1 | 30.8 |
| Open field vegetables | 38.5 | 23.1 | 38.5 | 64.3 | 26.8 | 8.9 |
| Facilities vegetables | 70.3 | 21.6 | 8.1 | 35.3 | 59.8 | 4.9 |
| Fruit trees | 69.6 | 8.7 | 21.7 | 48 | 36 | 16 |
| Facilities flowers | 64.3 | 17.9 | 17.9 | 54.1 | 45.9 | |
| Mushrooms | 87.5 | 12.5 | | 92.9 | 7.1 | |
| Dairy | 95.2 | 4.8 | | 79.8 | 19.3 | 0.9 |
| Beef | 98.6 | 1.4 | | 92.6 | 7.4 | |
| Pigs | 54.1 | 45.9 | | 41.8 | 41.8 | 16.4 |
| Hens | | | | 38.1 | 33.3 | 28.6 |
| Broilers | 42.1 | 52.6 | 5.3 | | | |

Source: Japan Finance Corporation

The major reasons for the negative impacts of the triple disasters have been "decline in sell prices" and "harmful rumors" while the damaged inputs supply and production affected less farms (Table 6). What is more, for farmers still affected by the disasters the importance of the first two factors increased considerably in 2012 comparing to the disaster year.

**Table 6. Reasons for those who are currently adversely affected in different regions (August, 2011; January 2012)***

| | Damage to production | | Damage input supply | | Damage to distribution | | Decline in sell prices | | Harmful rumors | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2011 | 2012 | 2011 | 2012 | 2011 | 2012 | 2011 | 2012 |
| Japan | 24.5 | 23.2 | 41 | 27.1 | 44.4 | 33 | 65.8 | 74.4 | 52.8 | 60.5 |
| Hokkaido | 12.6 | 14.1 | 55.9 | 39.7 | 34.4 | 31.3 | 63.5 | 79.8 | 44.1 | 46.4 |
| Tohoku | 46.3 | 38.2 | 51.5 | 25.2 | 60.8 | 41 | 55.2 | 65.8 | 58.3 | 72 |
| Kanto | 34.1 | 26.1 | 28.8 | 17.6 | 45.2 | 27.8 | 69.6 | 72.8 | 72.9 | 76.1 |
| Hokuriko | 12.4 | 14.8 | 47.6 | 29.6 | 40 | 24.1 | 44.8 | 63 | 45.7 | 55.6 |
| Tokai | 7.6 | 7.3 | 30.5 | 18.2 | 41.9 | 34.5 | 86.7 | 87.3 | 35.2 | 43.6 |
| Kinki | 5.4 | 11.4 | 25 | 28.6 | 29.3 | 25.7 | 73.9 | 77.1 | 44.6 | 28.6 |
| Chugoku-Shikoku | 6.3 | 9.7 | 31.7 | 23.9 | 33.7 | 29.2 | 72.6 | 80.5 | 38 | 50.4 |
| Kyushu | 8.6 | 9.1 | 27.9 | 29.9 | 40.5 | 32.5 | 77.5 | 86.8 | 37.5 | 36 |

Source: Japan Finance Corporation *multiple answers

There has been a great variation in the importance of different factors affecting producers in individual sectors of agriculture (Table 7). For instance, "damaged production" has been a major factor for the most broilers producers, "damaged input supply" for the majority of pigs, upland crops, and open field vegetables producers, while "declined sell prices" and "harmful rumors" impacted farmers in all sectors. Furthermore, in 2012 the impact reduced sell prices further increased for most subsectors, while of the harmful rumors for all producers.

**Table 7. Reasons for those who are currently adversely affected in different subsectors (August 2011; January 2012)**

| | Damage to production | | Damage input supply | | Damage to distribution | | Decline in sell prices | | Harmful rumors | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** | **2011** | **2012** |
| Rice | 26.3 | 27.4 | 48.8 | 32.3 | 36.7 | 33.5 | 41.2 | 55.9 | 53.7 | 67.9 |
| Upland crops | 10.4 | 16.3 | 63.6 | 55.6 | 32.9 | 34.1 | 50.3 | 73.3 | 41 | 49.6 |
| Open field vegetables | 9.2 | 19.9 | 41.4 | 43.8 | 38.5 | 42.5 | 81 | 70.5 | 51.7 | 54.8 |
| Facilities vegetables | 28.3 | 32.7 | 24 | 35.6 | 41.9 | 36.5 | 78.7 | 65.4 | 48.4 | 54.8 |
| Tea | 13.5 | 13.4 | 8.7 | 15.9 | 40.4 | 34.1 | 69.2 | 67.1 | 80.8 | 87.8 |
| Fruit trees | 14.7 | 21.3 | 35.3 | 20 | 42.2 | 41.3 | 56.9 | 65.3 | 49.1 | 61.3 |
| Facilities flowers | 15.5 | 19.8 | 26.8 | 25.2 | 52.1 | 27 | 88.7 | 88.3 | 14.6 | 19.8 |
| Mushrooms | 23 | 38.3 | 27 | 36.2 | 48.6 | 31.9 | 77 | 76.6 | 44.6 | 57.4 |
| Dairy | 32.3 | 26.3 | 50 | 21.2 | 42.9 | 29.8 | 71.8 | 84 | 57.1 | 58.2 |
| Beef | 22.4 | 18.4 | 29.5 | 10.5 | 55.9 | 35.6 | 96.7 | 94.8 | 87.4 | 80.8 |
| Pigs | 49 | 22.8 | 66.9 | 16.5 | 56.6 | 15.2 | 35.2 | 75.9 | 34.5 | 53.2 |
| Hens | 37 | 18.2 | 47.8 | 12.1 | 45.7 | 24.2 | 28.3 | 78.8 | 41.3 | 27.3 |
| Broilers | 67.7 | 72.7 | 90.3 | 45.5 | 51.6 | 18.2 | 6.5 | 36.4 | 6.5 | 63.6 |

Source: Japan Finance Corporation *multiple answers

Another nationwide survey on farms performance reviled that there is significant differences in the dynamics of sales volume and income in of individual and corporate farms [Japan Financial Corporation, 2013]. For instance, there was a considerable decline in the income of vegetable producing corporate farms in 2012 comparing to 2011 (11.2% for open field and 34.1% for facility vegetables) with simultaneously improved performance in the individual management entities. At the same time, declined in income in individual farms was much higher than in the corporate hen produces (69.8% and 30% accordingly) and the opposite for broilers producers (2.6% and 20.3% accordingly).

## IV. State of restoration of agricultural communities, lands, infrastructure and businesses

MAFF worked out a “Strategy for the Revitalization of the Agriculture, Forestry, and Fisheries” (2011) aiming to rapid restoration and resuming of farming in disaster affected regions. What is more, in line with the Government priority the strategy and accompanied measures have intended to rebuild economy, industry, and local communities with resilient structures through a “qualitative shift” towards a new socio-economic growth. Furthermore, the Basic Guidelines for Reconstruction called for reconstruction to make agriculture in Tohoku “serve as a model for the nation” [MAFF, 2011].

The Government reconstruction strategy incorporated seven basic principles:

- country’s revitalization will underpin the reconstruction of East Japan, and the reconstruction of East Japan will serve as a trailblazing example for Japan's revitalization;
- establish economic and social structures that are fortified against enormous risks;
- maintain confidence in public finances and social security, Japan brand;
- concentrated allotment and concentrated investment in new growth under resource restrictions, such as those on financial resources and electric power;
- realize local empowerment and private sector vitality;
- revitalize economy in an open manner by strengthening "kizuna" (the bonds of friendship);
- promote understanding in Japan and overseas regarding Japan's revitalization.

The MAFF strategy have been supported by a series of supplementary budgets including: subsidizing part of the cost necessary to recover farm land, granting aid to resumption of farming, and providing interest-free loans for the afflicted farmers and businesses. It also considers projects for integrated development of residential zones, agricultural zones and other zones, including conversion from residential to agricultural zones.

In addition, there has been easing in approval standards under the Agricultural Land Act and other laws, and one-stop procedure for zoning, approval and project planning introduced in affected areas. Further enlargement of the loans with a credit line of 100 billion yen and interest-free loan under the “Act on Temporary Measures on Financial Support of Farmers has been introduced. Subsequently, farms having 30% and more harvest reduction and over 10% of property damages can apply up to 2 million yen for persons and 20 million yen for companies with 3-6 years redemption period. What is more, for special cases individual loans have 2.5 million yen ceiling and extending period of redemption of 4-7 years under the “Special Financial Aid Act for Heavy Disaster” [MAFF].

Government measures aimed both recovery and increased farm efficiency. Particularly, they have been contributing to accelerating farmland transactions and expanding farm operations. It encourages communities in the afflicted area to discuss and submit “master plans” for local farmland use. Citizens have been faced with a task of discussing land use for public, commercial, residential, farming and other purposes from scratch in order to rebuild communities. This made it possible for agricultural commissions with participation of other stakeholders and citizens to discuss farmland use and mark land zones clearly and effectively. The later gave opportunity to adjust land uses among the area and aggregate farmland while

concentrating residence and commercial/communal facilities into uplands allowing to improve farmland efficiency and build a disaster-resistant community.

Government decided to pay 30 thousand yen for every 0.1 hectares of farm land to retiring farmers, non-farmer inheritors, etc. if they lease their land under certain conditions (e.g. period of lease is more than 6 years, land is to be blindly entrusted to government-approved agencies, which take part in farm land aggregation projects, and others). The later created incentives to increase farmland transactions within the afflicted area as well as opportunities for farm managers to expand production by borrowing consolidated land plots from farmland aggregation agencies.

Furthermore, there has been also a huge public support for all decontamination efforts – e.g. national budget for decontamination for the period of 2012-2013 comprises 1.1482 trillion yen [Koyama, 2013]. There has been also increased public (national, prefectural, local) support to farms and agri-business in the affected regions. The Government established the Nuclear Damage Liability Facilitation Fund to support nuclear damages payments. By March 2012, agricultural damages payments regarding the nuclear disaster totaled about 106.2 billion yen [MAFF].

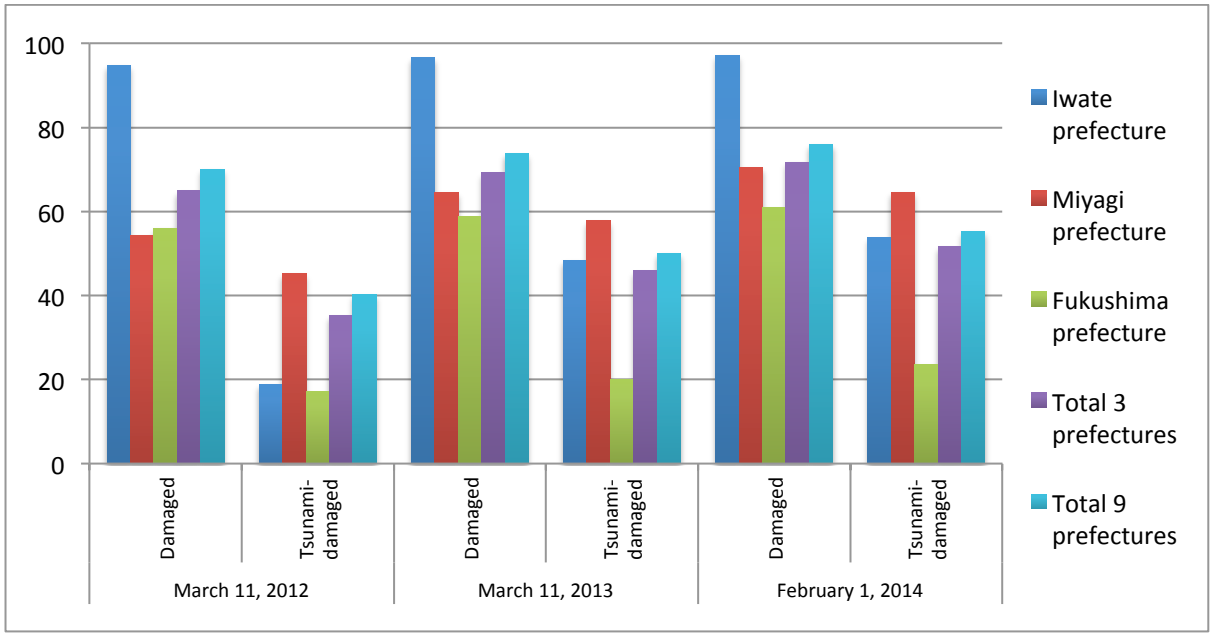
The Government support to prefectures and farmers to recovery from disaster has been substantial. For instance, farmers that have conducted complete inspection of all cattle and feed lots are paid 50,000 yen per head of raised cattle. In places where shipping restrictions are imposed funds have been provided for the purchase and disposal of the beef facing delayed shipment or already in distribution chains. The similar measures applied to other farm products as well.

Last but not least important, there has been significant support from diverse agricultural (agricultural cooperatives), business, academic, non-governmental and international organizations. All they intensify their activities in the affected regions and multiply relations with individual farmers and agri-business companies. That has been associated with increased "outside" service supply and likely positive effects on activity, innovations, incomes, etc.

Consequently, a good progress in removal of debris, restoration of damaged agricultural lands, and resumption of farming has been achieved with concerted efforts of government agencies, prefectural and local authorities, agricultural cooperatives, farmers, private companies, volunteers etc. In order to remove the salt following procedures have been applied – construction of temporary diversion canals or creasing cannels, pouring lime soil conditioner, mole draining, reverse plowing/soil crushing and flooding for removing salt [MAFF, 2011].

One year after the disasters around a third of damaged agricultural land was completely restored, including 27% of the tsunami damaged farmlands. During the same period about 90% of tsunami-afflicted farmland was cleaned of rubble, a large part of agricultural infrastructure reconstructed (including 100% of major draining pumping stations and 7.3 km priority restoration zones of coastal farmlands, and 92% of the rural community sewages) [MAFF, 2012]. Consequently, 70% of all damaged farms in 9 prefectures and 40.2% of tsunami damaged farms in 6 prefectures and 40% of resumed farming (Figure 22).

**Figure 22. Share of agricultural management entities, which resumed farming (percent)**




Source: Ministry of Agriculture, Forestry and Fisheries

By March 2013 restoration and salt removal on 38% of the tsunami-damaged farmland was completed and they were available for farming (with restoration on another 63% ongoing) [MAFF, 2013]. That was close to the target in the 3 years plan[12] for complete restoration of tsunami-damaged farming set by the Basic Guidelines for Reconstruction of Agriculture and Rural Communities after the Great East Japan Earthquake (Table 8). Consequently, a half of the affected by the tsunami farms resumed agricultural production or preparations for it [MAFF, 2013].

**Table 8. Master plan for restoration of tsunami-damaged farmland, June 2014 (ha)**

| Prefectures | FY2011 | FY2012 | FY2013 | FY2014 | FY2015 * | FY2016 or later* | Evacuation order area | Diversion | Total |
|---|---|---|---|---|---|---|---|---|---|
| Iwate | 10 | 100 | 150 | 190 | 40 | 190 | - | 50 | 730 |
| Miyagi | 1,220 | 5,450 | 4,240 | 1,120 | 540 | 1,140 | - | 630 | 14,340 |
| Fukushima | 60 | 400 | 890 | 280 | 240 | 890 | 2,120 | 580 | 5,460 |
| Aomori, Ibaraki, Chiba | 810 | 140 | - | - | - | - | - | - | 950 |
| Total | 8,100 | | 5,280 | 1,590 | 820 | 2,220 | 2,120 | 1,260 | 21,480 |
| Share (%) | 38 | | 25 | 7 | 4 | 10 | 10 | 6 | 100 |

*including scheduled enlargement of farmlands (710 ha in 2014, 1,570 ha in 2015)

Source: Ministry of Agriculture, Forestry and Fisheries, 2014

[12] published on August 26, 2011 (concequently revised several times) and specifying farmland restoration measurs and schedule.

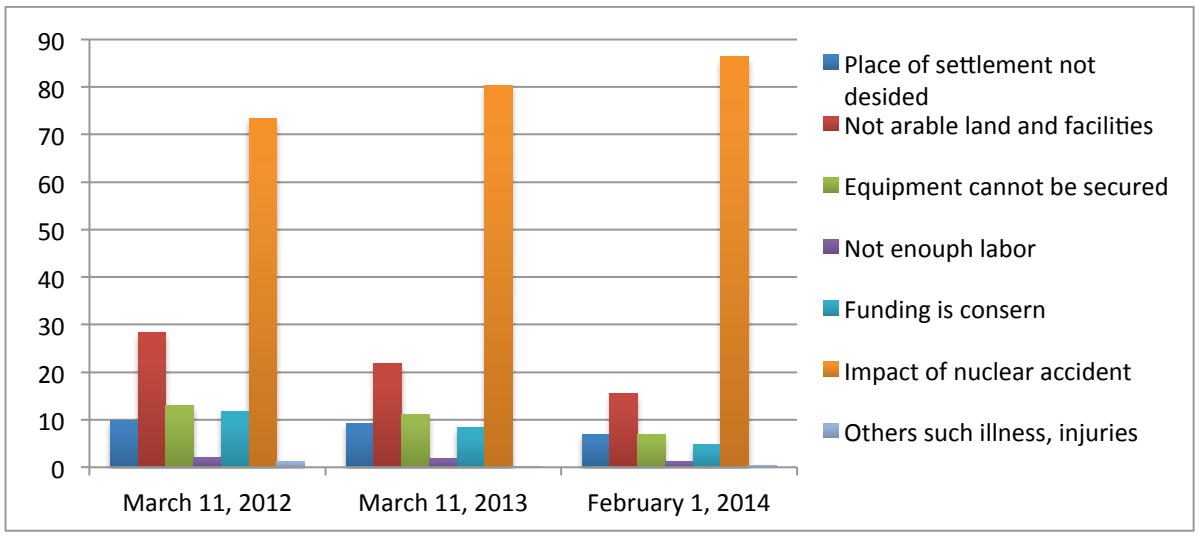
The latest figures indicate that 63% of tsunami damaged agricultural land has been made again available for farming [Reconstruction Agency, 2014], and more than 55% of the affected farms resumed operation.

In the three most affected by the disasters prefectures approximately 72% of the damaged farms and 52% of the tsunami-damaged farms resumed operations. The biggest progress in restoration of the damaged farms has been achieved in Iwate prefecture and for the tsunami damaged farms in Miyagi prefecture. Nevertheless, despite that agricultural land in Miyagi prefecture was planed to be fully recovered by 2015, the officials announced that in might be delayed by a few more years [Fuyuki, 2013].

On the other hand, in Fukushima prefectures restoration of operations in damaged farms has been progressing slowly. Until June 2014 merely 29.9% of the tsunami-damaged farmland has been restored and become resumeable for farming, 82.3% of damaged agricultural facilities have been restored, and 60.9% of agricultural management entities resume operations [MAFF, 2014]. Similarly, merely 69.3% of the planed agricultural lands (paddy, upland, orchards and pastures) from the Municipality decontamination area have been actually decontaminated [Reconstruction Agency, 2014]. Moreover, some parts of heavily contaminated areas remain almost untouched and probably require a long time before farming can be resumed.

Major reasons for "not resuming farming" in the three most affected prefectures have been the impact of nuclear accident, unavailable arable land, facilities and equipment, undecided place of settlement, and funding problems (Figure 23). Moreover, importance of most of these factors has been decreasing due to progression in reconstruction, returning of evacuees, restoration of farmlands and public support measures. On the other hand, the significance the nuclear crisis as a reason deterring effective resumption of operations by majority of farms has been increasing.

**Figure 23. Reasons for not resuming farming in Iwate, Miyagi and Fukushima prefectures, multiple answers (% of farms)**

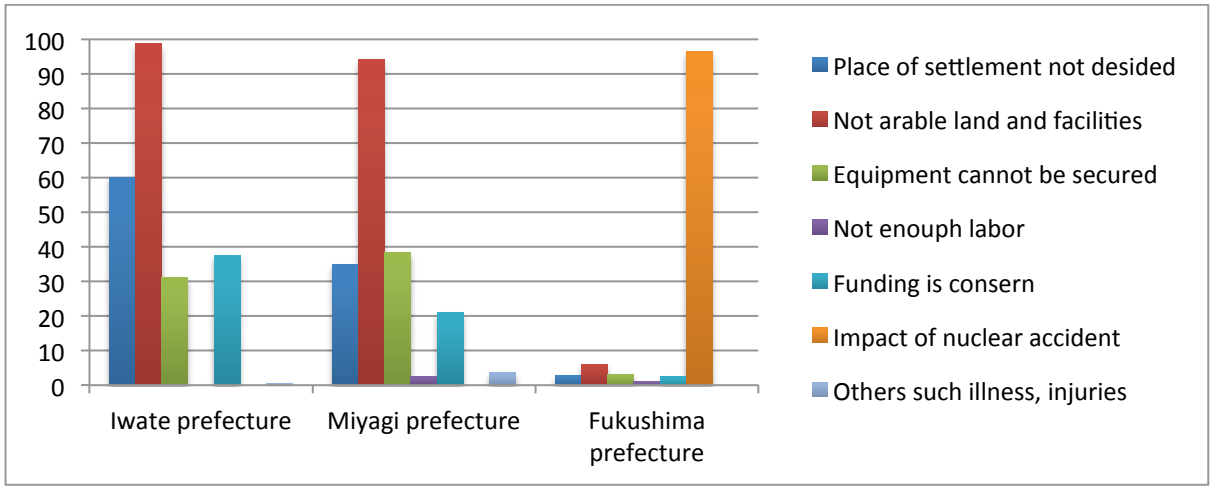



Source: Ministry of Agriculture, Forestry and Fisheries, 2014

Post disaster lack of family labor and other factors such as sickness and injuries prevented resumption of activity of few farms, and their number further decreased since in the last 3 years.

Most critical factors for "not resuming farming" for majority of farms in Iwate and Miyagi prefectures have been unavailable arable land and facilities (Figure 24). Other important factors for a significant number of farms in these prefectures are that farmers have still not decided on the place of settlement (affecting 60% of damaged farms in Iwate prefecture), funding of farming activities is an issue, and equipment can not be secured. On the other hand, the most important obstacle to restart operations for the most Fukushima farmers has been the "impact of nuclear accident".

**Figure 24. Share of farms with diverse reasons for not resuming farming, multiple answers (%)**

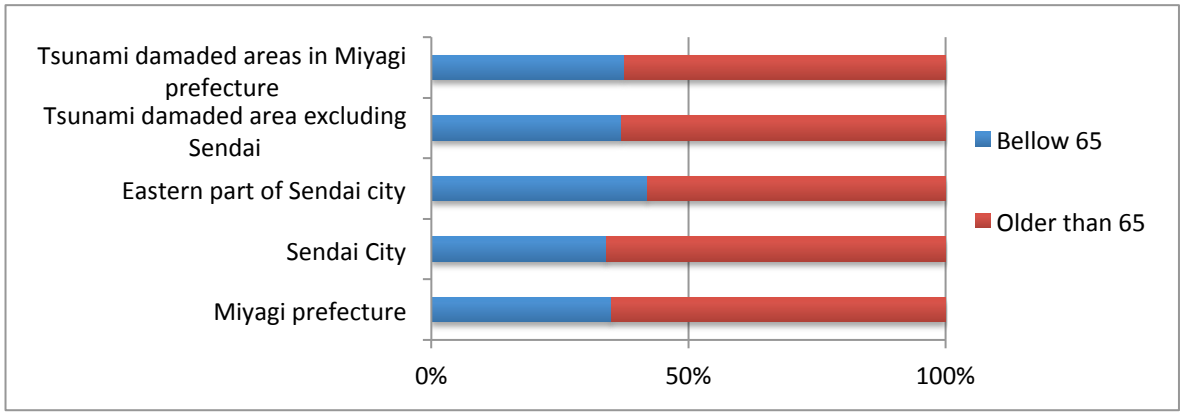



Source: Ministry of Agriculture, Forestry and Fisheries, 2014

Aging of farmers and lack of successors in business is a serious problem in the disaster areas as well a nationwide. For instance, presently a significant portion of regular farm male workers in tsunami-damaged areas of Miyagi prefectures are part-time farmers and older than 65 (Figure 25). Therefore, any further delay in the reconstruction would put great challenges for the resumption of farming the previous farm managers (older in age, lack of investment capability, short time span, lack of ability to put rebuilding efforts, lack of skills other than for rice paddy cultivation, unavailable successor, etc.).

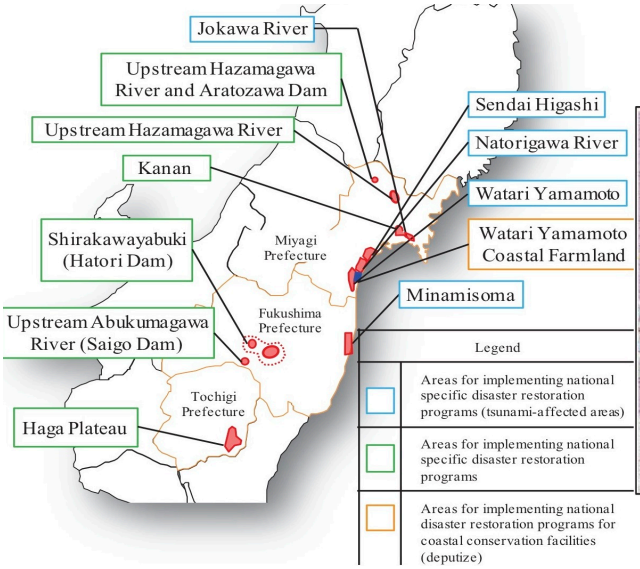
MAFF launched the National specific disaster restoration programs for farmlands and farming facilities in FY2011 (Map 11). In efforts to secure reconstruction after restoration, it is implemented to enlarge partitions for farmlands to achieve economies of scale and farming efficiency (Map 12). In March 2013 the later include 9,400 hectares in Iwate, Miyagi and Fukushima prefectures, using the Great East Japan Earthquake Reconstruction Grants and the like [MAFF, 2013]. In FY2012, MAFF kicked off its national specific restoration program of farming facilities in Minamisoma city of Fukushima Prefecture.

**Figure 25. Age of regular male farm workers in different parts of Miyagi prefecture**



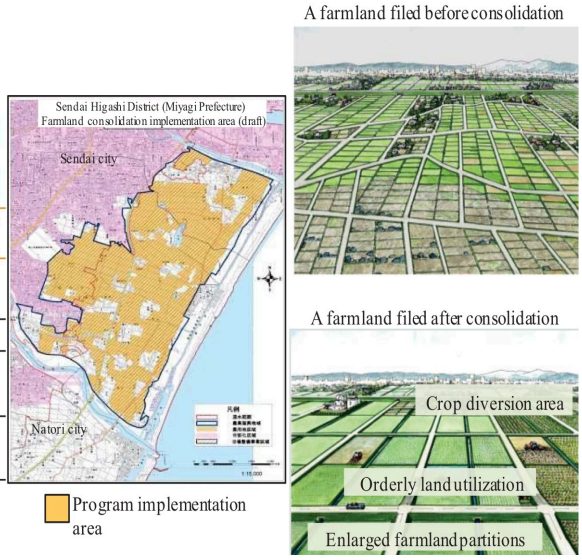

Source: Fuyuki, 2013

**Map 11. Districts for implementing MAFF national specific disaster restoration programs**




Source: MAFF, 2013

**Map 12. Overview of farmland enlargement in Sendai Higashi District**




Source: MAFF , 2013

The process of reconstruction of devastated by the earthquake and tsunami East Sendai agriculture is a good example for the efficiency of implementing programs and revitalizing strategy[13]. Few days after the disaster (April 5, 2011) the Liaison Meetings between the city authority and diverse actors (representatives of farmers, agricultural cooperatives, Land districts, etc.) was established, and discussions on agriculture restoration and development started.

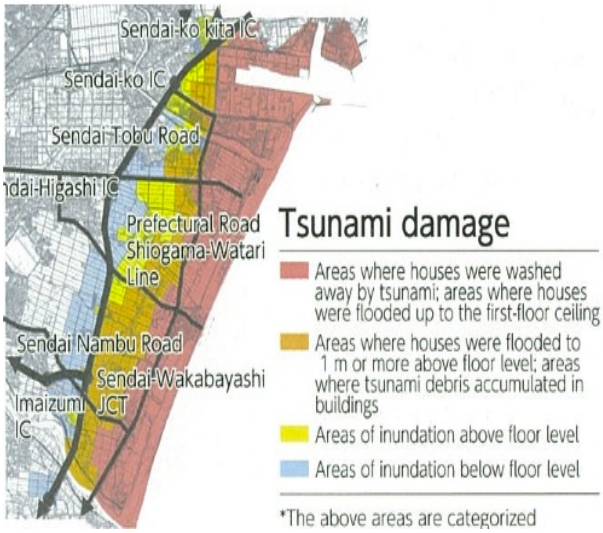
The strategy and the plan for reconstruction of agriculture is an essential part of the ten year "Sendai City Disaster Reconstruction Plan" for restoration, recovery and revitalizing of all aspects of social life and economies, and enhancing safety of residents and communities. The later include as major components the reconstruction projects such as: "Tsunami

[13] Goals and progress presented in "Fresh Breeze of Change in Agriculture Starts Here" [http://en.re-tohoku.jp/movie/15294]. basic concept in disaster reconstruction policy is "Not just restoration but also Restructuring".

reduction and housing reconstruction project to “protect lives from a tsunami”, “Residential area rebuilding project to “build a foundation for safe homes”, “Life recovery project to “support individual livelihoods”, “Agricultural and food frontier project to “strongly revitalize agriculture”, “Seaside exchange and revitalization project to “restore the beautiful coast”, “Model development project for a disaster-proof Sendai to “learn from past disasters for the future”, “Energy-saving and new energy projects for a “sustain energy supply”, “Sendai economy development project to “improve urban vitality and the quality of life”, “Exchange promotion project to “promote the features of the city and its reconstruction efforts”, and “Earthquake disaster memorial project to “convey the memory of the earthquake disaster to future generations” [City of Sendai, 2011].

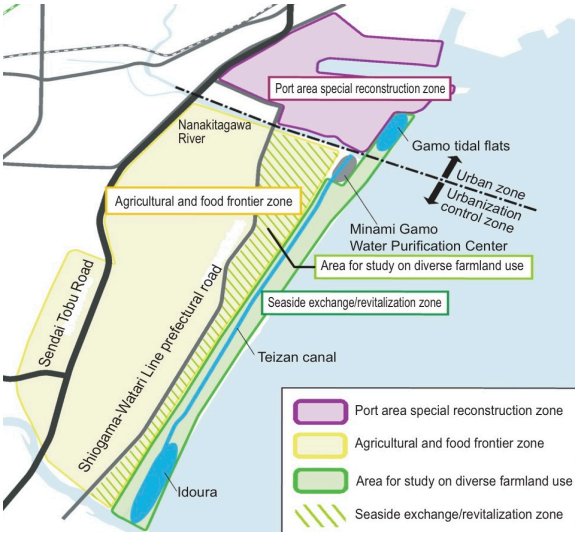
The Eastern Sendai agricultural zone includes four districts - Takasago, Miyaguno-ku, Shishigo, Wakayabashi-ku, Rokugo, Wakayabashi-ku, and Shiromaru, Taihaku (Map 13). The total area is 4,633 ha, population of 21,966 in 8,086 households, and number of buildings 12,277.

**Map 13. Tsunami damaged East-Sendai agricultural zone**




Source: City of Sendai, 2014

**Map 14. Plan for land use in Eastern Sendai**




Source: City of Sendai, 2011

The total cultivated land in East Sendai is 2,300 ha, and around 78% of it was damaged by the 2011 tsunami, including 1600 ha rice paddies and 200 ha vegetable fields [City of Sendai, 2014]. Furthermore, 2,400 tractors, rice planting machines and other equipment were lost, 10 ha greenhouses destroyed, 4 draining pumping stations completely collapsed, many buildings and houses heavily damaged or demolished, Sendai Agricultural and Horticulture Center flooded, and many water canals and farm roads were submerged.

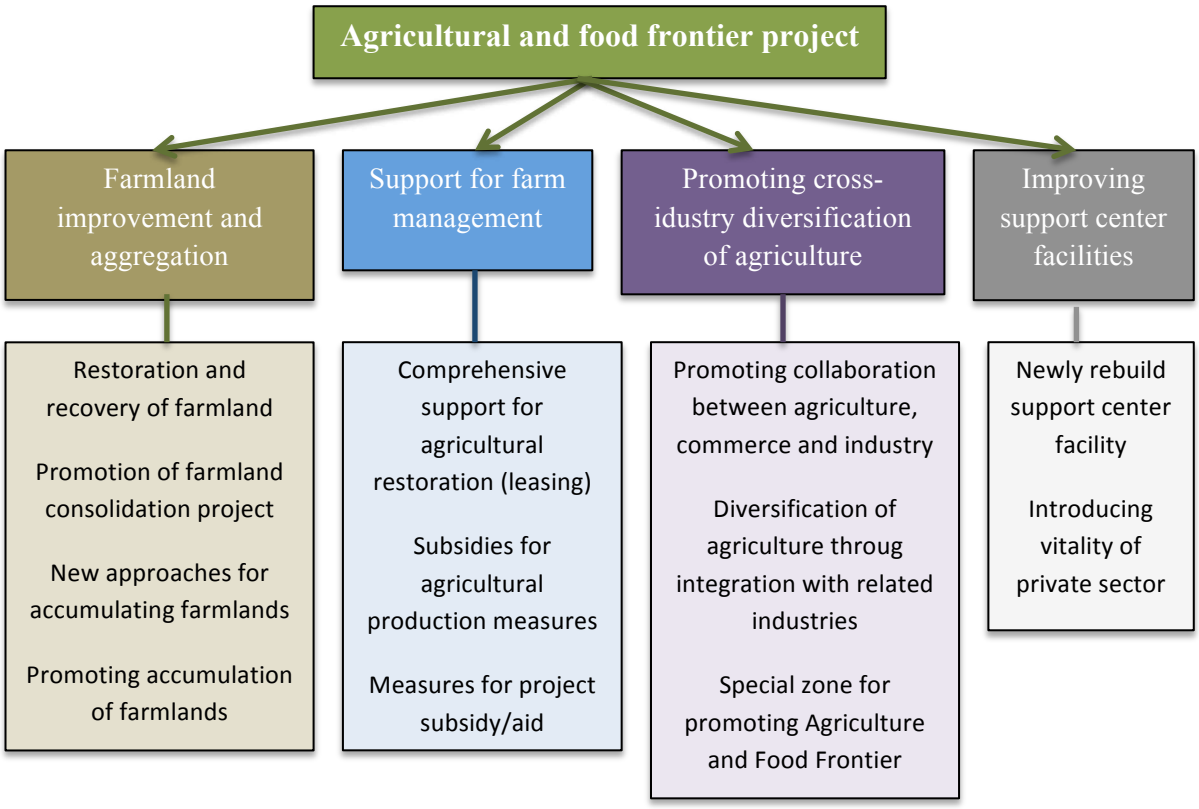
The economic damage to agriculture was enormous – it is estimated at 72,1 billion yen, including 39,6 billion yen for damaged farmland, 10.6 billion yen for damaged machines and facilities used in agriculture, and 21.9 billion yen for damaged land improvement facilities [City of Sendai, 2014)].

The Reconstruction Plan includes as an essential part a new land use vision in the Eastern Sendai envisaging: Agricultural and food frontier zone, Seaside exchange and

revitalization zone, Port area special reconstruction zone, and Sites left after collective relocation for urban infrastructure redevelopment (Map 14).

The Agricultural and Food Frontier Project has been undertaken to support recovery from the disaster and development of agriculture in East-Sendai agricultural zone. It is centered on four targets: farmland consolidation and improvement; supporting farmers in enhancement of management base; promoting "cross-industry diversification" (integrating farming with related industries such as food processing and sales), and improving support center facilities (Figure 26).

**Figure 35. City of Sendai "Agricultural and Food Frontier Project" components**




Source: City of Sendai, 2014

The cleaning up, restoration and recovery of farmlands have been an enormous task mobilizing efforts of the local and central authorities. The work included removal of large amount of debris and desalination of huge areas of farmlands.

The Debris Removal Project was carried out between July 1 and December 28, 2011 on 1,800 ha flooded farmland [City of Sendai, 2014]. It included clean up of damaged buildings, woody debris and cars swept into farmland, farm roads and irrigational channels. The project employed 1,202 farmers who were victims of the disaster with additional 64 registered for employment.

The Soil Desalination Project was conducted from March 25, 2011 until April 30, 2014 on 1,860 ha. It was proceeded by detailed surveys on extent of soils salinations and designing of feasible countermeasures for land improvement. By the end FY 2012 around 30% (560 ha) of damaged farmland were restored and made available for resuming farming,

while farming restarted on 60 ha (10.71%) of the area. Until March 2013 around 80% of the damaged farmlands was restored and the majority of farms resumed operations (Picture 3). According to the officials the quality of harvested rice was at level equal to that before the disaster and land steadily returning to its former rural landscape.

Simultaneously, restoration of irrigation and drainage channels has been conducted. Temporary Restoration Drainage Pumping Stations was carried out from May 2011 until June 2012, and all 11 of them timely restored as the pre-disaster capacity of 19 $m^3/s$ reached. The full-scale restoration continues taking into account the degree of ground subsistence (approximately 50 sm).

**Picture 3. View of successfully reconstructed East-Sendai agriculture**

Source: City of Sendai, 2014

**Figure 27. Conceptual plan for farmland development in Eastern Sendai**


Source: City of Sendai, 2014

The Farmland Consolidation Project has been currently promoted and involves readjusting small traditional plots to form new larger ones (Figure 27). The process is guided by a Council including representatives of different stakeholders – authority, farmers, JA, Land districts, etc. Before the aggregation farms plots were small and farm roads narrow which was obstacle for the efficient agricultural practices. What is more, poor draining made it difficult to plant wheat, soybeans and other crops. Consolidation raises the farm efficiency, expends crop possibility, and allows farmland borrowing and lending to progress smoothly.

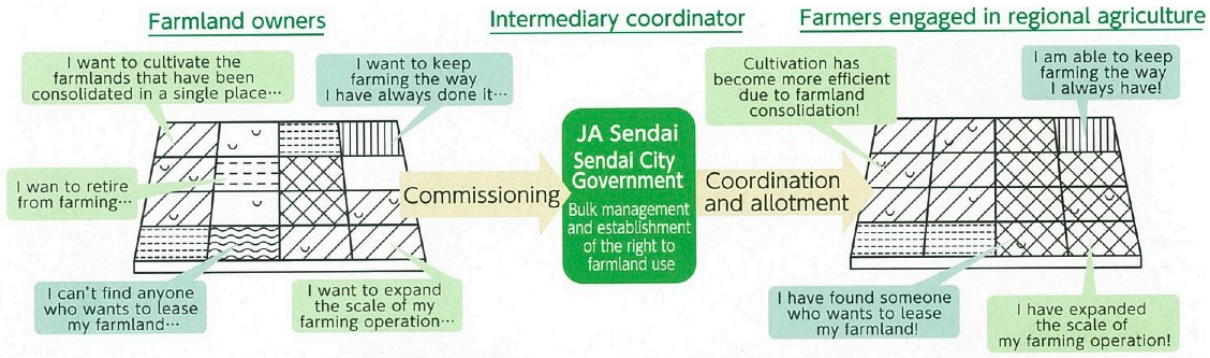
The East Sendai District Farmland Consolidation Project covers 1,979 ha out of the 2,244 ha of the total District area including farmlands, roads and irrigation/drained channels [City of Sendai, 2014]. The operational expenses are 19.7 billion yen and planed project period from FY2012 to FY 2016. The ratio of consent by the landlords for farmland consolidation is 94.6%.

The Natori District (Shiromaru area) Farmland Consolidation Projects covers 708 ha (91 ha of the Shiromaru area) out of the 809 ha of the District area (including 100 ha of the Shiromaru area). The project period is from FY2013 to FY2015, the operational expenses 10.6 billion yen, and there is 98.8% of consent by the landlords for farmland consolidation (including 100% in Shiromari area).

New Approaches for Accumulating Farmlands have been also reviewed. The goal is to promote land accumulation by leasing farmlands to current or future farm operators. The traditional approaches for accumulating farmlands include: transfer of ownership (buying and selling farmlands), reploting by exchanging farmlands (constructing the right of farmland use through implementing land consolidation), lease contract (establishing the right of farmland use though a contract to commissioning farming between a lender farmer and borrower farmer), and commissioning farm work (borrower farmer is commissioned to cultivate rice in paddy fields from plowing dry soils, tilling irrigated soils and transplanting rice seedlings to harvesting rice).

Since April 2013 the Sendai city in collaboration with the JA Sendai introduced a new approach to "bulk management of farmland" (Figure 28). Sendai city and JA Sendai act as intermediary by implementing bulk lease management practices of farmlands in the relevant areas so that borrower farmer are able to cultivate land that have been consolidated in a single place according to the scale of their farming and the status of operations.

**Figure 28. Bulk management approach for farmland consolidation in East-Sendai**




Source: City of Sendai, 2014

In addition, city authority has created "Sendai city Agriculture Enhancement Plan" (Master plan for resuming Agricultural Management) based on the discussions held in communities and areas in the 14 districts of Sendai, including the East-Sendai District. Among other things the Future Vision of the Regional Agriculture incorporate:

- recognizing regional agriculture so that farmers who operate large farmland plots can play a central role;
- encouraging associations for rice-crop diversion practice to form group-farming organizations based on integrated cultivation of rice and other crops;
- fostering community-based incorporated farming bodies as a model by establishing the right to bulk use and re-allotting farmlands to farm operators.

Ido and Arahama Districts have been selected as model districts, and measures to establish the rights of bulk use and re-allotment of farmland to farm operators started in 2013. According to the experiences obtained farmland accumulation is planed to be promoted in all relevant areas.

Furthermore, a variety of support measures have been provided to lender and borrower farmers in order to put the plan into action. Support funding for 2013 include Farm

Accumulation Support Fund (Central Government) and Project to Promote Accumulation of Farmlands for Use (Sendai city government). The former provides support funds to farmland owners who are listed in the "Sendai City Agricultural Infrastructure Enhancement Plan" when they newly commission JA Sendai to lease their land "giving full authority" (a contract without designating a borrower).

Concerning the tsunami-affected farmlands recovered for farming on or after April 1, 2012, subsidies are offered to both "farm lender disaster-victims" and "borrowing farmers" when they made a new contract for leasing farmland or commissioning farming that extend over a period of three years or longer.

The Comprehensive Support Project for Agricultural Restoration in Disaster-stricken Areas (Leasing) give opportunities through the Reconstruction Grant Project for community farming organizations to lease free-of charge large machines (such as tractors, rice planters, combines, etc.) and facilities (as plastic greenhouses for raising seedlings, machinery store houses, etc.) in the disaster-stricken farmlands making possible for farmers to resume operations.

In FY 2012 the target area covered Okada (Shinhama, Minami-gamo), Yotsuya, Sasayasaki, Kamiyashiki, Fujita, Arahama, Sambontsuka, Futaki, Ido, Nambu (Tanetsugi, Fujitsuka) and included 43 tractors, 24 rice planting machines, 32 combines, rotaries, harrows for soil paddling, seeders, plastic greenhouses for razing seedlings, wells, storehouse for agricultural machines, and various other machines. Similar items are included in FY2013 as well.

The Great East Japan Subsidy for Agricultural Production Measures include financial support by the national, prefectural and municipal governments to groups which are organized by farmers, agricultural producers cooperative corporations etc., so that they can install common facilities, do repair and renovations, and lease agricultural machines and materials.

In 2011, 2012 and 2013 the amounts of such subsidies have been accordingly 603 million yen, 1,528 million yen and 1,386 million yen. The subsidy ration has been less than 82.5%. In 2011 and 2012 the number of projects were accordingly 51 and 28 (including carrying overs) with total project costs of 787 million yen and 603 million yen.

Measures for Project Subsidy/aid includes: (1) Emerging Installation of Plastic Greenhouses for Vegetables and Flowers, and (2) Project to Support Disaster-stricken Farmers to Resume Farming.

The first one comprises city government subsidies of the part of expenses of the disaster-stricken farmers (farming groups, certifies farmers, eco-farmers, etc.) for installing plastic greenhouses to resume farming. The subsidy ration is less than 50% of the project costs with a limit of 2,650 yen per 1 $m^2$. In 2011 and 2012 the number of projects was accordingly 15 and 11 (including farming groups) for areas of 11,769 $m^2$ (78 buildings) and 24,172 $m^2$ (135 buildings). The total amounts of projects and subsidies in 2011 were 55.5 million yen and 26.5 million yen, while in 2012 it was 139.9 million yen and 62.5 million yen. The budget for FY2013 is 66.3 million yen.

The second project provides subsidies to farmers who jointly establish a recovery association to remove fine debris, weeding or clearing so that farming can be resumed. Area of coverage includes tsunami inundation areas including unit grant aid per 0.1 ha for rice paddy of 35,000 yen and vegetable fields of 40,000 yen. In 2011 target areas, where

associations were established, were four (Takasago, Shichiro, Rokugo, Nakada), and in 2012 three (Takasago, Shichiro, Rokugo). In 2011 and 2012 the number of farmers involved was accordingly 1,573 and 1.085, while the total amount of grant 641 million yen and 401.6 million yen. In FY2013 the budget for this measure is 141.3 million yen.

Another major aspect of the Agricultural and Food Frontier Project is the Promoting Diversification of Agriculture by integrating it with Related Industries such as Food Processing, Distribution and Sales.

It includes three measures:

a/ The Promoting Collaboration between Agriculture, Commerce and Industry - it aims to encourage regional industries based on agriculture by arranging business "matching" opportunities and supporting activities to develop high value-added products and services (in addition to efforts to boost demand). The idea is that the later can be done with the collaboration of agriculture, commerce and industry, and mutual utilization of their resources, technologies and networks.

The support measures include: seminars for promoting collaboration between agriculture, commerce and industry; support for development of new products (4 in 2012 and 4 in 2013); and project for support of the model to employ farmers based on collaboration between agriculture, commerce and industry (3 in 2011, 3 in 2013, and 1 in 2013).

b/ Diversification of Agriculture through Integration with Related Industries such as Food Processing, Distribution and Sales. Measures are carried out to promote "cross-industry diversification of agriculture" – e.g. farmers independently enter the businesses of by food processing, distribution and sales, and collaborate with the secondary and tertiary industries to produce and develop new and market-competitive products and provides new services. It also fosters young farmers who will play a major role in management in the cross-industry diversification of agriculture.

Support measures include: fostering human resources capable of developing the cross-industry diversification of agriculture; and support for promoting the cross-industry diversification of agriculture (3 in 2012, and 4 in 2013).

Example for so called "six industry" is the Cotton Project where some farmers grow cotton on salted fields cooperating with a textile company [Fuyuki, 2013].

c/ Special Zone for Promoting Agriculture and Food Frontier Project – set up in East Sendai as a part of the central government special reconstruction zone program. It allows farm operators in the area to receive special tax provisions so that they can acquire machinery and facilities, start new incorporated businesses and other projects without difficulties.

The target area covers approximately 3,000 ha in tsunami-affected Miyagino-ku, Wakayabashi-ku and Taihaki-ku. Target businesses includes incorporated entities or small independent companies that contribute to creating employment opportunities and promote agriculture or operate businesses that correspond to cluster industries in the approved area. Twenty different businesses are designated including: agriculture, food processing, distributing and sales-related industries, renewable energy-related industry, research and testing-related industry. The preferential measures include: special tax provisions, tax credit or special depreciation against taxes (income tax and corporate tax), exemption from prefectural tax (corporate tax and real property acquisition tax), exemption from municipal tax (fixed assets tax).

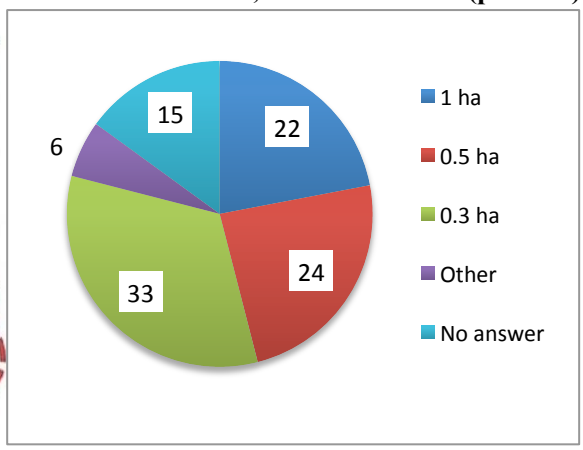
Presently, 18 operators are developing businesses, which have been designated for the special zone project.

Finally, the Renovation and Remodeling of the Support Center Facility has been under way. The goal s to rebuild and modernize the Sendai Agriculture and Horticulture Center as a support center to promote Agriculture and Food Frontier Project (Figure 29). The Center facilities include vegetables greenhouses, food-processing facilities, an allotment garden for "amateur farmer" city residents, direct sales shop, multipurpose open areas, and restaurant.

**Figure 29. Conceptual plan for Sendai Agriculture and Horticulture Center**


Source: City of Sendai, 2014

**Figure 30. Size of plots desired by farmland owners in East Sendai, December 2011 (percent)**




Source: Tohoku Regional Agricultural Administration Office

The center support development of lucrative agricultural business by providing training sessions to expend agricultural diversification and integration and multiple management in agriculture. It also exhibits the operation of its horticulture and food processing facilities, foster human resources and release information on its activities.

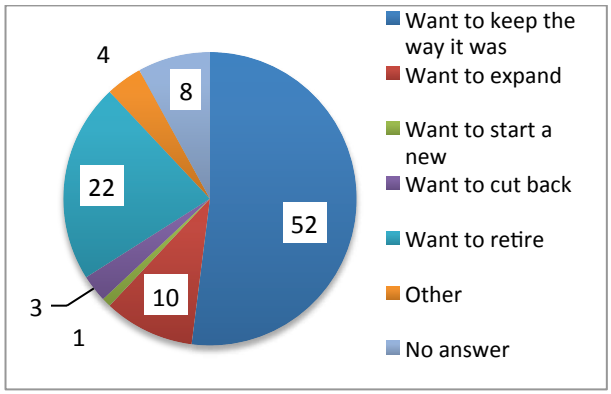
By using know-how and accurately understanding market needs, the Center conveys information to the public on the progress being made in the recovery of Eastern Sendai and the revitalization of agriculture as well as residents new involvement with agriculture. It organizes a variety of events where visitors have hands-on experience with agriculture and opportunities to speak wit farmers.

In December 2011 Sendai city carried out a questionnaire survey in order to figure out farmers' intentions on: resuming farming, participating in the re-development scheme, selling or leasing the land if they would want to give up or cut back on farming, etc. The majority of the respondents wanted the new paddy field to be plotted by blocks of 0.3 or 0.5 ha while merely 22% preferred 1.0 ha (Figure 30). Therefore, the authority should try to persuade farmers into large-scale operation by explaining the merits clearly and supporting farmers' moves toward corporate or community farming [Hori, 2012].

Furthermore, the survey showed that a quarter of farmers wanted to retire or cut back on farming (most likely because they do not have a business successor) while 11% wanted to expand or start out from the scratch (Figure 31). Thus authority is to find an efficient means to aggregate retiring farmers' land persuading them to sell or lease out land as well as encourage

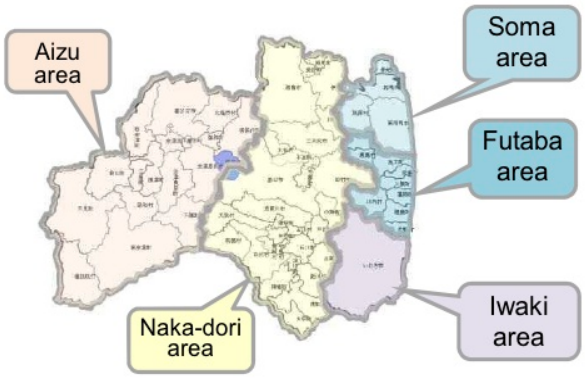
ambitious farmers to take up as much land as possible, so that restored farmland would not be left uncultivated.

**Figure 31. Paddy field operations intended by farm land owners in East Sendai (percent)**




Source: Tohoku Regional Agricultural Administration Office

**Map 15. Specific measures areas in Plan for Revitalization in Fukushima Prefecture**




Source: Fukushima Prefectural Government, 2012

Preventing farmland from being left uncultivated is a task common for all tsunami-afflicted areas and country as a whole [Hori, 2012]. While the government has already come up with incentives for retiring farmers, it should also consider providing incentives to farmers who would expand operations in the afflicted areas. After all, they are the ones who are expected to play a major role in agricultural recovery.

Some experts suggest that government should learn from the experience in farming modernization in the afflicted areas and apply the suggested measures nationwide to prevent further decline of Japanese agriculture [Hori, 2012]. That would require a fundamental modernization of agricultural policies allowing consolidation of farm management in bigger more competitive structures, removal of restrictions on farmland transactions, new entrants and corporative management, easing approval of farmland diversion to other uses, reforming agricultural cooperatives, further liberalization of internal and international trade, changing costly for tax-payers subsidy system for producers and introduction of new forms of public support to agriculture, etc.

Namely, the agricultural reform incorporating some of above measures have been an essential part of the growth strategy of the new Abe administration [The Japan News, June 14, June 18, June 25, October 20, 2014.].

What is more, more and more people support the major new agricultural policies of the Government [The Japan News, July 15, 2014]. Recent nationwide survey has found out that the policy of large-scale farming is supported by 73% of respondents, while only 17% were opposed. Moreover, most people support drastic reforms in the agriculture sector, as 79 of respondents backed the abolition of the rice paddy reduction program. Likely wise, 64% support the easing of regulations on buying and selling farmland to make it easier for corporations to own farmland for investment purposes, and 23% were against it. Furthermore, 76% agree with the policy of abolishing a system that the Central Union of Agricultural Cooperatives (JA-Zenchu) direct and control regional agricultural cooperatives, while 11% were opposed.

In addition, the policy of encouraging farmers to change from mainly cultivating rice to producing other products such as vegetables and fruits was supported by 78% of respondents and only 11% opposed it. Finally, the gap in opinions was narrower regarding participation in the Trans-Pacific Partnership multilateral free trade agreement with nations in the Asia-Pacific region, with 43% in support and 35% opposing. Many people also called for improved food self-sufficiency, as 60% responded that the percentage of domestic agricultural products consumed in Japan should be raised.

There is no official statistics on whether farmers have been able or not to harvest any produce on officially restored land in affected prefectures.

However, there are reports that some of already desalinated and restored tsunami-damaged farmland is still unproductive. For instance, farmers have been unable to harvest any soybeans in a 30-hectare area out of planted nearly 45-hectare field in Rokugo, Eastern Sendai [Ishikawa and Ishikawa, 2014]. According to farmers remained high salt concentration in the farmland soils might have been reason for that.

Similar complaints have also been heard from farmers in Iwate Prefecture who have seen seawater flowing back to five kilometers in the upper stream of some rivers due to land subsidence [Ishikawa and Ishikawa, 2014]. Even after restoration work is done, people in Ofunato have been unable to harvest crops on some farmland because of the lack of freshwater.

What is more, not all farmers could joint the government projects, including many medium and small-scale operators, and recover in lines with government priorities[14]. For instance, in tsunami-damaged areas of Miyagi prefecture most farmers are elderly (over 65), small-scale (under 1 ha), part-time and single crop (paddy only) farmers [Fuyuli, 2013]. Nevertheless, some severely damaged farming communities recovered earlier than in other regions – e.g. Fujitsuka Hamlet of the Wakabayashi Word has been supported by a non-for-profit organization Re-Roots, which members[15] on farmlands and sell output in temporary shop in Sendai [Fuyuli, 2013].

The process of reconstruction and rebuilding communities progress differently in individual places. For instance, Iwanuma was among the first municipality that initiated a collective relocation project[16] [Pushpalal, 2013]. The plan is to relocate 348 coastal homes and build 156 public housing unit in 20ha Tamaura Nishi District by April 2014[17]. Agriculture was the largest industry in Tamaura but most workers were aging part-time farmers in predominately rice production. Enormous losses of houses, workshops, machineries etc. have

[14] e.g. to integrate with downstream industries.

[15] Primarily students from Tohoku University.

[16] cost of purchasing land is born by the government while most residents bear construction costs as in some cases partial subsidies are also available. Those who can not buy own land and house can rent distaste recovery public housing.

[17] Plan was approved in March 2012 with estimated project costs of about 10.8 billion yen. Out of almost 400 households 300 are planning to move to new relocation cite, while remaining chosen to live elsewhere by purchasing house, renting apartment or other means [Pushpalal, 2013]. Nevertheles, according to intervewed a major downsize of group relocation was “all-or-nothing decision” since people who do not follow the plan might not receive financial support from autority [Koch, 2013].

made it difficult to restart farming, 90% of farmers left the industry[18], and citizen group decided to focus on large-scale agriculture revitalization.

On the other hand, in Natori relocation plans have been delayed due to the conflicts of residents who want to return to previous neighborhood and who are against it[19].

One of the important issue affecting new land development is the disaster areas is that more than 40% of residents in three Tohoku prefectures hope to sell their land or move away from areas subject to land use reallocation projects, instead of returning to live there after the ground in designated areas is raised to rebuild new tsunami resistant towns (The Japan News, March 9, 2014). Residents hoping to rebuild their lives are concerned that this widespread reluctance could leave the redeveloped areas with a host of vacant towns. Also, many municipalities involved are worried over revisions to the project plan plans, and say that more residents will leave if town rebuilding continues to be delayed due to plan revisions.

Land development in residential areas due to the March 2011 disaster is planned on 1,315 hectares in 40 areas across 16 municipalities in Iwate, Miyagi and Fukushima prefectures (The Japan News, March 9, 2014). In surveyed 15 of the designated municipalities (covering 998 ha in 38 areas subject to land rezoning) 43% of the respondents[20] said they want to sell the land or move away from the areas. Meanwhile, a half of respondents answered they "want to continue living there," or "want to keep the land." 9% are still "undecided" which indicates that the number of people who could choose to sell their land or move out of the areas will rise.

In Sendai there are two projects – group resettlement in the "High Hazard Risk Zone" (funded by central government) and City support Zone as a complementary program (financed by city government). The plan[21] covers 3,860 households (1,560 under the relocation project and 2,300 under city support program) from 7 places in the east coastal zone to be resettled in 14 residential estates in the inner part [Yonekura, 2013].

Major problems associated with the planning and implementation of relocation has been: opposition of part of affected population, financial burden to individuals[22], different treatment and splitting of communities due to demarcation rule, unequal capability of local government for additional assistance for covering replacement costs, delays in land procurement, deficiency of traditional land registration and related disputes, inadequate manpower in authority[23], mortgage status of some lands[24], different regulations for alternative resettlements, complicated procedures and higher costs for individuals, etc. [Yonekura, 2013].

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[18] Damaged agricultural land (1,200 ha) accounted for 65% of the total farmland. Merely one eight of the later was cultivated in 2012 and one fifth in 2013.

[19] In spring 2013 as much as 25.2% of all residents still intended to "return to their native home" down from 34.1% in the summer of 2012 [Pushpalal, 2013].

[20] around 90% (12,223) of residents and landowners in the areas responded, with multiple answers permitted in certain municipalities.

[21] Approved in December 2011, total project costs of 57.7 billion yen, be committed in fiscal 2015.

[22] e.g. huge (6 times) differences in the land price in disaster (10,500-17,800 yen per $m^2$) and new settlement (60,000-81,500 yen per $m^2$) areas .

[23] to complete land ownership investigation, land surveys and registration.

[24] E.g. in Sendai a quarter of land was under a mortgage and cannot be sold to government as par of group relocation arrangement. By end 2012 most banking institutions accepted request by the Financial Service Agency to release mortgages on the land [Yonekura, 2013].

For instance, costs differences for individuals in the alternative resettlement schemes (Group Relocation Project, Land Consolidation Project, and Non-project Zone) in Natori are presented in Table 9. On the other hand, Sendai city implemented totaling 7.1 billion yen support program for reducing the burden of individuals including: costs of purchasing new houses in area outside of the Group Relocation Project, rebuilding houses in disaster area and moving to resettlement estate[25]; inclusion of displaced persons moving outside Sendai; and establish community support institutions (NGOs) [Yonekura, 2013].

**Table 9. Cost estimation of alternative resettlement schemes in Natori (thousand yen)**

| Alternatives | Type of resettlement | Buying price of land | Rebuilding cost of housing | Selling price of land | Interest subsidy housing loan | Support for moving costs | Total resettlement costs per household |
|---|---|---|---|---|---|---|---|
| Group Relocation Project | Buying project land | 9,700 | 20,000 | 3,420 | 4,300 | 200 | 21,700 |
| | Rental of city land | 0 | 20,000 | 3,420 | 2,630 | 200 | 13,750 |
| | Buying land by individuals | 11,200 | 20,000 | 3,420 | 4,380 | 200 | 23,200 |
| Land Consolidation Project | Rebuilding on owned land | 0 | 20,000 | 0 | 0 | 0 | 20,000 |
| | Land selling and resettlement | 11,200 | 20,000 | 6,280 | 0 | 0 | 24,920 |
| Non-project Zone | | 0 | 20,000 | 0 | 0 | 0 | 20,000 |

Source: Yonekura, 2013

Another major problem has been that a significant portion of land plots is the "property of unknown persons" since information in the real estate registrations is out of date due to inheritors not properly changing registration[26], known owners are dead or moved to urban areas abandoning land, population decline, etc. [The Japan News, August 5, 2014]. Consequently, authorities have been hindered in conducting reconstruction work from disasters or public works projects, as they cannot obtain approval from landowners[27].

For instance, in Tokura district of Minami-Sanriku, Miyagi prefecture, the prefectural government planned to buy land around dikes damaged by 2011 disasters to repair and improve them. It has found a 300-square-meter plot for which 53 people are registered as common owners (in 1924) and about 300 people having inheritance rights. Some of the right

[25] Government covered interest on loans up to a maximum of 7.08 million yen for rebuilding a new housing as well as costs for moving, which amounted 780,000 yen in Sendai.

[26] Due to hight costs or other reasons (multiple owners, disputes, etc.). For instance, relatives have to pay ¥500,000, including commission fees for a judicial scrivener and transport expenses, to change land ownership [The Japan News, August 5, 2014]. There are 1.7 million ha of land in Japan that worth less than the cost of changing ownership and formal titles would not be changed. In addition, ownership of 400,000 ha of abandoned arable land and 1 million ha of forests owned in common would not be changed since inheritance procedures with multiple owners tend to be complicated.

[27] property rights are guaranteed by Constitution and Civil Code. In addition, real estate registrations protect personal property and changing ownership registration is left to the discretion of each owner.

holders are great-grandchildren of original owners and their whereabouts is unknown while approval has to be obtained by the end of next fiscal year given the construction period.

Furthermore, decontamination of lands, houses, roads etc. in the affected areas has been a complex and slow process. Inevitably, priority has been given to decontamination of residences, public facilities and their surroundings, rather than farmlands [Watanabe, 2013].

Appropriate radioactive decontamination technologies have been applied according to the radioactive cesium density levels in farmland soil: up to 5,000 Bq/kg - inventing plowing, radiation transfer reduction cultivation, topsoil removal (unplowed land); 5,000-10,000 Bq/kg - top soil removal, inverting plowing, padding with water; 10,000-25,000 Bq/kg - topsoil removal; more than 25,000 Bq/kg - using soil hardener for topsoil removal [MAFF, 2012].

Results of farmland decontamination demonstration projects show that the topsoil removal reduced the radioactive cesium levels in plow layers by about 80-90% and air dose rates at a height of 1 meter above surface about 60-80% [MAFF, 2013]. Similarly, inverting plowing reduced the radioactive cesium in plow layers by about 60% and air dose rates at 1 meter above surface about 30%. Moreover, all results of test cropping on farmlands decontaminated under these projects[28] have been below the minimum detection limit.

Various trials have been also made at grass-root level[29] and some new plant introduced such as rape blossom seeds, sunflower etc. which reduce contamination of soils and air [JFS, 2011; NHK World, December 9, 2013, March 10, 2014].

Likewise, a number of measures were used to reduce radioactive materials in farm trees and crops such as: removal of rough bark in apple, pear and other fruit trees with rough bark; high-pressure washing for peach and other fruit trees having no rough bark; and for tea - pruning (deep skiffing and medium level cutting) covering leave layers, and at non-pruned tea fields puning branches to increase leaves for cutting [MAFF, 2011].

Besides, diverse measures to reduce the transfer of radionuclides from soil to crops have been recommended such as: changing crop structure; application of potassium-based fertilizers (such as potassium silicate) and zeolite (natural mineral effective in improving soil quality); using combines for harvesting in order to reduce adhesion of soil; abating the impact of ambient radiation by avoiding the practice of drying harvested rice plants naturally in the sun; transition to organic farming; bioremediation of farmlands, etc. [NHK World, March 10, 2014; Moqsud and Omine, 2013; Watanabe, 2013].

In relation to livestock and livestock products, different measures have been promoted by the MAFF for preventing grass from absorbing radioactive cesium. Until the end of FY2012 such measures were completed for 17,000 ha (44.73%) out of the 38,000 ha in grassland subjected to these measures [MAFF, 2013]. Consequently, the frequency of exceeding the maximum limit of radionuclides in farm and livestock products has declined substantially.

Similarly, new crops, products and technologies have been introduced such as plant factory, IT and smart innovations, biodiesel fuel made from sunflower and camellia seeds, land-sharing for crop and solar energy productions, etc. [Fukushima Minpo News, April 24,

[28] 5.7 ha of rice and 1 ha of vegetables in Iitate village, and 6.4 ha of rice in Kawamata town.

[29] For instance, recovery group "Resurrection of Fukushima" was established three months after the accident. Now there are 250 members in the group, including researchers in the fields of physics, IT, and agriculture, as well as volunteers from all over the country [NHK World, December 9, 2013].

2014; Cyberpunk World, January 8, 2014; The Mainichi Shimbun, April 4, 2012; NHK World, June 12, 2012, July 15, 2013].

Decontamination of farmlands outside the evacuation zone has been completed and farming resumed in most places. According to the officials appropriate reduction of radiation was achieved to allow the safe production. The later has been also confirmed by the multiple safety checks up and the removal of restrictions on production and shipments of major farm produce. For instance, a farmer (Mr. H. Kikuchi) in Shinchi town resumed recently shipping "shiitake" mushrooms cultivated on logs for the first time in three years[30] following the lifting of shipment restrictions[31] [Fukushima Minpo News, July 26, 2014].

However, according to experts still there are many hot spot with excessive contamination. For instance, since October 2012 a soil screening project[32] has been going on in Fukushima-shi on 28,382 ha with 24721 agricultural cooperative members. Mapping is done by 7 full time stuff and many volunteers with modern instruments (equipped with GPS) measuring contamination of soil and air. Samples are taken in 3 points of each of the 28,392 paddy fields and 10,058 orchards and current results show a great variation of radioactivity - between 1,000-3,000 Bq/kg in paddies and up to 10,000 Bq/kg for orchards (Interview with the project leader Mr.Park, June 17, 2013).

Experimental rice production on some farmlands in the evacuation zone started in 2012[33] and it has been gradually expending [Fukushima Minpo News, December 14, 2013; Ishii, 2013; Kageyama, 2012]. After restrictions were lifted in the spring 2014[34] farmers in 6 municipalities have resumed rice planting in about 2% of available rice fields (NHK World, June 11, 2014). Most of the rice planting has resumed in Minamisoma City (111 hectares or 3.4% of the total available area), followed by Tomioka Town (0.2%), Namie and Okuma towns (0.1%), and Katsurao Village (0.06%)[35]. Officials in 5 of the 6 municipalities say that will resume full-scale rice farming after planting rice on experimental basis and confirming the impact of radioactivity on crop.

Furthermore, the first public cow pasture (Shibayama pasture) has recently reopened in Iwaki city, Fukushima prefecture after a closure of 2 years due to high radiation levels (NHK World, July 14, 2014). According to the city officials the level fell below the limit in 7 ha of the 50-ha land after workers cut down some grass, sowed seeds, and removed surface soil. Four farmers brought 10 cows that had to raise their cows in a shed while the pasture was closed. Bringing livestock to open land makes farmers job much easier and city wants to reopen the entire pasture as soon as possible.

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[30] Shipments had been restricted since July 2011.

[31] Levels of radioactive cesium detected in the mushrooms stood at a maximum of 5 Bq/kg.

[32] expected to complete in April 2014 and continue afterwards if funding is available.

[33] in 2012 in Minami Soma, right next to the no-go zone, 135 farms were granted special permission to plant rice on the condition that all rice, regardless of radiation levels, will be destroyed (Kageyama, 2012). In 2013 in Miyakojimachi district of Tamura within the 20 km evacuation zone, where decontamination was completed, 3 farms planed 6 ha with rice intended for sale [The Japan Daily Press, May 20, 2013].

[34] Restrictions and self-imposed suspensions on rice planting were lifted on about 5,200 hectares of land since radiation levels declined and the ban on entering the areas lifted.

[35] Rice planting has not resumed yet in Futaba Town.

Insufficient decontamination of farmland and irrigation canals, decreased motivation among farmers, and local anxiety over rumors about contaminated harvests are major reasons for the low resumption rate of farming in former evacuation zone [NHK World, June 11, 2014]. Furthermore, it has been difficult to farm efficiently (e.g. water control in paddy fields) since farmers were not allowed to stay permanently, there has been uncertainty associated with marketing of output (high contamination, unwillingness of buy the region), and in some case radioactive water runoff from mountains to reservoirs for irrigation and/or paddy fields. The later has been an issue for farmers beyond the evacuation areas as well [HNK World, March 10, 2014].

Recent survey in Fukushima Prefecture found 8,000 Becquerels or more per kilogram of radioactive substances in the soil at the bottom of agricultural dams and reservoirs in 568 out of the 1,940 dams and reservoirs they inspected between June and December 2013 [NHK World, March 22, 2014]. Only 108 of them were in the evacuation zones around the Fukushima Daiichi power plant, and 460 were further away. Officials detected 370,000 Becquerels per kilogram in the soil of a reservoir 58 kilometers away from the plant. It is the highest reading so far recorded outside the evacuation zones, and more than 46 times the government limit of 8,000 Becquerels for radioactive waste. According to the officials rain may have carried radioactive substances into the waters from surrounding forests. Water from the reservoir with the highest reading outside the evacuation zones is being used for rice paddies nearby. But officials say they have not found radiation levels exceeding food safety limits in locally produced rice, probably because radioactive substances in the soil barely dissolve in water. Residents were told them they will not be exposed to radiation as long as there is water in the reservoir but they fear radioactive levels may surge if it dries up.

The central and prefectural governments are set to resume the supply of dam water for agricultural use to the Odaka district of Minamisoma city (designated as evacuation area) in fiscal 2017 [Fukushima Minpo News, July 12, 2014]. The supply of water from the Ogaki dam in the town of Namie has been suspended after the nuclear power accident. Work to repair the damaged dam was launched in full swing from fiscal 2014 and the authorities are seeking to launch decontamination work on the dam proper in October 2014. The city office is aiming to have residents return to the district in April 2016 and dam restoration and resumption of agricultural water supply are expected to go a long way toward helping local people resume farming. Around 1,613 farming families used to receive dam water to irrigate a combined total of 1,531 ha of farmland in the Odaka district before the disaster.

Resumption of the water supply from the Ogaki dam will be the first case among 10 dams for agricultural water in the no-go zone. Monitoring of surface water samples from the dam has found that radioactive cesium levels are below the lower detectable limit. The prefectural government intends to use only surface water for agricultural use, and take no water when the level of dam water declines or when water becomes turbid due to heavy rain.

Nevertheless, many farmers have been refusing to return back to homeland even after decontamination is completed because of the high radiation (residential areas, forests around houses and farms, hot spots) and unrestored infrastructure (shops, hospitals, schools etc.). Furthermore, once farms are abandoned, “it is really tough, both mentally and physically, to start all over again, especially when many farmers are aging” [The Japan Times, March 7, 2012].

According to the official it is not clear when the thousands of evacuated farmers will return back to their land (interview with Ma. Satou, June 17, 2013). A survey of the Fukushima prefectural government found out that as much as 50% of farms do not return back to their land. In JA Futaba, where all farmers were evacuated, merely 25% of the farmers "want to farm their own land again" [Nagashima, 2013]. Even combining with farmers who "continue farming in other lands" those who want to continue farming is just 38% and who do not is a third.

Moreover, the number of people who wish to buy land and start farming in Fukushima is 92, while 9 have already started farming, 4 are planning to start, and 9 are ongoing farming [Nagashima, 2013]. Similarly, the number of individuals who wish to rent land in and start farming is 39, while 10 have already started, 5 are planning, and 6 are ongoing farming. In addition, 209 wish to make kitchen garden, 59 have already started such gardens, 11 are planning to start, and 9 are ongoing that practice. Besides, 42 wish to rent land out and start farming, 12 have already done so, 5 are planning to start, and 5 are ongoing.

Nevertheless, many farmers still fear that "disaster is not over" and they do not want to return to their land. For instance, one of the interviewed by us farmer Mr.Tanaka said: "I think no matter how we decontaminate and make ND products, it means nothing if we cannot make the consumers trust us and consume our products. Also the nuclear power plant disaster is still continuing. I think people are afraid that something could happen again and refrain from investing or restarting the farm" (June 14, 2013).

The Plan for Revitalization in Fukushima Prefecture [Fukushima Prefectural Government, 2012] envisages "building a safe, secure and sustainable society free from nuclear power"[36]. It includes a number of priority projects for revitalization in three major areas (Figure 32) with specific measures for each region (Map 15). The First Version of the Plan focused on 38 specific measures and 729 major projects, out of which 235 priority projects. The Plan also contains communication, cooperation, legislating, adjustment and monitoring measures to secure efficiency. Its Second Version was release in December 2012.

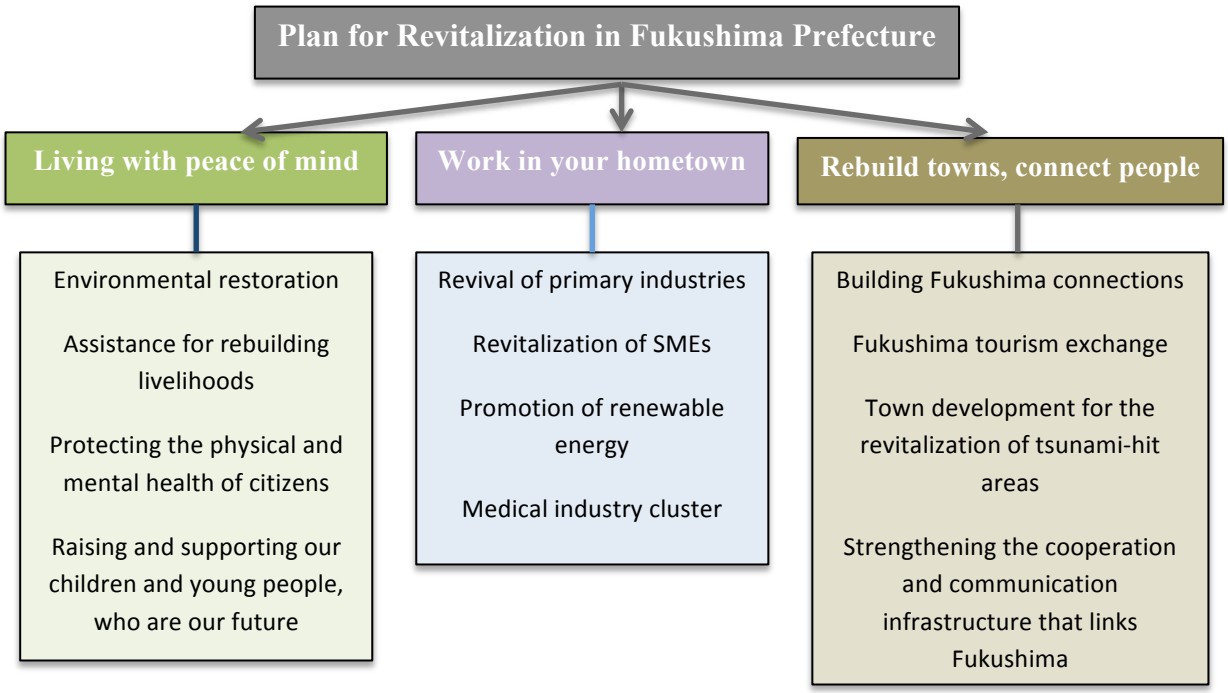
Different projects have "agricultural and food dimension" as well. For instance, the Environmental Restoration Project encompasses: Decontamination, Ensuring food safety, Waste disposal, and Establishment of Environmental creative strategy hubs. The Primary Industry Revival Project include measures for farming revitalization; the Renewable Energy Promoting Project comprise expansion of agricultural related solar, wind, and biomass energy; etc.

Furthermore, the Industrial Reconstruction and Revitalization Plan (2013) underline specific initiatives for Agriculture, Forestry and Fisheries aiming at "Create affluent and attractive rural districts and supply safe and trusted agricultural, forestry and fisheries products" through decontamination, improvement of production bases, efforts to help those engaged in agriculture, forestry and fisheries resume business, development of next generation of farmers and fishermen, stable supply of agricultural, forestry and fisheries products, branding and added value creation including the development of 'sixth-order' local

[36] The prefecture is calling on the national government and Tokyo Electric Power Co. to decommission all nuclear reactors in Fukushima.

industry, and development of the Fukushima Prefecture Coastal Agriculture Revitalization Research Center (provisional title).

**Figure 32. Priority Projects in Plan for Revitalization in Fukushima Prefecture (Second Version)**




Source: Fukushima Prefectural Government, December 2012

Among the specific Industrial reconstruction and revitalization projects are:

- Opening up Demand for Products and Services using the Regionally Based Collective Trademark System to establish Fukushima brands renewed (Nango tomatoes; Tsuchiyu Hot Spring; Aizu miso; and Soma ware) and new (Aizu Tajima asparagus), as charges, etc. are halved;
- Developing original new species and building new brands such as Paddy rice (four types); strawberries; asparagus; peaches; nashi pears; apples; gentians; and calla lilies as application fees, etc., reduced by 75%.

In the proposed fiscal 2013 budget of the central government a special attention has been given to Fukushima [Reconstruction Agency, 2014]. The government plans to set aside JPY50.3 billion to create temporary communities for the Fukushima evacuees, using funds to build public infrastructure including housing, schools and improved roads. A further JPY10 billion is to be budgets to improve the living environment for families with children (e.g. through creation of indoor gyms or playgrounds so younger generation return and once again settle in these areas). As part of efforts to revitalize the local economy, JPY14.8 billion has been allocated for renewable energy related initiatives as well as promoting tourism and agriculture. Particular focus is to be placed on maximizing the benefits of renewable energy

initiatives, as well as research and development in the area of pharmaceuticals and medical devices, with the aim of nurturing new globally competitive industries in Fukushima.

There have been also positive effects on product, technological and organizational development and innovation in agriculture and related industries. The enormous public funding as well as the novel business possibilities (and restrictions) have created new opportunities for revitalization and expansion of farming and agri-business in the most affected regions and beyond trough technological and organizational modernization.

There have been huge incentives for investment in soil decontamination, emergency aid, agri-food safety, production recovery and modernization, product and technologies innovations and diversification, agri-food marketing, reconstructing of business and infrastructure, other public and private research and development projects. All they have been opening up more entrepreneurial, employment and income opportunities for agricultural and general population, and diverse form of business and non-for profit ventures.

Furthermore, according to experts there are many companies (especially from outside of affected areas) wanting to lease in abandoned farmland and start large-scale corporate farming. That will let consolidate and enlarge farm size, introduces large-scale machineries and innovations, explore economies of scale and scope, increase investment and efficiency, diversify and improve competitiveness of farming enterprises.

For instance, rice paddies and farming equipment in the Nobiru district, Miyagi prefecture was ravaged by the tsunami and a large number of rice growers given up farming leasing out paddies to a local farming corporation [NHK World, June 12, 2012]. Before the disaster, the corporation managed 55 ha of 49 farmers but area increased to 81 ha after of 46 more farmers the disaster. The government has backed that move toward "mass farming" as well.

In addition to a great variety of brand name rice with the name of the district where it was grown and its brand name, there have appeared new brand name rice associated with environmental conservation and social contribution. The later include Fukko-mai[37], which is Sasanishiki rice grown in the disaster area of the Great East Japan Earthquake [The Japan News, October 16, 2014].

In Iwate prefecture farmers had to gave up tea production in the aftermath of the Fukushima nuclear disaster since long-term contracts were canceled by counterparts. Nevertheless, an innovator from Kunohe village managed to overcome challenges introducing a new special organically grown sweet tea ("ama-cha"), which is caffeine, tannin and calories free [NHK World, August 20, 2014]. The new developed product with enhanced quality and packaging (tea bags) won a gold medal among 8000 products in UK and it is planed to appear next year on markets.

The plant "no-soil" factories have been developing in Japan for many years and now about 130 on them grow lettuce, herbs, tomatoes, strawberries, etc. [JFC, 2012]. Expansion of this new technology has been perceived as an efficient way to overcome some of major challenges associated with the post-disaster recovery in the affected regions such as – degradated (salinized or radioactive) soils, destructed farms and equipment, lack of

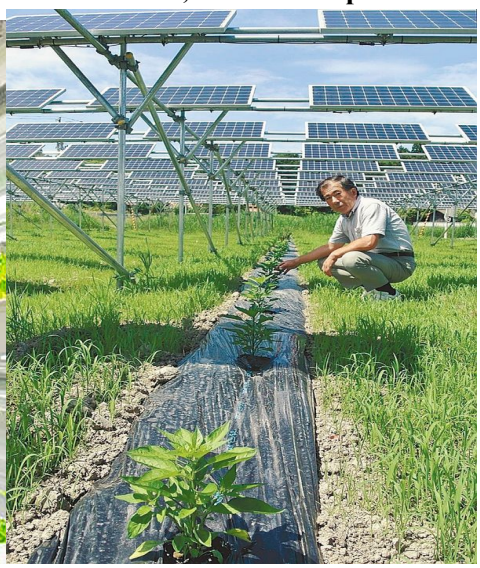
[37] "Fukko" means happiness, but also has the implication of reconstruction from the disaster.

employment and income opportunities, aging farm population, insufficient integration in supply chain, etc.

For instance, a large futuristic vegetable plant has been recently opened led by Fujitsu Ltd. (Picture 4). Aizuwakamatsu Akisai Vegetable Factory uses renovated 2,000 $m^2$ idle semiconductor-manufacturing clean (free of environmental contaminants and pests) room facility of the company in Aizuwakamatsu, Fukushima Prefecture [Fukushima Minpo News, 26 January 2014]. Production technology is chemical-free and completely controlled to maintain optimal growing and atmospheric conditions.

**Picture 4. Aizuwakamatsu Akisai Vegetable Plant, Factory, Fukushima prefecture**

**Picture 5. Solar sharing project in Odaka district, Fukushima prefecture**



Source: Lisa, 2014

The factory produces low-potassium leaf lettuce on a demonstration basis handling the whole process of production ranging from seed sowing to shipment. Initial daily output of 1,800 heads of leaf lettuce is to be boosted to a maximum 3,500. Production space will be also expanded (by 1,000 $m^{2)}$ in the future. About 30 people are employed as staff is expected to increase as output grows. The product, containing 86% less potassium on average, is intended for people suffering from chronic kidney disease requiring dialysis. It is also kid-friendly since a low nitrate level makes it less bitter and more appealing to children.

Produced in a clean-room environment, output features few bacteria and a longer shelf life. Main customers include hospitals and department stores in and outside Fukushima. Annual sales are targeted at about 150 million yen in the initial fiscal 2014 year and 400 million yen in the third year (fiscal 2016). The plant's production is more expensive than the common varieties, but they have medical value, grow year around, they are organic and most importantly radiation-free [Lisa, 2014].

Similar factory has been built in Natori, Miyagi prefecture where the tsunami inundated more than half of the farmland. A 5,900 $m^2$ plant factory producing 1.4 million bulbs of lettuce in a year and costing 4.3-million dollar was built on tsunami-hit area by 3 farmers after their farms were devastated by the disaster [NHK World, June 12, 2012]. Soil salt contamination has not been not a problem because the crops are grown in water while

water temperature is controlled to enable year round production. Output is sold to a nationwide restaurant chain operator. The biggest challenge was the high construction cost since the Government subsidies covered 80% and farm group had to borrow one million dollars. Farmers expect to pay back the borrowed money in 7 years.

A newly formed agricultural corporation Michisaki built indoor hydroponic "plant factories" on a just under seven acres rented land where tomatoes, spinach, and other vegetables grow under precisely regulated conditions from April 2013. It hires 10 full-time and 50 part-time workers, and market the produce to convenience stores and chain supermarkets. Using recycled heat from a nearby sewage treatment plant and fish byproducts from the port as fertilizer is also planed [Bird, 2013].

Another example is the state-of-the-art "Domed" Indoor Farms in Rikuzentakata, Iwate prefecture that harnesses solar energy and water to grow lettuce (Reconstruction Agency, 2014). The facility was built on 1.8 ha of land that was devastated by tsunami and transformed into a sustainable agriculture project with eight 5-by-30-meter domed indoor farms that utilize a number of innovative energy efficient features to reduce costs and improve production. This public-private partnership project was developed through a joint venture between Granpa Co. Ltd and Tobishima Corporation with the support of a JPY300 million subsidy from the Ministry of Economy, Trade and Industry in January 2012.

The facility was established in July 2012 and immediately began shipping produce. Each dome produces about 450 heads of lettuce per day, which is supplied to supermarkets, major sales retailers and sandwich chains. In addition to the solar power capabilities, the facility's innovative features include air conditioning system that uses an exhaust opening in the ceiling to improve energy efficiency during the summer and winter months.

The facility also incorporates a unique layered seedling planting design, which maximizes efficiency of space, increase production capacity and reduce labor and energy costs. Since lettuce produced at the facility is natural and guaranteed to be free from any forms of pollution, the local governments regard it as a promising new agricultural model that can appeal to customers while contributing to local revitalization. The project contributes to local economy by creating 20 new jobs and establishing sustainable business model of partnership with major food-chain actors.

Due to the project's success the same model has already been adopted in Minamisoma in Fukushima Prefecture where municipality plans to build 7 plant factories over the 3 years in the hope that local farmers can make a fresh start [NHK World, June 12, 2012].

For instance, a Kawauchi farmer and a local government official (Takeo Endo) leads a group that farm in a sealed-off hydroponics factory with a technique where plants are grown using minerals and nutrients dissolved in water without using soil [The Japan Daily Press, May 12, 2013]. Aluminum-clad, soccer field-sized building was completed in April 2013 and produce 8,000 heads of lettuce for every farming cycle. The lettuce factory use filtered ground water, which is proven to be free of contaminants. Operations started with 25 employees providing jobs to unemployed idle farmers who were by the nuclear leak disaster. The produce is sold in Fukushima's supermarkets labeled "Kawauchi".

Some young entrepreneurs have seen new business opportunities in the most devastated areas. For example, Kei Watanabe was living in Tokyo but nuclear disaster instilled in him a determination to return to Kawauchi village and help set up a state-of-the-art

hydroponic vegetable factory (Landline, 2013). The sealed-off factory costs $6 million, has a size of a soccer field, uses LED lights and a water solution infused with fertilizer, and is able to produce 8,000 heads of lettuce a day which are sold in supermarkets across Fukushima. Nevertheless, despite the product is safe many worry about radiation and the company has to overcome the "bad image" of local produce.

Another example is the innovative Luxury Strawberry Farms in Yamamoto, Miyagi prefecture where March 2011 disaster wiped out nearly all strawberry farm greenhouses (Reconstruction Agency, 2014). The project has been realized by IT specialist Hikoki Iwasa, who combined technology expertise with passion for reviving hometown agriculture. He established the General Reconstruction Association (July 2011) and has been able to rebuild the strawberry industry using advanced IT systems and creating something new and innovative. The business uses technology to optimize the climate for growing strawberries by automating windows and sprinkler systems.

Local strawberry farmers, who lost their jobs as a result of the tsunami, have been hired and their expertise used to enhance product quality and secure knowledge digitally for future generations. The business led to the stabilization of the strawberry industry in Yamamoto and helped building a high-quality luxury brand image. The unit price has more than tripled from about ¥980 per kg before the tsunami to ¥3,000 per kg with the luxury "migaki-ichigo" strawberries selling for ¥1,000 per piece.

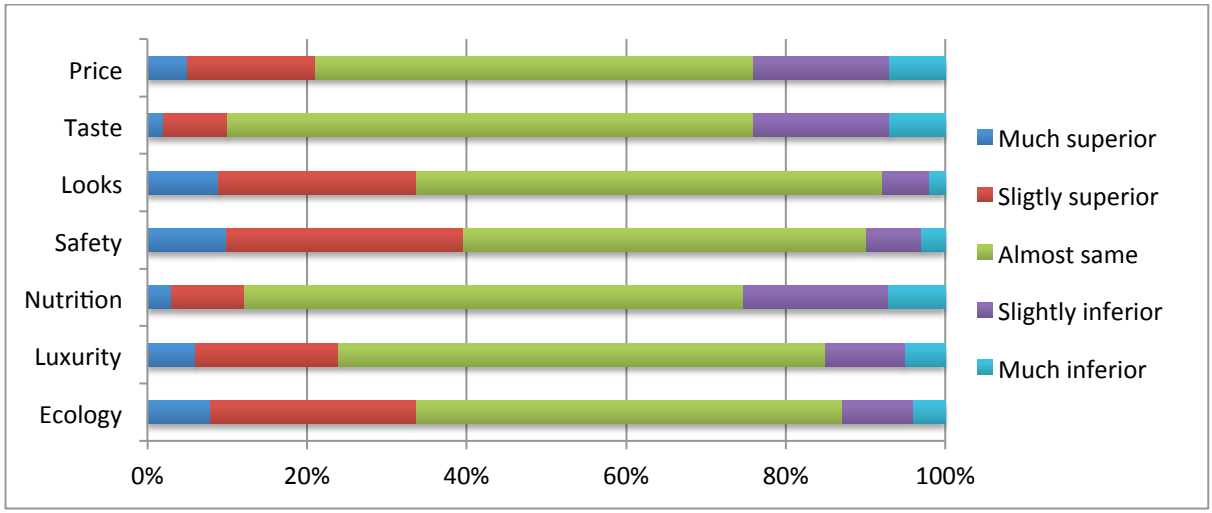
The plant factory technology has a number of advantages: capacity for stable year-round production; possibility to be installed on non-farmland areas (industrial parks, vacant stores etc.) in shopping districts; safe and high-quality agricultural produce with no or minimal pesticide use; employ novice farmers due to the light workload and the ease of standardizing procedures; comfortable work environment in which the elderly and people with disabilities can work with ease.

Comparative survey shows that the consumers' awareness of plant factory has increased in recent years (from 69% in 2009 to 76% in 2012) while the purchase experience also raised (from 9% to 17% accordingly) [JFC, 2012]. Furthermore, consumers find superiority in the plant factory vegetables over the conventional farming in terms of safety, looks, ecology, etc. (Figure 33).

What is more, the financial institutions (e.g. JFC) provide long-term financing with fixed, low-interest rates, taking into account unique business characteristics such as long investment recovery periods and unstable incomes influenced by the weather risk [JFC, 2012]. Besides, JFC also serves as a safety net for the agriculture, providing quick and flexible finance for disasters, etc.

Furthermore, in response to March 11 disaster the JFC established an interest-free Special Earthquake Loan for those who suffer from direct or indirect damages by the earthquake or tsunami. The Agricultural Improvement Loan is an interest-free financing program that supports farmers' challenges such as when they adopt a new crop or technology. Moreover, for the Eco farmers the maximum repayment periods can be extended from 10 years to 12 years and the maximum loan amount from 80% to 100% of total project costs.

**Figure 33. Consumer image for vegetables produces in plant factory comparing to conventional farming (percent)**




Source: Japan Finance Corporation, 2012

In order to support further challenging projects the JFC also provides Capital Subordinated Loan [JFC, 2012]. The later is not recognized as debt but as capital in borrowers' financial statement because there is no need to repay principal for the first 8 years and interest rates are reviewed regularly according to the financial performances.

Nevertheless, there a number of challenges associated with that new technology such as: high building and running costs, difficulties in establishment of cultivation technique, and securing of human resource development, difficulties to use existing food certification system (because fertilizers for nutriculture are used to the water prepared for breeding and cultivation)[38], etc. Under the new technology plant factory produce is a little more expensive (less competitive) than products grown outdoors or in greenhouses. Therefore, the key to success is to secure stable outlets for marketing the output through close vertical integration. Since food and food service industries need a stable supply of good quality produce it is extremely important to build business ties with vertical counterparts to secure outlets for the produce at the initial stage.

Another prospective technology applied in the disaster-hit area is "solar sharing" - a process in which farmers generate solar power on the same land where they grow crops.

Farmers in Fukushima prefecture have been testing that new technology and hope to sell power to help improve farmland or cover losses in income caused by radiation fears [Asiaone News, June 26, 2013]. In Minami-Soma, the prefectural government has begun a model project (Picture 5). A 2,000 square meter piece of farmland in the city's Odaka district is an example of solar sharing. On the farmland, 500 solar panels, each 70 centimeters by 1.6 meters, are installed atop 1.9-metre poles. Below the rows of panels, eggplants, chili peppers and produce are grown on an experimental basis.

The prefectural government set up the project to determine how the use of the panels affects plants. An increasing number of farmers affected by the nuclear plant crisis want to

[38] Since March 2012, a new third-party certification system evaluating the safety of vegetables produced in plant factories has been introduced.

convert their land into mega solar power plants while continuing to grow crops on the same land. Farmers can sell the electric power to the utilities because since July 2012 there is a system that obliges electric power companies to buy power generated by renewable energy sources at fixed prices. However, MAFF set some conditions for farmers wanting to use their land for solar sharing – e.g. they must continue to cultivate the land, and annual crop volume cannot fall 20% or more compared with the regional averages after introducing solar sharing.

In addition, Eco Ene Minami-Soma Kenkyu Kiko, an incorporated foundation, plans a solar sharing project on about 600 $m^2$ of farmland. According to the foundation about 1 million yen of annual revenue is expected from selling the electric power generated in the project [Asiaone News, June 26, 2013]. Rapeseed has been already planted because its oil is free of contaminants even though the plants themselves take in some radioisotopes such as those of cesium.

In the end of 2013 the community run project Renewable Energy Village (REV) boasts 120 photovoltaic panels, generating 30 kilowatts of power, which is sold to a local utility [Gilhooly, 2013]. Plans are afoot to put wind turbines on some of the land. Recreational and educational facilities as well as an astronomical observatory will also be built if further funding can be secured.

Generous feed-in tariffs (renewable energy payments) set by the government also support the project. While the proceeds from the crops and energy will be ploughed back into the project, the REV's creators hope the model will be mimicked by farmers whose livelihoods were decimated by the nuclear disaster.

Other large scale solar projects[39] treat farming traditions since if farmers sell up land entire communities will be wiped off. The REV model offers a way around this issue – it protects farmland and communities, and with two parallel revenues creates increased prosperity compared with before the disasters.

Minamisoma's Solar Agripark opened in spring 2013 and combines a 500KW solar power facility with indoor plant farms [Reconstruction Agency, 2014]. A new children's park is being created, where youth affected by the disaster can receive hands-on learning experience featuring renewable energy and advanced agriculture, helping to educate the future leaders of the region on the importance of sustainability and energy efficiency. This project is supported by a JPY115 million investment from Toshiba and subsidies from the MAFF totaling JPY90 million. Energy generated from the solar facility is used to power the indoor farms, while surplus energy will be sold back to the grid through the feed-in-tariff system.

Other innovations have been also experimented. For instance, Dutch bio-farming company Waterland International and a Japanese federation of farmers made an agreement in March 2012 to plant and grow camellia on 2000 to 3000 ha [The Mainichi Shimbun, Aril 4, 2012]. The seeds will be used to produce bio-diesel, which could be used to produce electricity. The affected region has a big potential for production of clean energy since some

[39] Since the feed-in tariff was introduced (mid-2012), several other large-scale solar parks around Japan have been announced or are already in operation – but none uses solar sharing. Most solar parks have solar panels resting on the ground itself (including country's largest also in Minamisoma), which makes growing crops impossible.

800,000 ha could not be used to produce food anymore. Experiments have been carried out to find out whether camellia was capable of extracting cesium from the soil since experiment with sunflowers had no success.

Various areas in Tohoku have been also considering rapeseed as a source of bioenergy for the future [NHK World, July 29, 2013]. The recovery project called Nanohana, or Rapeseed Project is run by a company. The oil extracted from the rapeseed is processed into motor fuel. For one liter about 30 kilograms is needed. Concerned about environmental problems, this company started manufacturing biodiesel several years ago from used cooking oil that was collected through their cleaning services. Now they apply the same technology, for processing rapeseed oil into biodiesel fuel. Since the rapeseed is being grown on a very small scale the process is far from turning a profit.

Test runs on diesel vehicles have been completed. They hope to eventually produce and sell the biodiesel for use in ordinary vehicles. The main problem is the lack of farmland to grow rape. Members of the Rapeseed Project are focusing on farmland contaminated by saltwater. It is believed that if salt-resistant rapeseed could be grown there, the businesses could take off, which would also bring considerable relief to the farmers who lost their fields.

Meanwhile Tohoku University scientists have been conducting research on rapeseeds, their resistance to salt, application and improvement. The leafy part of the rape plant called nabana, is edible so it can be sold as food. Farmers can earn income from this plant by extracting the oil or selling it as food. The oil can be used to make soap, candles or biodiesel fuel so the plant can be used according to the needs of each farm. The project is expected to take a minimum 10 years before achieving practical results.

Furthermore, Nonprofit body Koriyama Area Technopolis Promotion Organization (KATPO) has been set to begin a demonstration test of a hybrid renewable energy system combining geothermal and solar power generation for the heating of an agricultural greenhouse at the Iwase Ranch in Kagamiishi, Fukushima prefecture [Fukushima Minpo News, January 21, 2014]. Two greenhouses are built for flower and vegetable plantation starting March 2014, with one of the facilities set aside for the hybrid energy system.

The experiment is implemented under the Fukushima prefectural government's project for the development of next generation technology for renewable energy. KATPO is the coordinator and study is done by Nihon University, Naito-Kogyosho Co. of Koriyama, Suzuki Seisakusyo Co. of Tanagura, Rhizome of Koriyama, and SK Electronics Industry Co. of Sukagawa. A budget of 50 million yen has been allocated to the experiment. The period of demonstration is expected to be around three years. Expertise and comparative data (on energy efficiency and cost of heating) obtained from the project will be made available to farmers after cost effectiveness has been confirmed.

An increasing applications of ICT in agriculture have been also reported leading to precision technologies, higher farming productivity, efficient use of resources, enhanced food safety, and improved relations with counterparts and consumers [NHK World, July 15, 2013].

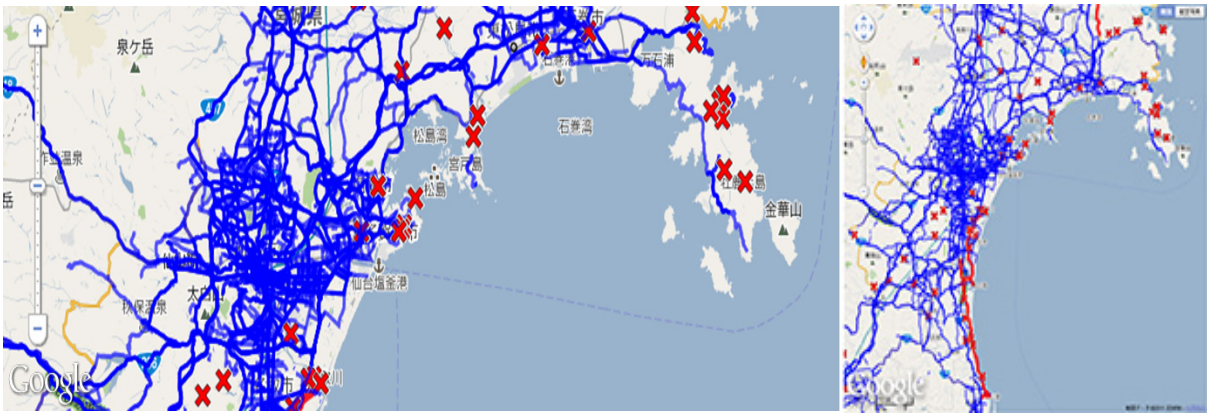
The demand for proper measurements have induced numerous smart innovations for agriculture and related industries. For instance, a team of researchers from Fukushima University, PerkinElmer Japan Co. (a Japanese subsidiary of U.S. technology firm PerkinElmer Inc.), Japan Atomic Energy Agency, and Japan Agency for Marine-Earth Science and Technology has developed a new system that can quickly analyze the density of

strontium 90 in soil (Fukushima Minpo News, September 19, 2013). The new system cuts the time of analysis to only 20 minutes from the existing one of two weeks to one month. The smallest amount of strontium detectable in soil is about 5 Bq/kg a figure that is sufficient to be deemed a risk to humans.

Similarly, a teach of scientists developed a car-borne radiation measurement method for the farmland and roads in the Minamisoma Ota area of Fukushima, and a community led radiation measurement framework was established and implemented [Furutani et al. 2012]. As a result, radiation measurements and visualization for farmlands, paddies, and forests, which had been conventionally unachievable, has been made possible. Furthermore, effective verification of the effect of decontamination also became possible by feeding back radiation measurement results before and after decontamination to residents.

Another example for rapid cooperation for disaster recovery has been initiated by a nonprofit organization promoting intelligent transportation systems. The day after the massive quake and tsunami in 2011, ITS Japan, requested related companies such as Toyota Motor Corp., Honda Motor Co., Nissan Motor Co. and car navigation system maker Pioneer Corp. to provide it with probe data including information such as the roads driven by the vehicles. On the same day, Honda and Pioneer began providing probe data to users of their products while Toyota began providing probe data on March 16. On March 19 ITS Japan began providing consolidated probe data compiled from Toyota, Honda, Nissan and Pioneer. Drivers get the data from either the car navigation systems in their cars or ITS Japan's website via smartphones or personal computers (Map 16).

**Map 16. Integrated probe data for traffic used in Tohoku region after 2011 disasters**




Source: Resilient ITS

New use of probe data helps speed up Japan's recovery[40]. Truck drivers could not have delivered the necessities of life to evacuees who lost their homes after the quake and tsunami without knowing which roads were clear of debris. Road information from cars that had already driven in the coastal area of the Tohoku region was helpful for those who were to come later to continue delivering food, blankets and other goods for months. According to

[40] On April 28, 2011, ITS Japan stopped providing probe data to the public in the Tohoku region due to declining demand as drivers already became aware of which roads were clear of debris by then.

users the system was really helpful and it would have been even better if the data showed the breakdown of the size of trucks that had driven each road.

Individual carmakers had already developed a system in which drivers share probe data. Consolidating the system from multiple companies was essential because more probe data give more precise information to drivers. The probe cars have data-sending functions installed in their navigation systems. Drivers who volunteer to offer the data obtain the function when they purchase sophisticated types of navigation systems[41]. Currently, approximately one in every several hundred cars is a probe car in the Tohoku area, while the rate is higher in urban areas.

Optimism of business prospects in the post-disaster years could be demonstrated with the statement of one of the interviewed by us experts - Mr.Kishi, running a processing company: "Currently there are many subsidies supplied in Fukushima. We think that we could change this to a chance by producing new product from Fukushima. Our company is now on work for next year's new product and planning for capital investment (June 5, 2013).

In the years after Fukushima nuclear accident an increase interests in renewable energy introduction has been reported, including in the sector "Agriculture". In most affected regions and nationwide the later has been motivated by the new opportunities of development (including Government support measures) as well as souring costs of energy supply.

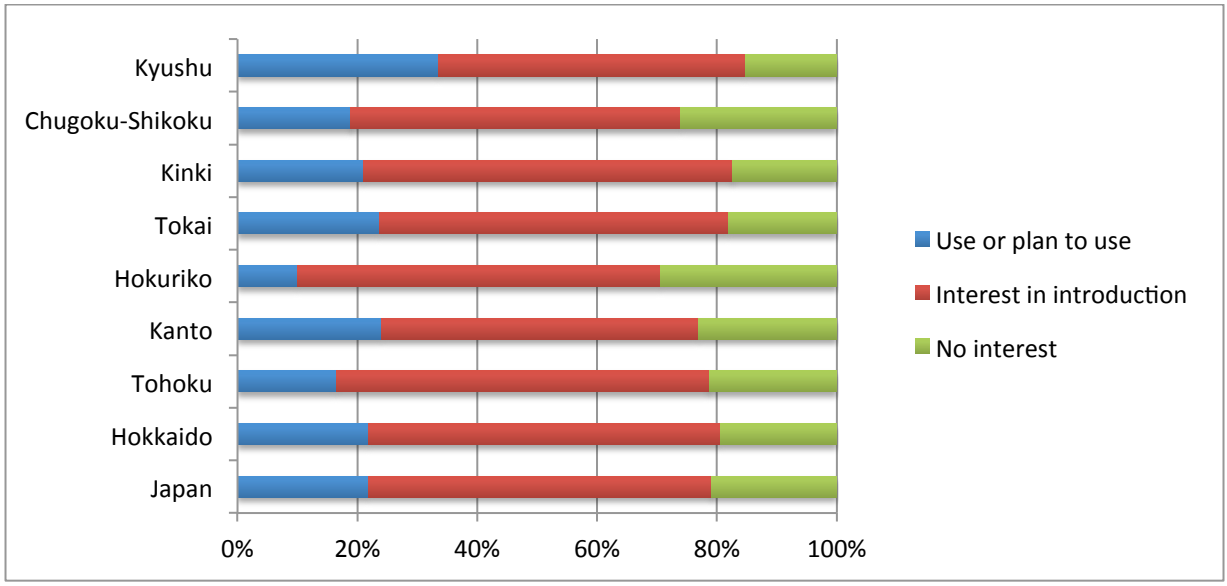
Recent survey has found that 11.6% of the Agricultural Management Entities already use renewable energy, 10.2% of them are planning to do so, while 57.3% of all report interests in introduction of renewable energy [JFC, 2014]. The highest rate of application or plans for introduction of renewable energy are among agricultural producers of Kyushu and Kanto regions (Figure 34). In Tohoku farms the transition to renewables is among the lowest in the country but there is a high interest in introduction of this type of energy in future. On the other hand, the greatest are shares of farms with "No interest to renewables" from Hokuriko and Chugoku-Shikoku regions.

The highest rate of usage or planning of introduction of renewable energy is in Broilers, Dairy and Tea productions, while the lowest is in Rice cultivation (Figure 35). At the same time the largest shares of farms with "Interests" in renewable energy is among Rice, Vegetables in facilities and Mushrooms producers. On the other hand, the greatest portion of producers with no interest in that issue is among the Hence farms.

There is a great variation in the interests in the type of renewables by producers in general and in different regions on the country (Figure 36). The "Solar" energy is reported by the greatest number of agricultural producers who use, plan to or are interested in introduction of renewable energy in all regions of the country. The Tea and Upland crop producers are particularly strongly using or interested in that energy source (97% and 95% of them accordingly) while the Broilers producers relatively less (82.1%).

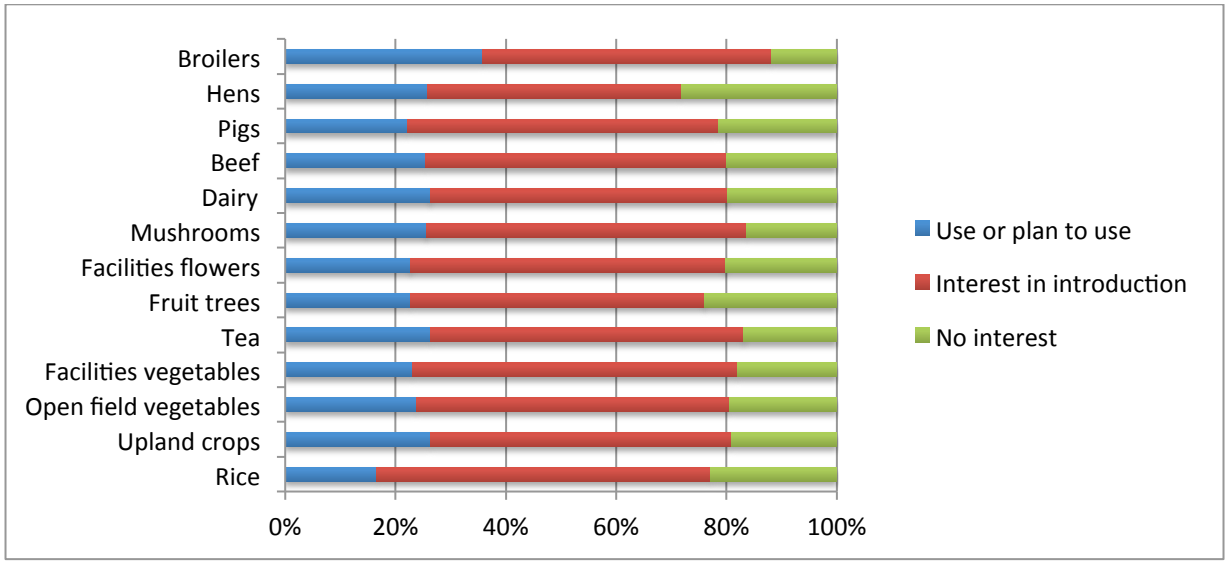
[41] ITS Japan had originally anticipated probe data to be used to mitigate traffic jams and notify drivers of spots with frequent accidents as the data also show where probe cars put on the brakes or stopped.

**Figure 34. Interests for renewable energy introduction in agriculture in Japan (January, 2014)**




Source: Japan Finance Corporation

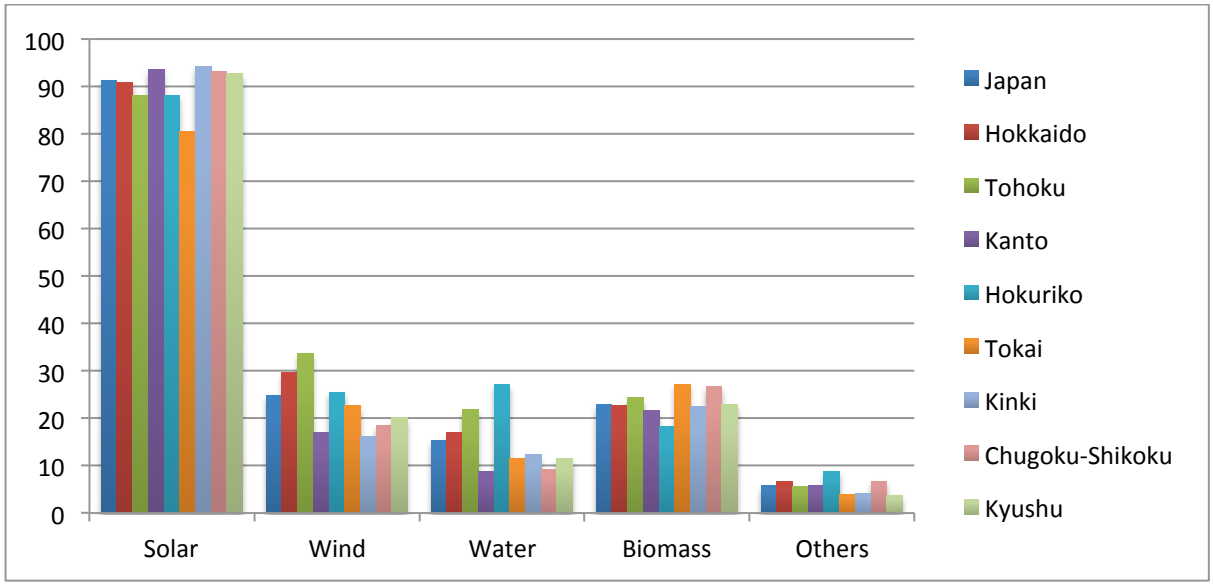
**Figure 35. Interests for renewable energy introduction in different subsectors of Japanese agriculture (January, 2014)**




Source: Japan Finance Corporation

Almost every forth of the farms using, planning or interested in introduction of renewable also report Wind energy. The biggest interest to this energy source is shown by the farmers in Hokuriko region while the lowest interest in Kanto region. Above a third of interested farms from Tohoku region also indicate that source of energy. The application or interest to that energy source is the highest among Rice producers (31.3%) and lowest in Mushrooms producers (8.7%).

**Figure 36. Interests in different renewable energy among farms* using, planning or interested in introduction of renewables in Japan (January, 2014)**




Source: Japan Finance Corporation * up to 3 selections

The third most important source of energy in agriculture is Biomass and the biggest interest to that energy source which is shown by the farms in Tokai, Chugoku-Shikoku and Tohoku regions. Usage and interest to biomass is the highest among Pig, Broilers, and Dairy farms (58.7%, 57.1%, and 55% of them accordingly) and lowest in Tea producers (6.1%).

Relatively good portions of producers in Hokuriki and Tohoku regions are also interested in Water as a renewable energy source. The application of or interests of hydro energy is the highest among rice producers (23.8%) and weakest in Hence farms (1.7%).

## V. Impact on food industries

After March 2011 the food industry in the disaster regions and throughout the country was also seriously affected by the production drops, business suspensions, distribution ruptures, etc. due to damaged plants, rolling blackouts, packaging material production shortages, gasoline shortfalls, etc. [MAFF, 2011].

Regular surveys on food industries dynamics reviled that 71% of the country's food companies were "affected" by the March disasters, including more than 35% "still affected" at the beginning of 2014 (Figure 37).

The strongest hit were food-industry companies in Tohoku's most affected regions (Iwate, Miyagi and Fukushima prefectures) (92.5%) and in Northern (84.6%) and Southern (82.3%) Kanto region. What is more, a significant share of food industry was not still recover from the disaster by the end of that year in Iwate, Miyagi and Fukushima prefectures and Northern Kanto region.

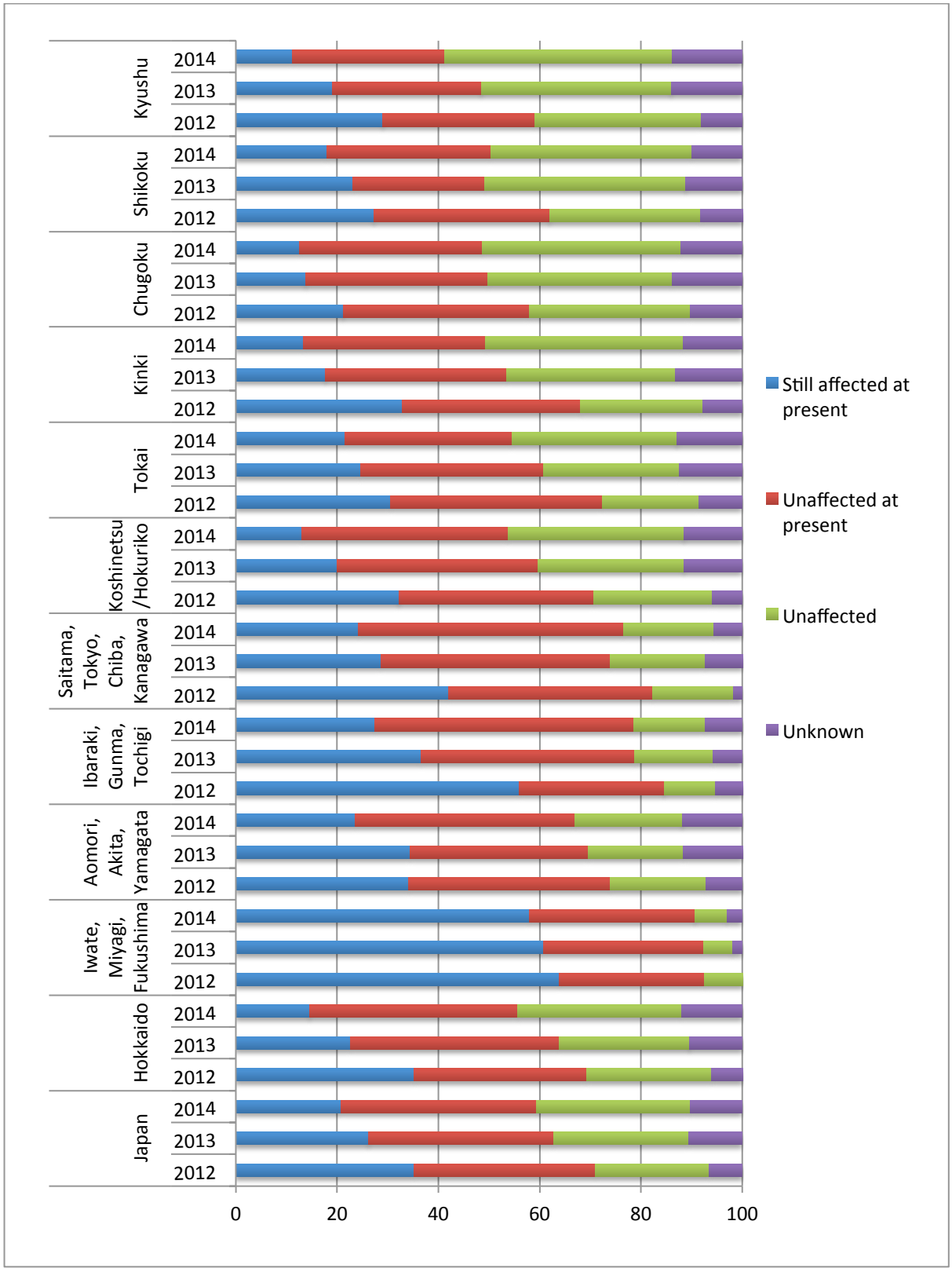
Relatively less affected by the disasters were food industry in Chugoku (57.9%), Kyushu (59%), and Shikoku (62%). Despite the fast recovery a significant amount of food companies in these regions reported they were still affected in end of 2011.

Similarly, 57.9% of country's food companies have been negatively affected by the Fukushima nuclear disaster as about 35% still affected in the beginning of 2014 (Figure 38). The most severely affected have been the companies in Northern Kanto (83.4%) and in Tohoku's Iwate, Miyagi and Fukushima prefectures (81.9%).

In the most impacted Fukushima prefecture 93.8% of all food companies have been adversely affected by the nuclear accident, including 92.6% of them "still affected" in the beginning of 2014 [Japan Financial Corporation, 2014]. On the other hand, food industries in Kyushu have been relatively less affected by the nuclear disaster as only 38.8% of the companies report negative impact on activity (including 20.5% still impacted).

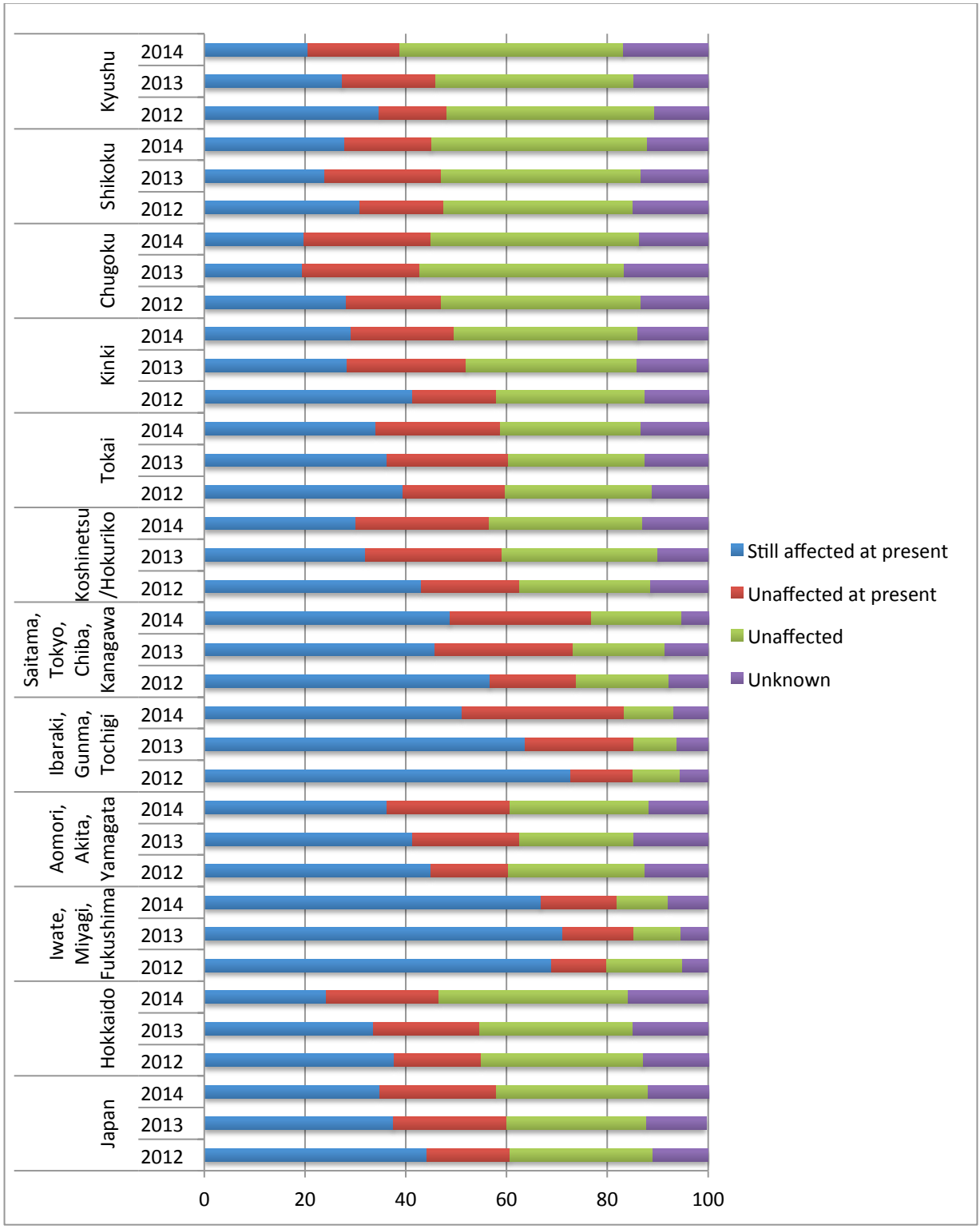
In 2011 the most common reasons for the negative impact of the triple disasters was the reduction in sales volume, increase in the price of ingredients and materials, and the decrease in the demand and number of costumers (Figure 39). There has been also reported a great variation of the individual factors for the adverse impact of nuclear accident in different regions of the country.

**Figure 37. Earthquake-tsunami disaster effects on food industry in Japan (January, 2012, 2013, 2014)**



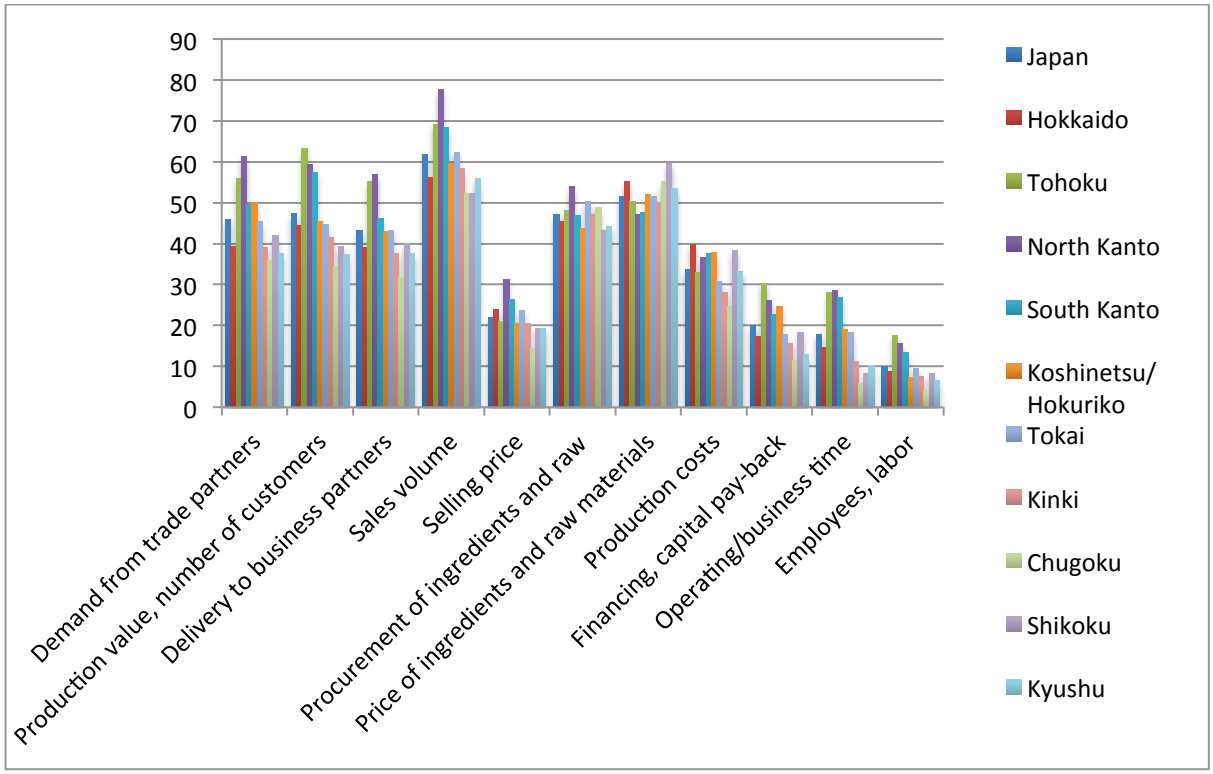

Source: Japan Finance Corporation

**Figure 31. Impact of Fukushima nuclear power plant accident on food industry in Japan (January, 2012, 2013, 2014)**




Source: Japan Finance Corporation

**Figure 39. Share of food industry companies in Japan affected by Great East Japan Earthquake (September, 2011)***



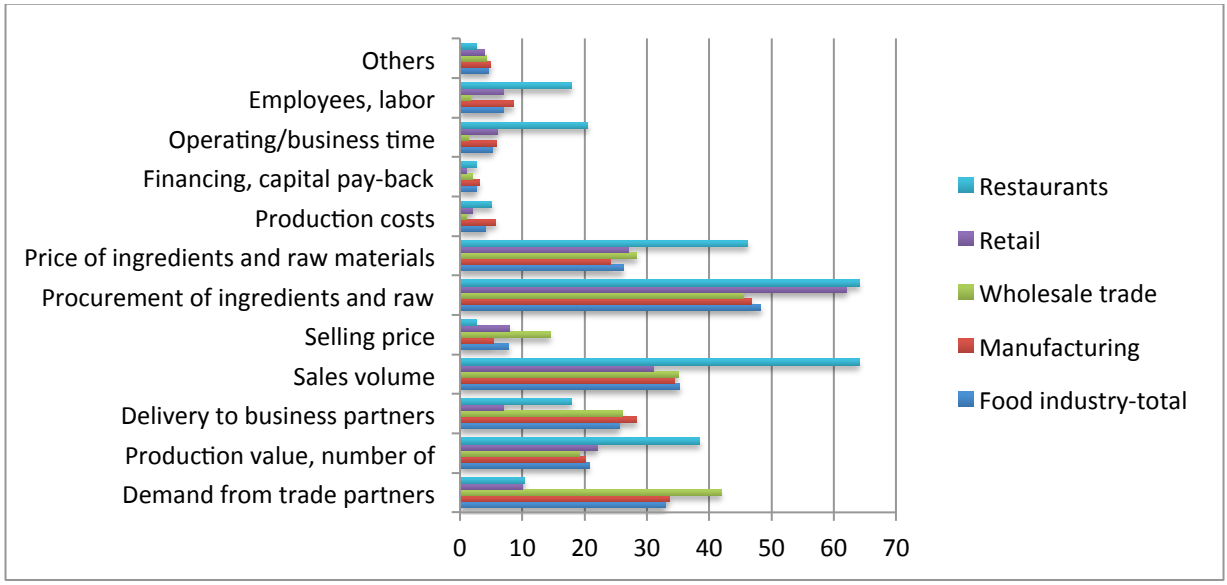

*"increase" for Price of ingredients and raw materials and Production costs, "decrease" for all others

Source: Japan Finance Corporation

There is also difference in the adverse impact in different subsectors of food industry. According to 2014 survey the earthquake and tsunami have affected negatively the selling prices, procurement of ingredients and raw materials, and demand from trade partners of a good number of food industry companies (Figure 40). Disasters affected uniformly strong the Procurement of ingredients and raw materials of the majority of companies in all subsectors. In addition, disasters affected the Demand from trade partners of many companies in Wholesale trade, and the Sales volume, number of consumers, and the Price of ingredients and raw materials in Restaurants business.

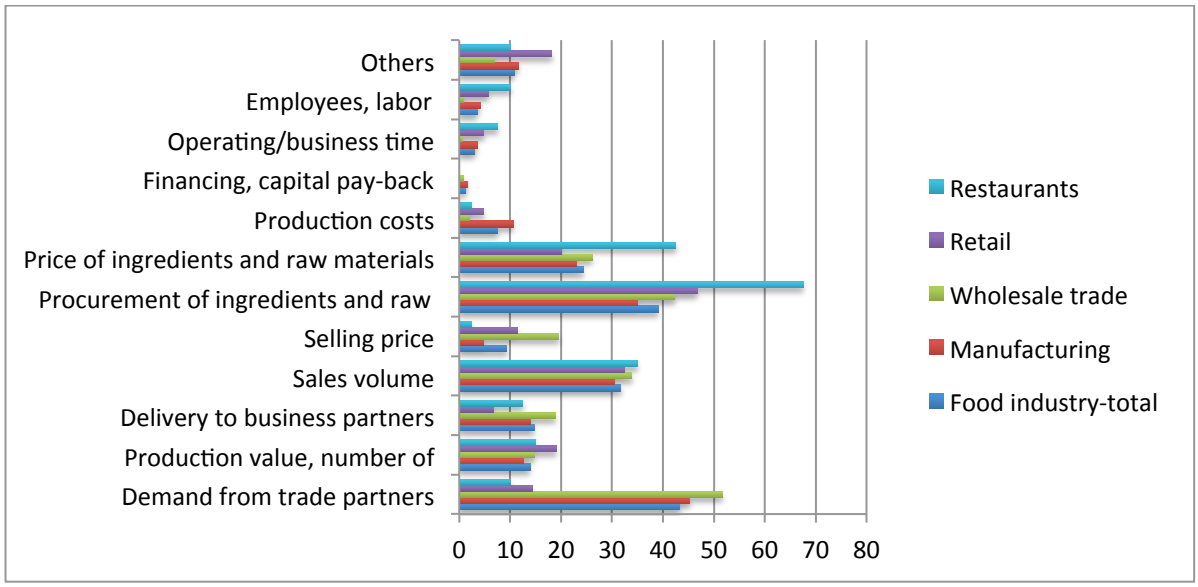
Fukushima nuclear disaster has also affected mostly Demand from trade partners, Sales volume, and Procurement of ingredients and raw materials of many food companies (Figure 41). However, while most food Manufactures and Wholesale traders suffered mainly from the decrease in the demand of trade partners, for the most the Restaurants operators and Retailers the Procurement of ingredients and raw materials has been predominately affected by the nuclear accident.

**Figure 40. Impact of earthquake and tsunami on overall management of food industry in Japan (January, 2014)**




Source: Japan Finance Corporation

**Figure 41. Impact of Fukushima nuclear plant accident on overall management of food industry in Japan (January, 2014)**




Source: Japan Finance Corporation

The food industry in Fukushima and neighboring regions has been also severely affected by the nuclear accident. For instance, 2013 survey of 55 food industry companies in Fukushima prefecture show that three quarters of them have seen sales declined after the nuclear accident (Table 10). Moreover, in 40% of companies the 2012 sale decreased comparing to 2011. Consequence of declined sales, prices, restriction in shipment, and/or increased costs, more than 83% of the companies report a decrease in income after the nuclear

accident. On the other hand, a great part of companies with no income changes say that is a result of received compensations.

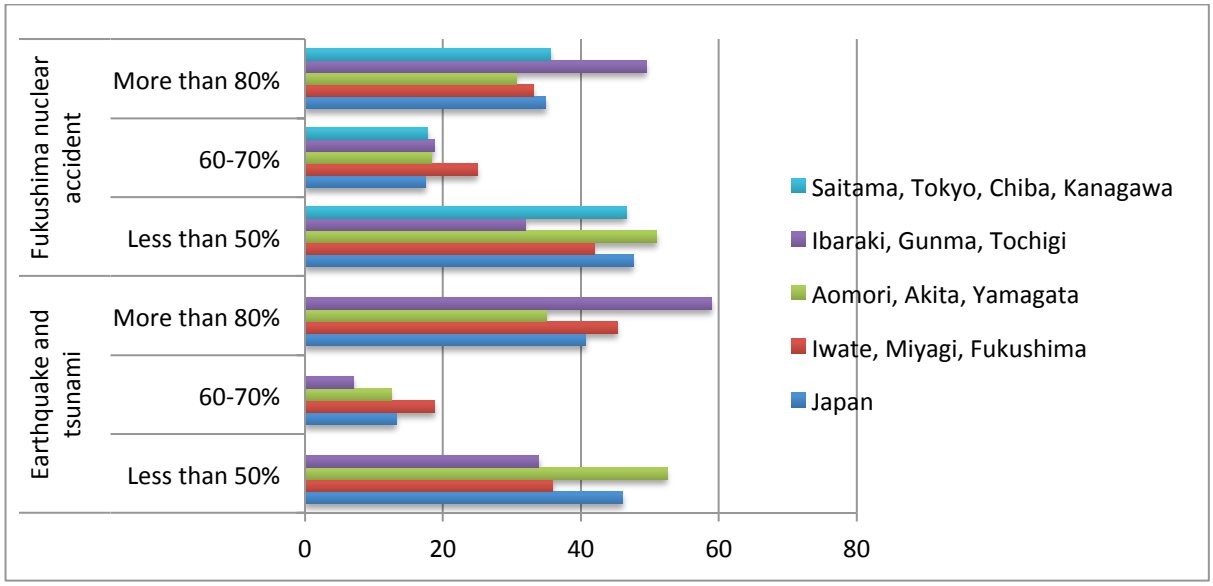
**Table 10. Impact of 2011 nuclear disaster on food industry companies in Fukushima prefecture**

| | Companies with changes in sales | | | | | | Companies with changes in income | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | Decrease | | | | Increase | Increase | Decrease | No |
| | | ≤ 10% | 11-20% | 21-30% | 31-40% | | | | |
| % | 7.3 | 29.1 | 23.6 | 21.8 | 5.4 | 12.7 | 3.6 | 83.6 | 12.2 |
| **Sub-sectors** | grocery, milk, fermented milk drink , wrapping | pickles, canned food, breed, confectionary, noodles, ramen, liqueurs, sake, flours, soya source, chicken and pork meat | ramen, pickles, and delicatessen, milk and milk drink, chicken meat, flours, delicatessen, fruits and vegetables, wrapping | pickles, honey, peach, cucumber, dried persimmon, sake, noodles, beer, milk and yogurt, miso | kimchi, chicken meat, soya sauce | cut vegetables, miso, pickles, fish processing, sake, ice cream and frozen desserts, konnyaky and tokoroten, meat | meat, konnyaky and tokoroten, liqueurs | pickles, ice cream and frozen desserts, honey, ramen, delicatessen, flours, noodles, confectionary, sake, peach, cucumber, dried persimmon, milk, milk drinks, yogurt, chicken and pork meat, beer, soy source, miso, cut vegetables, canned food, kimchi, breed and confectionary, fruit juice, ramen, miso, fish processing, fruits and vegetables, wrapping | grocery, noodles, sake, wrapping, |

Source: Fukushima Food Industry Organization, February 2013 survey

There has been different speed of recovery in the affected food industries in different parts of the country. Until January 2013 more less than 50% of pre-disasters operations were reported in 46.1% of the earthquake and tsunami affected food companies, and in 47.6% of Fukushima nuclear accident affected food companies (Figure 42). The biggest progress in disasters destructed food companies has been achieved in Ibaraki, Gunma and Tochigi prefectures, while the slowest one in Aomori, Akita and Yamagata prefectures.

**Figure 42. Extent of food industry recovery from Great East Japan Earthquake effects (January, 2013)**




Source: Japan Finance Corporation

Before the March 2011 disaster only 6.8% of the food industry companies had Business Contingency Plans [Japan Financial Corporation, 2013]. After the disasters 6.1% of the companies formulated such plans, 16.2% are considering to do so, and 22.6% have plans for development in the future. The biggest companies (10 or more billion yes of annual sales) are in more advance stage in formulation of BCP after the disasters.

## VI. Radioactive contamination of agri-food products

A large scale contamination of crops, livestock and agri-food products by radionuclides has happened as a result of the direct radiation exposure, the fallouts and distributed by wind and rains radioactive elements, the crop and livestock uptakes from leaves, soils, waters and feeds, the diffusion from affected inputs, buildings and equipment, the dissemination through transportation and wildlife, etc.

On March 18, 2011 the radioactive iodine exceeding the provisional regulation limit[42] was detected in raw milk produced in Fukushima prefecture [MAFF, 2011]. On the next day 54,100 Bq/kg of iodine-131 was found in a sample of spinach, taken in Hitashi, Ibaraki prefecture (approximately 120 km south of the nuclear plant) [ISRN, 2012]. In a kukitachina sample (local leafy vegetable) taken on March 21 in Mitomiya, Fukushima prefecture (70 km west of the plant) was detected 41,000 Bq/kg of Caesium-134 and 41,000 Bq/kg of Caesium-137 [ISRN, 2012].

On March 21, 2011 restrictions on food distribution were launched instructed by the Director General the Nuclear Emergency Response Headquarters[43]. Distribution restriction was put on milk from Fukushima prefecture and spinach and kakina in Ibaraki, Tochigi, Gunma, and Fukushima prefectures. On March 23, similar restrictions were placed on more leafy vegetables (komatsuna, cabbages) and all flowerheads brassicas (like cauliflower) in Fukushima, while parsley and milk distribution was restricted in Ibaraki prefecture.

According to reports virtually all milk and vegetable samples taken in Fukushima (March 18–21) and Ibaraki (March 16–22) prefectures were above the safe limit [IAEA, 24, 2011]. Samples from Chiba, Ibaraki and Tochigi prefectures also had excessive radiation levels in celery, parsley, spinach and other leafy vegetables. In addition, certain samples of beef mainly taken on March 27–29 showed concentrations of iodine-131 and/or caesium-134 and caesium-137 above the regulatory levels.

On April 8, 2011 the "Policy on rice planting" was announced and restrictions on rice planting on 11,200 ha imposed (April 22, 2011)[44] in restricted areas, planned-evacuation areas, and areas prepared for evacuation in case of emergency in 12 municipalities [MAFF, 2011]. Voluntary moratorium of additional 2,000 ha of rice paddies was also introduced[45].

Other agricultural products from Tochigi and Ibaraki prefectures were also found to exceed the government limits such as pasture grass collected on May 5, approximately 11 times the state limit of radioactive cesium [NHK, May 13, 2011]. Hay and straw were found contaminated with Cesium[46] 80 kilometers from the nuclear reactors.

[42] Provisional regulation values for radioactive substances under the Food Sanitation Act were set up for drinking water and agri-food products on March 17, 2011 and for fish and shellfish on April 5, 2011 [MHLW, 2011].

[43] Shipment restrictions are lifted if radioactive substances fall bellow the regulation valued in three consecutive weekly inspections (implemented from April 8, 2011).

[44] on farmland that contained more than 5,000 becquerels per kilogram of radioactive cesium.

[45] Together with the areas under mandotoy ban it makes 8.9% of all paddies in Fukushima prefecture.

[46] No Iodine-131 was detected after mid-May [ISRN, 2012].

Contaminated beef was traced on farms as far as 100 km away from the Fukushima nuclear plant. The cesium was found in meat from animals fed by contaminated rice straw[47]. By July 26, 2011 it was known that more than 2,800 cows fed with cesium-contaminated food were shipped to markets in 46 of the prefectures (with exception of Okinawa)[48]. Measurements of some beast shipped form Miyagi were 1,150 Bq/kg.

All shipment of beef raised in Fukushima prefecture was prohibited after July 19, 2011, from Miyagi prefecture on July 28, and Iwate prefecture on August 1. Later on the shipment of cattle and meat was only allowed after examination, and when the level of cesium is below the regulatory standard[49]. On August 3, 2011 the local government in Shimane prefecture decided to conduct radiation checks on all beef cattle to ease consumer concerns about food safety[50]. Furthermore, authority introduced testing on all beef heads for radionuclides in 4 prefectures (Fukushima, Iwate, Miyagi and Tochigi) and testing on all farms in 3 other prefectures (Ibaraki, Gunma, and Chiba)[51].

In addition, MAFF urged farmers and merchants to renounce the use and sale of compost made of manure from cows that may have been fed the contaminated straw. The measure also applied to humus from leaves fallen from trees. That "voluntary ban" could be lifted after developing guidelines for safety levels of radioactive cesium in compost and humus [JAIF, July 26, 2011].

On August 19, 2011 radioactive cesium (at one-tenth of the government limit) was found in a sample of rice from Hokota, Ibaraki prefecture about 160 km south of the nuclear plant. On September 16, 2011 measurements of radioactive cesium in rice conducted in 17 prefectures found radioactive materials in 94 locations (4.3% of the total). The highest level detected in Fukushima prefecture was 136 Bq/kg.

On September 23, 2011 radioactive cesium in concentrations above the government safety limit was found in rice samples collected in the northeastern part of Fukushima prefecture. Rice-samples taken before the harvest showed 500 Bq/kg in Nihonmatsu. The government ordered a two-way testing procedure of samples taken before and after the harvest. Pre-harvest tests were carried out in nine prefectures of Tohoku and Kanto regions. Farmers who already started harvesting were ordered to store crop until the post-harvest tests is available [JAIF, September 25, 2011].

On November 16, radioactive cesium of 630 Bq/kg was detected in rice harvested in the Oonami district of Fukushima city [NHK World, Novermebr 17, 2011]. All rice of the fields nearby was stored and none sold to the market. All 154 farmers in that district were asked to suspend shipments of rice and tests were ordered on rice samples from all farms. Five more

[47] Similar contamination did not affects pigs and chickens since they are not fed with rice straw.

[48] Even in July radioactive beef was found on sale in 11 prefectures (until then testing had only been performed on skin and exterior of livestock while animal feed and meat cuts not checked).

[49] All cattle have to be checked for radiation exposure before shipment, and the government asked prefecture to temporarily reduce the number of shipments to match its inspection capability.

[50] Late July at one farm rice-straw was discovered with radioactive cesium levels exceeding safety limit. Traders started to avoid all cattle from Shimane and beef prices plummeted.

[51] In practice, all heads of cattle are tested in meat processing plants throughout Japan [Watanabe, 2013].

farms were found with cesium-contaminated rice at a distance of 56 kilometers from the disaster reactors with the highest level of cesium detected of 1,270 Bq/kg.

On November 28 cesium-contaminated rice up to 1050 Bq/kg was reported in samples of 3 farms in Date, 50 km from the Fukushima Daiichi reactors. Consequently prefectural government decided to control more than 2300 farms in the whole district. On 29 November orders were given to 2381 farms in Nihonmatsu and Motomiya to suspend part of rice shipments in addition to already halted shipments at 1941 farms in 4 other districts (including Date), totaling 4322 farms [The Mainichi Daily News, November 29, 2011].

On May 11, 2011 cesium levels in tea leaves from Kanagawa prefecture were reported to exceed government limits [Osawa, 2011]. On September 3 radioactive cesium exceeding the government's safety limit was also detected in tea leaves in Chiba and Saitama prefectures. One type tea leaves from Chiba prefecture contained 2,720 Bq/kg of radioactive cesium. A maximum of 1,530 Bq/kg was detected in 3 kinds of tea leaves from Saitama prefecture. Tea producers were asked to recall their products when that is necessary [JAIF, September 4, 2011].

In the end of spring, summer and autumn high levels of Cesium 134 and 137 were fund in Fukushima bamboo shoots (several hundreds of Bq/kg) and fruits like Japanese apricots (up to hundreds of Bq/kg), yusu (up to 2,400 Bq/kg), kiwi (up to 1,100 Bq/kg), pomegranates, chestnuts etc. [ISRN, 2012].

On October 13, 2011 Yokohama city terminated the use of dried shiitake mushrooms in school lunches after tests had found radioactive cesium up to 350 Bq/kg. In shiitake mushrooms grown outdoors on wood in Ibaraki prefecture, 170 kilometers from the nuclear plant, samples contained 830 Bq/kg of radioactive cesium. Radioactive contaminated shiitake mushrooms above safety limit were also found in two cities of Chiba prefecture. Consequently, restrictions were imposed on shipments from these regions.

On October 29, 2011 it was announced that shiitake mushrooms grown indoors at a farm in Soma (north from nuclear plant) contained 850 Bq/kg of radioactive cesium: Mushrooms were grown on beds made of contaminated woodchips mixed and 1,070 (100-gram) packages of them had been shipped to supermarkets [The Mainichi Daily News, September 25, 2011].

In March and October food was served in Yokohama city with highly contaminated dried shiitake-mushrooms[52] that came from a farm near this town (250 km away from Fukushima). On November 10, 2011, in Tochigi prefecture, 120 km away southwest from the Fukushima reactors, 649 Bq/kg of radioactive cesium was measured in kuritake mushrooms. Four other cities in that region already stopped sales and call back their mushrooms [NHK World, November 11, 2011].

On February 7, 2012 noodles contaminated with radioactive cesium (258 Bq/kg) were found in Okinawa [The Mainichi Daily News, February 13, 2012]. “Okinawa soba” was apparently produced with water filtered through contaminated ashes[53] from wood originating

[52] Test-results of mushrooms showed 2,770 Bq/kg in March, 2011 and 955 Bq/kg in October, 2011 [JAIF, November 5, 2011].

[53] It is a custom to use ashes when kneading noodles or to take away a bitter taste, or "aku" from "devil's tongue" and wild vegetables.

from Fukushima prefecture. On February 10, 2012 MAFF set out a warning not to use ashes from wood or charcoal, even when the wood contained less than the governmental set maximum of 40 Bq/kg for wood or 280 becquerels for charcoal.

In mid November 2011 radioactive cesium up to 30.8 Bq/kg was found in milk-powder for baby-food produced by Meiji Co. While this level was under the governmental safety-limit it could be harmful for young children. Previous tests in July-August on 25 baby products did not reveal any contamination [The Mainichi Daily News, December 10, 2011].

On March 20, 2011 radioactive substances were detected in tap water in Tokyo, and Tochigi, Gunma, Chiba and Saitama prefectures [The Japan Times, March 20, 2011]. Permissible levels of iodine-131 were exceeded in drinking water samples taken in Fukushima and Ibaraki Prefectures and in Tokyo from 17 to 23 March [IAEA, March 24, 2011]. On March 24, iodine-131 was detected in 12 of 47 prefectures, of which the level in Tochigi was the highest (110 Bq/kg). Caesium-137 was detected in 6 prefectures but always below 10 Bq/kg. On March 25, 2011, tap water was reported to have reduced to 79 Bq/kg and to be safe for infants in Tokyo and Chiba but still exceeded limits in Hitachi and Tokaimura. On April 27, 2011 the radiation in Tokyo's water supply fell to undetectable levels for the first time since 18 March [Inajima and Nakayama, 2011]. On July 2, 2011 in samples of tap water taken in Tokyo Shinjuku ward radioactive caesium-137 with concentration 0.14 Bq/kg was detected for the first time since April.

Voluntary restrain on planting tobacco were also imposed in Fukushima prefecture in 2011 [Watanabe, 2013]. Furthermore, some tests found a high radiation level in wild mushrooms (28,000 Bq/kg of cesium) and a wild boar (6 times above the safety limit) [JAIF, September 12, 2011].

Furthermore, many farm related services such as eco-tourism, eco-farm, etc. were suspended in the most affected areas. For instance, Mr. K. Yamauchi farm in Kitakata, Fukushima prefecture were popular with green tourism before the nuclear disaster, and accepted students from 10 schools from and outside prefecture to experience agriculture. However, no students visited the farm in 2011 and 2012 due to public concern over radiation, until May 15, 2013 when students visits started again [Fukushima Minpo News, May 16, 2013].

In March 2012 radioactive cesium was detected in yamame (landlocked masu salmon) caught in Niida river near Iitate town, which was over 37 times the legal limit [The Mainichi Shimbun, March 30, 2012]. Fishing cooperatives were asked to refrain from catching yamame fish from this river and all streams adjacent to it, and no fish was sold on market. Moreover, no fishing was allowed in the river Nojiri in the region Okuaizu in Fukushima after-mid March 2012. Although this river is located 130 km from the damaged reactors the caught fish contained 119-139 Bq/kg of cesium. In 2011 the fish measured only 50 Bq/kg but fishing was not popular.

On March 28, 2012 smelt caught in the Akagi Onuma lake near Maebashi city in Gunma prefecture was found to be contaminated with 426 Bq/kg of cesium [The Mainichi Shimbun, April 4, 2012]. In April 2012 radioactive cesium concentrations of 110 Bq/kg were found in silver crucian carp fish caught in Tone river, north of Tokyo, 180 km away from the nuclear plant. Six fishery cooperatives and 10 towns along the river were asked to stop all

shipments of caught fish. In March 2012 fish and shellfish caught in a pond near the same river were found to contain levels above the new legal safety limits [JAIF, April 26, 2012].

High levels of radioactive cesium were found in 23 varieties of freshwater fish sampled at five rivers and lakes in Fukushima prefecture between December 2011 and February 2012 and in 8 locations on the open sea. On July 2, 2012 the authority announced finding radioactive cesium between 61 to 2,600 Bq/kg in a kind of goby caught in Mano river flowing from Iitate village to Minamisoma city (north of the nuclear plant). Water bugs, common food for freshwater fish, also showed high levels of 330 to 670 Bq/kg.

All coastal fishery and trawl fishing offshore Fukushima, except trial fishing[54], have been voluntarily suspended since the accident at the nuclear plant. After detection of radioactive cesium above legal limits in Sand lances caught off the coast of Ibaraki, prefectural government banned fishing [NHK, May 13, 2011]. Marine fish was found less contaminated and showed levels between 2.15-260 Bq/kg since it might be more capable of excreting cesium from bodies (saltwater fish have the ability to excrete salt). Radioactive cesium was also found in high concentration in plankton in samples taken up to 60 km from the coast of Iwaki city in July 2011 as up to 669 Bq/kg was measured in animal plankton 3 km offshore [JAIF, October 15, 2011]. Occasional incidents of caught fish with enormous amount of cesium have been reported since the nuclear accident – e.g. radiation 2540 times the legal limit for seafood was measured in a 'murasoi'-fish caught in January 2013 at the coast of Fukushima [Bullones, 2013].

Furthermore, forestry industry has been severely affected by the nuclear accident. For instance, Fukushima's broad-leaf forest area is one of country's leading producers of mushroom growing logs [Fukushima Minpo News, September 26, 2014]. After the nuclear accident, radioactive cesium levels exceeding the maximum standard (50 Bq/kg) were detected in many log producing areas and in 2012 only 300,000 logs were produced or 6% of the pre-disaster level[55].

During the year after the nuclear accident officials tested 137,037 agri-food samples across the country and detected 1,204 cases (0.88%) exceeding the provisional safety limit in 14 prefectures (Figure 43).

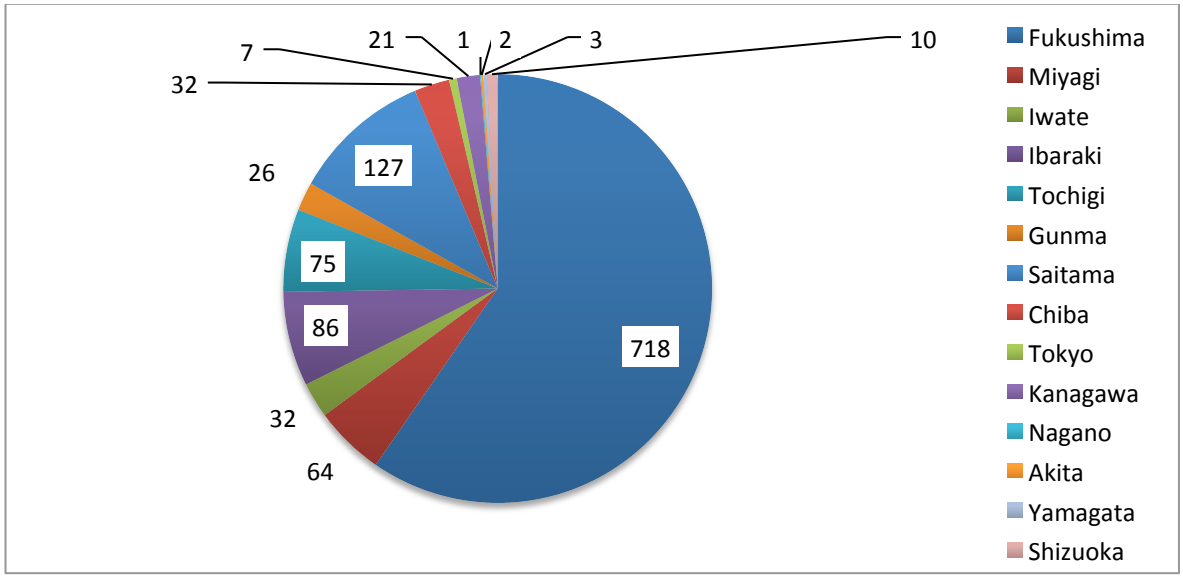
Most of the contaminated food samples were in Fukushima prefecture (59.63%), followed by Saitama (10.55%), Ibaraki (7.14%), Tochigi (6.23%) and Miyagi prefectures (5.32%). The share of contaminated items in all inspected samples was highest in Saitama (3.64%), Fukushima (3.33%) and Kanagawa (1.98%) prefectures, and in Tokyo (1.42%).

The majority of highly contaminated items In Fukushima prefecture were vegetables, fishery products and meats, in Ibaraki and Chiba prefectures vegetables, in Miyagi prefecture beef, in Tochigi prefecture vegetables and meats, in Saitama prefecture and Tokyo tea leafs.

[54] Test-fishing began in 2012 for limited species of marine products. It targets 27 species of which redioactive cesium concentration has been remarcably decreased and they are cought on a trial basis at the limited offshore area (20 km away from the nuclear station) and sold after inspection of each landing for each species [Fishery Agency, 2014].

[55] In 2010 Fukushima prefecture produced about five million such logs, of which nearly three million sold outside the prefecture, earning the prefectural forestry industry about 1 billion yen in annual sales.

**Figure 43. Number of agri-food samples above radiation safety limit detected until March 31, 2012**




Source: Ministry of Health, Labor and Welfare

More than 3600 fishery products were tested in Fukushima prefecture during the first year after the accident, and 34.7% of them found above 100 Bq/kg [Fishery Agency, 2014]. In the rest of the country from almost 5000 inspected fish samples 4.5% were above safety norm.

The mandatory and voluntary restrictions on shipment covered a number of products from designated areas of affected regions. In addition, there was a ban on rice planting on 8000 ha of paddies in evacuation (95%) and other contaminated areas [MAFF, 2012]. What is more, several municipalities (Minami-shi, Hirono-machi, Kawauchi-mura and Tamura-shi) called for voluntary restraints on planting of paddy rice on total area of 5,600 ha.

In order to meet growing public safety concerns since April 1, 2012 new more stringent official limits on radioactive elements in food items have been enforced in the country as longer transitional periods were set for some commodities like rice and beef (until September 30, 2012), and soybean (December 31, 2012).

In August 2012 authority reported that cesium levels had dropped to undetectable levels in most cultivated vegetables from the affected areas, while food sourced from forests, rivers or lakes in the Tohoku and northern Kanto regions were showing excessive contamination [Aoki, 2012]. Reported contamination mostly involved fish (landlocked salmon and flounder) and seafood, Shiitake-mushrooms, and meat of wild animals. Radiation levels remained especially high in species like cod, sole, halibut, landlocked kokanee, carp, trout, and eel.

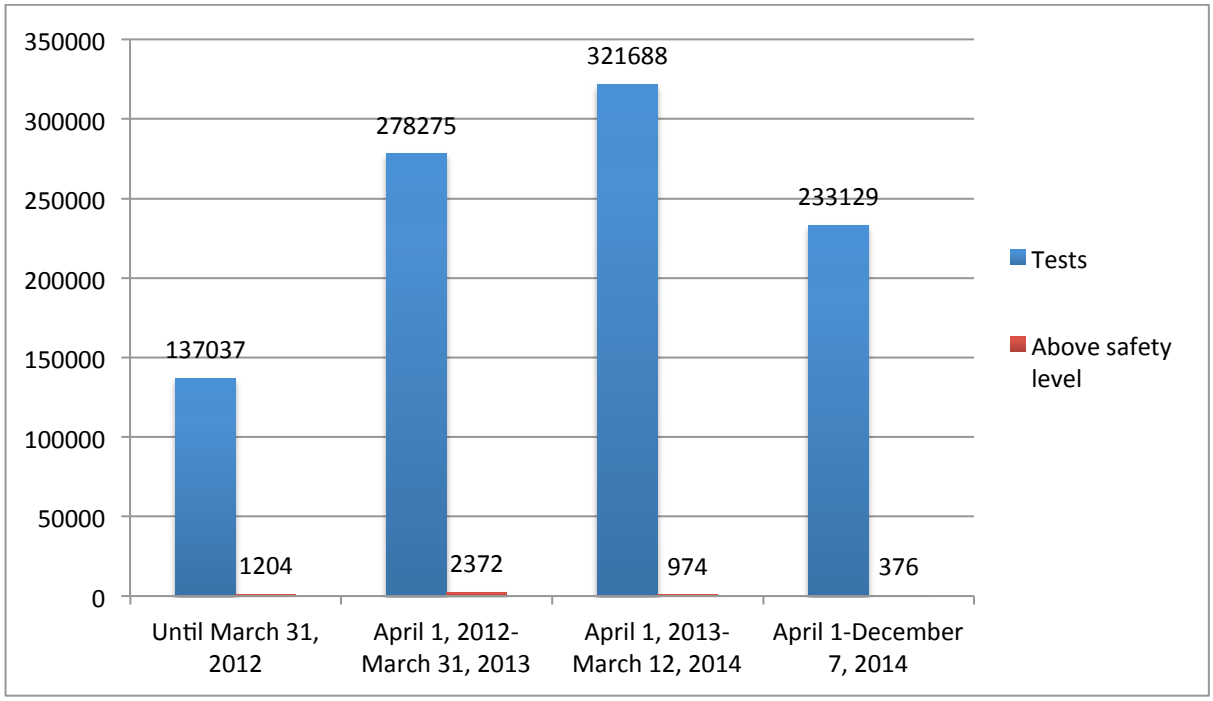
In the last two years the number of (official, collective, private) food inspections has multiplied in the 17 most vulnerable prefectures[56] and around the country.

Officially tested food items doubled in 2012, 0.85% of all samples were found exceeding safety limit for radionuclides, and a few highly contaminated items were detected

[56] Regular tests on 98 items have been carried out in Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima, Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa, Niigata, Yamanashi, Nagano, and Shizuoka prefectures.

in 4 more prefectures (Aomori, Nigata, Yamanashi and Hiroshima) (Figure 44). The biggest number of unsafe food items was detected in Fukushima (58.05%), Iwate (10.96%), Tochigi (10.79%), and Miyagi (6.91%) prefectures. The portion of highly contaminated food items was biggest in samples from Fukushima (3.95%) and Iwate (1.03%) prefectures.

**Figure 44. Number of radionuclide food tests and items above safety standard in Japan**




Source: Ministry of Health, Labor and Welfare

Most of the detected items were fishery products, wild animal meats, vegetables and mushrooms. In Ibaraki, Tochigi, Gunma, and Iwate prefectures there were also detected samples of drinking water exceeding safety standard.

In FY 2013 the number of inspections increased further but only 0.30% of samples were found with level higher than the safety standard[57]. The bulk of highly contaminated items were in Fukushima prefecture (62.42%) followed by Gunma (10.99%), Tochigi (8.42%) and Miyagi (8.32%) prefectures. The greatest segment with highly-contaminated items was detected in samples from Fukushima (1.5%) and Yamanashi (1.18%) prefectures.

Most of the detected items in Fukushima prefectures were fishery products, agricultural products (vegetables, soybean, rice, etc.) and wild animals meat; in Miyagi prefecture agricultural products (bamboo shoot, vegetables, etc.), wild animal meat and fishery products; in Gunma and Tochigi wild animal meats; and in Yamanashi prefecture mushrooms.

Up to December 7, 2014 of the FY 2014 positively tested items were fond inly in 14 prefectures and their number of was further diminished – just 0.16% of the total. Above a half of the contaminated items were in Fukushima prefecture (50.26%), followed by Miyagi (14.09%), and Gunma (10.63%) prefectures. The greatest proportion with highly contaminated items was detected in samples from Yamanashi (2.14%), Fukushima (0.63%), and Shizuoka (0.34%) prefectures.

[57] No drinking water sample above safety limit was detected.

Most of the detected items in Fukushima prefectures were wild animals meat, fishery products, and agricultural products (mostly wild ones, and soybean); in Miyagi prefecture wild animal meat, agricultural products (mostly wild, and log-grown Late fall oyster mushrooms), and fishery products; in Gunma prefectures wild animal meats, fishery products, and agricultural products (wild ones, and log-grown Shitake powdered.

Official inspections results in the last years indicate that for all agricultural food products, but mushrooms and wild edible plants, the number of samples with radioactive cesium above safety limits is none or insignificant (Table 11).

What is more, the share of samples with detected radioactivity higher than the half of the new safety norm (>50 Bg/kg) has been minor, declining or zero. For instance during April 1, 2013 - March 31, 2014 this portion was merely 0.002% in beef meat, 0.008% in rice, 0.01% in vegetables, 0.45% in tea infusion (>5 Bg/kg), 0.66% in fruits, 1.19% in other cultivated plants, 3.03% in honey, 4.58% in pulse, and 6.76% in mushrooms and wild edible plants [MAFF, 2014]. Similarly, for the period April 1, December 31, 2014 the proportion of such items in all samples was merely 0.0001% for rice, 0.068% for fruits, 0.27% for pulses, and 3.03% for in mushrooms and wild edible plants.

**Table 11. Results of inspections on radioactivity levels in agricultural products in Japan***

| Products | March, 2011 - March 31, 2012 | | | April 1, 2012 - March 31, 2013 | | April 1, 2013 - March 31, 2014** | | April 1, 2014 – November 27, 2014*** | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of samples | Above provisional limit | Above new limit | Number of samples | Above maximum limit | Number of samples | Above maximum limit | Number of samples | Above maximum limit |
| Rice | 26,464 | 39 | 592 | 10.4 million | 84 | 11 million | 28 | 10 million | 0 |
| Wheat and burley | 557 | 1 | 27 | 1,818 | 0 | 592 | 0 | 366 | 0 |
| Vegetables | 12,671 | 139 | 385 | 18,570 | 5 | 19,657 | 0 | 12,719 | 0 |
| Fruits | 2,732 | 28 | 210 | 4,478 | 13 | 4,243 | 0 | 2,955 | 0 |
| Pulse | 698 | 0 | 16 | 4,398 | 25 | 6,727 | 59 | 1,485 | 2 |
| Other plants | 498 | 1 | 16 | 3,094 | 14 | 1,613 | 0 | 751 | 0 |
| Mushrooms and wild edible plants | 3,856 | 228 | 779 | 6,588 | 605 | 7,583 | 194 | 6,801 | 102 |
| Tea/Tea infusion (*) | 2,233 | 192 | 1,562 | 867(*) | 13(*) | 446(*) | 0(*) | 183(*) | 0 |
| Raw milk | 1,937 | 1 | 7 | 2,453 | 0 | 2,052 | 0 | 1,393 | 0 |
| Beef | 91,973 | 157 | 1096 | 187,176 | 6 | 208,477 | 0 | na | |
| Pork | 538 | 0 | 6 | 984 | 1 | 693 | 0 | na | |
| Chicken | 240 | 0 | 0 | 472 | 0 | 385 | 0 | na | |
| Egg | 443 | 0 | 0 | 565 | 0 | 418 | 0 | na | |
| Honey | 11 | 0 | 1 | 124 | 0 | 66 | 0 | na | |
| Other livestock | 23 | 0 | 0 | 99 | 1 | 118 | 0 | na | |

* for crops in 17 northeastern and eastern prefectures, for livestock products all prefectures

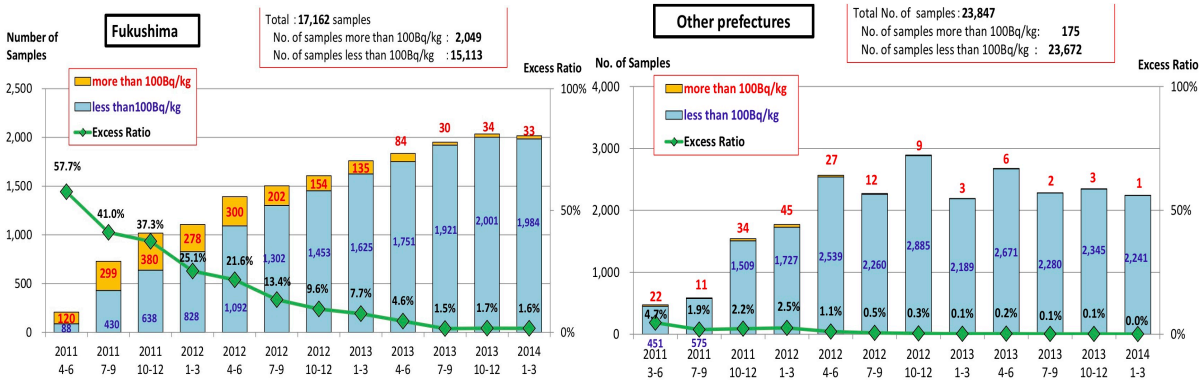
** for meat and eggs – January 31, 2014; *** for raw milk - December 31, 2014
Source: Ministry of Agriculture, Forestry and Fisheries

The Fukushima Prefectural Government checks every bag of rice produced in the prefecture. For instance in 2014 some 10.75 million bags were tested and found that all bags had lower than standard radiation levels (in contrast with 2012 and 2013 when ther a small percentage of rice unfit for shipment). Experts attribute the achievement to efforts to prevent cesium from entering rice fields during cultivation, and to the use of fertilizers based on potassium chloride, which prevents the grain from absorbing the isotope[58] (Fukushima Minpo News, January 9, 2015).

Test data for marine fishery products radioactive contamination also indicate that the number of cases above safety limit has dropped considerably (Figure 45). In Fukushima prefecture, in the months after the accident, the share of highly-contaminated fish was 57.7% but it reduced by half after one year. The portion of samples above safety limit decreased considerably to around 1.5-1.7% in the last three quarters.[59] In other prefectures the share of contaminated fish decreased from 4.7% to less than 1% in 3nd quarter of 2012.

The Fukushima Agricultural Technology Center performs regular tests on 461 agricultural and food items from Fukushima prefecture with the state of the art equipment. For the period March 19, 2011-March 31, 2014 as many as 109,853 agricultural and food items were tested at the FATC laboratories [FATC, 2014]. By the first anniversary from the nuclear accident (end of FY2011) contamination above provisional safety limit was found in 3.58% of checked samples (Table 12). One third of all highly contaminated items were fish, 23.8% livestock forage, 18.6% mushrooms and wild plants, 21.3% vegetables and fruits, a small portion other products, and no detection for meat, eggs and brown rice.

**Figure 45. Monitoring results for marine fishery products radioactive levels in Japan**




Source: Fishery Agency

[58] The prefecture is shouldering all costs for the fertilizers and in 2014 distributed ¥1.61 billion in subsidies to farmers to buy enough potassium chloride-based fertilizer to treat 68,000 ha of paddies.

[59] After the 2nd quarter of 2012, monitoring has been focusing on species that have records more than 50 Bq/kg.

**Table 12. Results of inspections on radioactivity levels in agri-food products in Fukushima prefecture**

| Products | Items | June 1, 2011 - March 31, 2012 | | April 1, 2012 - March 31, 2013 | | April 1, 2013 - March 31, 2014 | |
|---|---|---|---|---|---|---|---|
| | | Number of samples | Above provisional limit | Number of samples | Above the maximum limit | Number of samples | Above the maximum limit |
| Brown rice | 1 | 1,724 | 0 | 35,238 | 71 | 601 | 28 |
| Cereals without rice | 8 | 607 | 3 | 2,169 | 10 | 4,428 | 55 |
| Vegetables and fruits | 232 | 6,010 | 145 | 7,264 | 7 | 5,806 | 0 |
| Milk | 1 | 651 | 15 | 441 | 0 | 405 | 0 |
| Meat | 5 | 5,001 | 0 | 6,310 | 0 | 4,888 | 0 |
| Eggs | 1 | 221 | 0 | 144 | 0 | 133 | 0 |
| Forage for livestock | - | 773 | 162 | 1,664 | 48 | 2,368 | 19 |
| Fish | 146 | 3,330 | 227 | 6,037 | 879 | 8,282 | 237 |
| Mushrooms and wild plants | 64 | 922 | 127 | 1,090 | 90 | 1,377 | 80 |
| Others | 3 | 51 | 2 | 68 | 1 | 63 | 0 |
| Total | 461 | 19,290 | 681 | 60,425 | 1,106 | 28,351 | 419 |

Source: Fukushima Agricultural Technology Center

During the second years after the accident (FY 2012) the share of detected items above safety limit dropped to 1.83% almost three quarter of them being fish. The portion of highly-contaminated fish, and mushrooms and wild edible plants was considerable (14.6% and 8.3% accordingly), no detection was reported for meat, milk and eggs, and insignificant portion of contaminated items for others.

During the last year (FY2013) only 1.48% of tested samples exceeded the safety limit. The majority of highly contaminated items were fish (56.6%), mushrooms and wild plants (19.1%) and cereals (19.8%). The radiation detection in mushrooms and wild plants, fish and cereals has been relatively high (5.8%, 2.9% and 1.6% respectively), merely 0.8% for forage for livestock, and none for all other products.

The latest data show that a high contamination still remains in certain Fukushima products like edible wild plants attributed to radioactive substances on mountains surfaces (NHK World, May 14, 2014). Out of 383 samples tested during the last season 4.2% exceeded the safety limit[60].

Furthermore, a recent survey has found that the levels of radioactive cesium in home-cooked meals in Fukushima prefecture are mostly below the maximum allowable limit [Fukushima Minpo News, March 7, 2014]. Out of 100 households surveyed during period November 2013 - February 2014 using meals prepared over two days, only 4 showed measurements slightly above the limit for radioactive cesium (the one with the highest level of 2.6 Bq/kg for Cesium 137 and 1.1 Bq/kg for Cesium 134). Household members were also

[60] On May 13, 2014 Fukushima prefecture restricted shipment of 7 varieties of edible wild plants after detecting high levels of radioactive contamination – 700 becquerels in fiddleheads, 430 becquerels in varieties of bracken, and 460 becquerels in Japanese spikenard [NHK World, May 14, 2014].

tested for internal exposure to radioactive materials by a whole-body counter, and all screened persons (82) had counts below the 300 Becquerel threshold for human radiation exposure.

Currently there are still a number of products from certain areas of 17 prefectures, which are subject to mandatory or voluntary shipment restrains (Table 13).

**Table 13. Agricultural and fish products subject to shipment restraints in designated areas of Japanese prefectures (as of February 3, 2014)[61]**

| Prefectures | Mandatory | Voluntary |
|---|---|---|
| Aomori | | Wild mushrooms |
| Iwate | Shiitake, Nameko and Kuritake mushrooms grown on Raw Log (open fields); Koshiabura; Fiddlehead fern; Wild Bracken; Wild Japanese parsley; Bamboo shoots; Wild mushrooms;<br>Cattle*;<br>Japanese seaperch; Japanese black porgy; Iwana mountain trout; Japanese dace | Dried shiitake mushrooms grown on Raw Log in 2011 and spring 2012; Shiitake mushrooms grown on Raw Log; Wild Kusasotetsu; Wild Taranome; Wild Uwabamisou; Wild butterbur; Wild Sanshou; Hiratake, Bunaharitake and Mukitake mushrooms grown on Raw Log (open field); Kuwai (open field); Natural Yamame |
| Akita | | Wild Nemagaridake |
| Miyagi | Shiitake mushrooms grown on Raw Log (open fields); Kusasotetsu; Bamboo shoots; Koshiabura; Fiddlehead fern; Wild mushrooms;<br>Cattle*;<br>Takifugu pardalis; Japanese seaperch; Japanese black porgy; Yamame (except cultured); Sweetfish (except cultured); Iwana mountain trout (except cultured); Japanese dace | Mukitake mushrooms grown on Raw Log; Nameko mushrooms grown on Raw Log (open field); Wild Taranome; Wild Bracken; Shiitake mushrooms grown on Raw Log (mushroom facilities); Natural Eel; Iwana mountain trout (except cultured) |
| Yamagata | | Koshiabura |
| Fukushima | Non-heading leafy vegetables; Heading leafy vegetables; Bud vegetables belonging to brassicaceae; Kabu; Japanese plum; Yuzu; Japanese chestnut; Kiwi; Shiitake and Nameko mushrooms grown on Raw Log (open field); Shiitake mushrooms grown on Raw Log (mushroom facilities); Wild mushrooms; Bamboo shoots; Kusasotetsu (open field); Wild Taranome; Wild butterbur sprout; Wasabi (grown in fields); Koshiabura; Fiddlehead fern; Bracken; Wild Bracken; Wild butterbur; Wild Uwabamisou; Cattle*; Raw milk; Yamame (except cultured); Sweetfish (except cultured); Iwana mountain trout (except cultured); Carp (except cultured); Japanese dace; Fat greenling, Red tongue sole, Ikanago (except for fry), Stone flounder, Sebastes thompsoni, Surfperch, Brown hakeling, Fox jacopever, Black cow-tongue, Jacopever, Japanese black porgy, Sea raven, Okamejei kenojei, Masu salmon, Poacher, Sebastes cheni, Japanese seaperch, Nibe, Starry flounder, Slime flounder, Takifugu pardalis, Bastard halibut, Red gurnard, Spotted halibut, Common Japanese conger, Yellow striped flounder, Marbled sole, Flathead, Pacific cod, Roundnose flounder, Spotbelly rockfish, Frog flounder, Stimpson's hard clam, Northern sea urchin, Long shanny, Barfin flounder, Starspotted smooth-hound, Shosai-fugu; Japanese halfbeak, False kelpfish; Crucian | Loquat; Walnuts; Japanese persimmon; Dried shiitake mushrooms; Wild Udo; Wild Sanshou; Koshiabura; Bamboo shoots; Wild Taranome; Chocolate vine; Mokuzugani; Honmokoro (cultured); Himemasu; Weather loach |

[61] more details and updates on requests for shipment restrains and other measures are available at: http://www.maff.go.jp/e/quake/press_since_130327.html

| | | |
|---|---|---|
| | (except cultured); Eel | |
| Ibaraki | Shiitake mushrooms grown on Raw Log (open fields); Shiitake mushrooms grown on Raw Log (mushroom facilities); Bamboo shoots; Wild koshiabura; Sebastes cheni, Japanese seaperch, Nibe, Okamejei kenojei, Pacific cod; Bastard halibut; Stone flounder; Channel catfish (except cultured), Carassius auratus langsdorfii (except cultured); Eel | Wild mushrooms; Bamboo shoots; Shiitake mushrooms grown on Raw Log; Dried shiitake mushrooms; Wild Taranome; Ikanago; Takifugu poecilonotus; Natural iwana mountain trout; Natural Carassius cuvieri |
| Tochigi | Shiitake mushrooms grown on Raw Log; Nameko and Kuritake mushrooms grown on Raw Log (open field); Wild Taranome; Bamboo shoots; Wild Kusasotetsu; Wild Koshiabura; Wild Sanshou; Wild fiddlehead fern; Wild bracken; Wild mushrooms; Japanese chestnut; Cattle* | Dried shiitake mushrooms grown on Raw Log); Shiitake mushrooms grown on Raw Log; Uwabamisou; Wild Myoga; Wild Momijigasa; Yamaguri; Natural fishes in mountain streams |
| Chiba | Shiitake mushrooms grown on Raw Log; Bamboo shoots; Silver crucian carp; Natural carp | Bamboo shoots; Dried shiitake mushrooms; Shiitake mushrooms grown on Raw Log (open fields); Japanese seaperch; Stone moroko; Crucian carp; all kinds of fish and shellfish; Silver crucian carp; all species of fish and shellfish except for Freshwater prawn; Eel |
| Tokyo | | Eel |
| Gunma | Wild mushrooms; Yamame (except cultured); Iwana mountain trout (except cultured); Eel | Dried shiitake mushrooms grown on Raw Log; Bamboo shoots; Nameko mushrooms grown on Raw Log (open field); Wild Taranome; Natural Japanese smelt; Natural Japanese dace; Natural carp; Natural iwana mountain trout; Natural yamame |
| Saitama | Wild mushrooms | Natural catfish; Eel |
| Nagano | Wild mushrooms | Koshiabura; Taranome |
| Kanagawa | | Shiitake mushrooms grown on Raw Log (open fields) |
| Nigata | | Wild mushrooms |
| Yamanashi | Wild mushrooms | |
| Shizuoka | Wild mushrooms | Dried shiitake mushrooms (picked and processed after March 11) |

* whole area of prefecture, moving from other prefecture (except less than 12 months old) and shipping to slaughterhouses), excluding cattle controlled under shipment and inspection policy of Prefectural Government
Source: Ministry of Agriculture, Forestry and Fisheries

In Fukushima prefecture mandatory and voluntary restrictions cover a wide range of vegetables, fruits, livestock and fish products grown in heavily contaminated areas.

In addition, there is still a ban on rice planting on 2,100 ha (almost 3 times lass than in 2013) and overall production management restrictions on 4,200 ha paddies in the evacuation area (Table 14; Map 17).

In other prefectures mandatory and voluntary shipment restrictions mostly concern mushrooms, wild plants, and fish.

Furthermore, for the most contaminated areas of Fukushima prefecture there are still requests for intake restraints for a wide range of non-heading leafy vegetables (such as Spinach, Komatsuna, Kakina etc.), heading leafy vegetables (Cabbage, Hakusai, Heading lettuce, Brussels sprout etc.), bud vegetables belonging to brassicaceae (Broccoli,

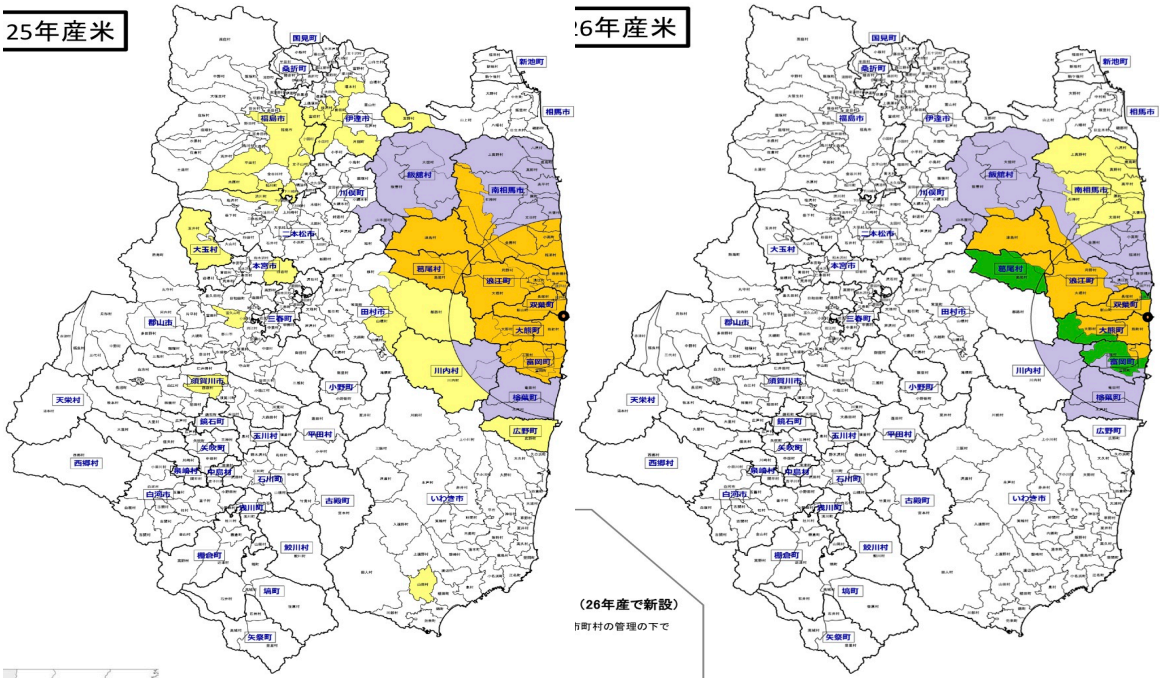
Cauliflower, Stick Broccoli etc.), shiitake mushrooms grown on Raw Log (open field), wild mushrooms, and non cultured Yamame [MAFF, 2014].

**Table 14. Target areas of rice planting restrictions (ha)**

| Type | 2013 | 2014 |
|---|---|---|
| Planting restrictions | 6,000 | 2,100 |
| Farmland preservation and cultivation test* | - | 700 |
| Planting resume preparation | 6,200 | 5,100 |
| Total volume production delivery management | 5,200 | 4,200 |

* set in the new "Policy on the planting of the 2014 annual rice"
Source: Ministry of Agriculture, Forestry and Fisheries

**Map 17. Target areas* for planting restrictions of 2013 and 2014 annual rice**




* orange - areas with a ban on rice planting; green - farmland preservation and cultivation test; blue - areas planting to restart; yellow - rice planted allowed
Source: Ministry of Agriculture, Forestry and Fisheries

The challenges associated with food contamination continue all the time. For instance, recently it has been found out that the rice paddies located about 20 km from the Fukushima nuclear plant were with radioactive cesium blown by the wind [NHK World, July 14, 2014]. The prefectural government revealed that last year's harvested rice from 14 locations in the city of Minami Soma contained more than 100 becquerels of cesium per kilogram.

MAFF says cesium was detected on the outside of the husk. Debris removal work conducted last August at the Number 3 reactor may be one of the reasons for the contamination. TEPCO reportedly told the ministry it will use chemicals to stop dust from spreading during debris removal work and increase monitoring of the spreading dust. Neither the ministry nor the utility told Minami Soma City officials the work at the plant may have

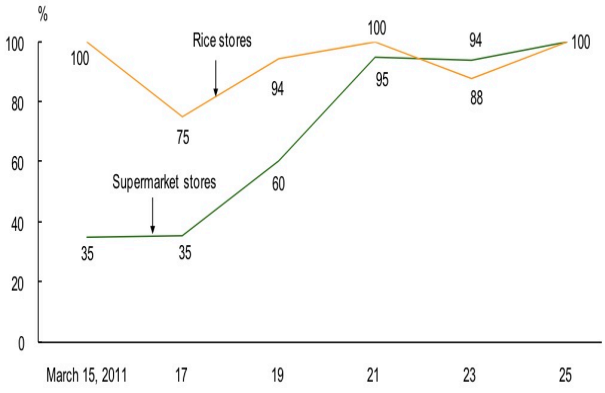
contaminated the crop. City officials were greatly startled and complained that the ministry should have explained the matter to local authorities much earlier.

MAFF called for plant operator TEPCO to take more measures. TEPCO is scheduled to conduct a large-scale debris removal work at Number One reactor. It plans to disassemble covers, which had been put to prevent the radioactive materials from spreading.

## VII. Effects on markets, consumers and international trade

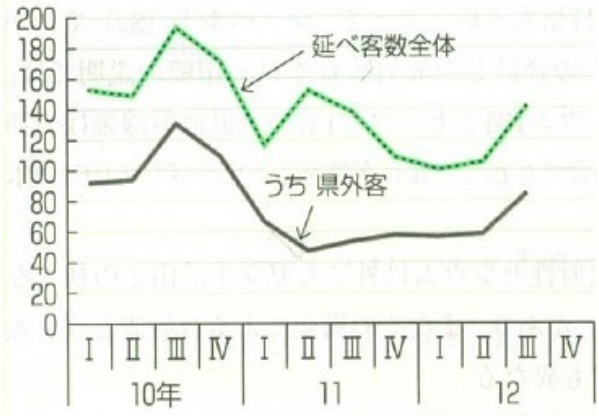
In the days after the 2011 disasters there was destruction of supply of potable water, foods and other necessities in most affected regions [MAFF, 2011; Watts, 2011]. What is more, food shortages spread beyond the worst affected areas as many people were panic buying after the nuclear crisis (Figure 46). Unprecedented for the post war period situation of food rationing and empty stores shelfs was prevailing in the days after the crisis across the disaster areas and big cities like Tokyo.

**Figure 46. Stores with over-the-counter rice inventories in Tokyo and its vicinity**




Source: MAFF, 2011

**Figure 47. Total (green) and local (black) tourists visiting Fukushima prefecture (000)**




Source: Fukushima prefectural government

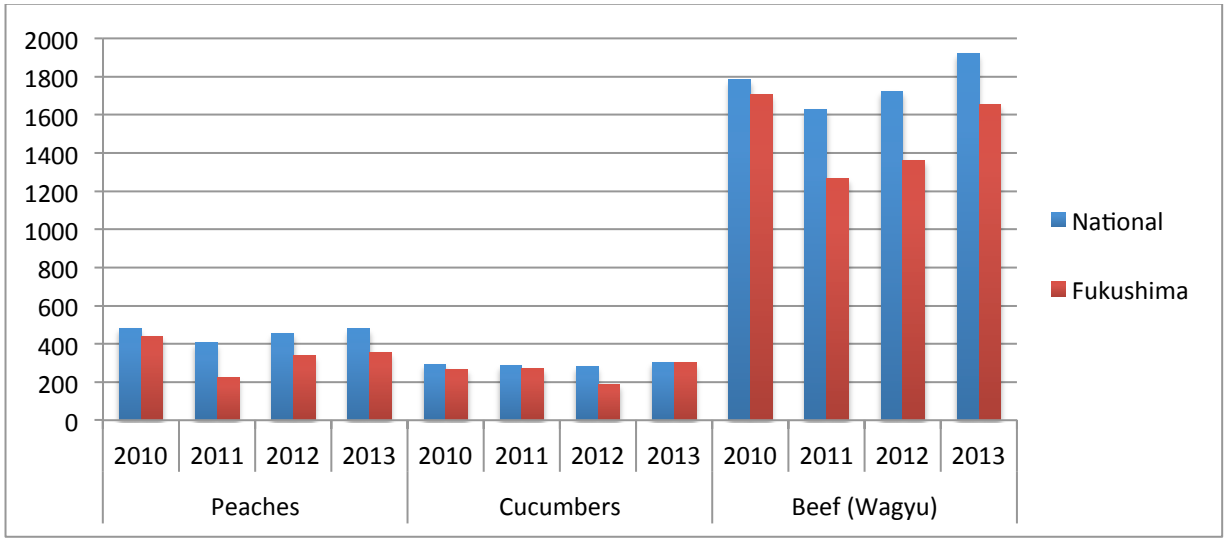
The Government implemented swift measures to procure and provide emergency food, beverages, fuel etc., and rapidly restored damaged agri-food production and distribution facilities. During the period March 11 - April 20, 2011 the Ministry of Agriculture, Forestry and Fisheries procured and delivered 25.84 million packs of meals, 7.62 million bottles of drink (3.81 million liters) and 53 thousand cans formula milk for infants [MAFF, 2012].

"Normal" food supply to all affected by the disasters people was quickly restored and important infrastructure (production and storage facilities, wholesale markets, transportation network etc.) rebuilt. Nevertheless, there have been numerous restrictions on production, sells, shipments and consumption of basic agricultural and food products in the affected by the nuclear accident regions. All they stopped, delayed or significantly reduced the effective supply of a great range of local agri-food products.

Furthermore, due to genuine or perceived health risk many Japanese consumers stop buying agricultural, fishery and food products originated from the affected by the nuclear accident regions ("Northern Honshu"). Even in cases when it was proven that food is safe some wholesale traders, processors and consumers restrain buying products from the contaminated areas [Futahira, 2013; Koyama, 2013; MAFF, 2012; Watanabe 2011, 2013].

What is more, there was sharp decline in the demand and prices for the agricultural products mostly affected by the accidents such as vegetables, fruits, beef, etc. (Figure 48). In Fukushima prefecture the extent of price reductions and the pace of price recoveries have been much slower than the nation ones.

**Figure 48. Dynamics of prices of major agricultural products affected by nuclear disaster**




Source: Fukushima prefectural government

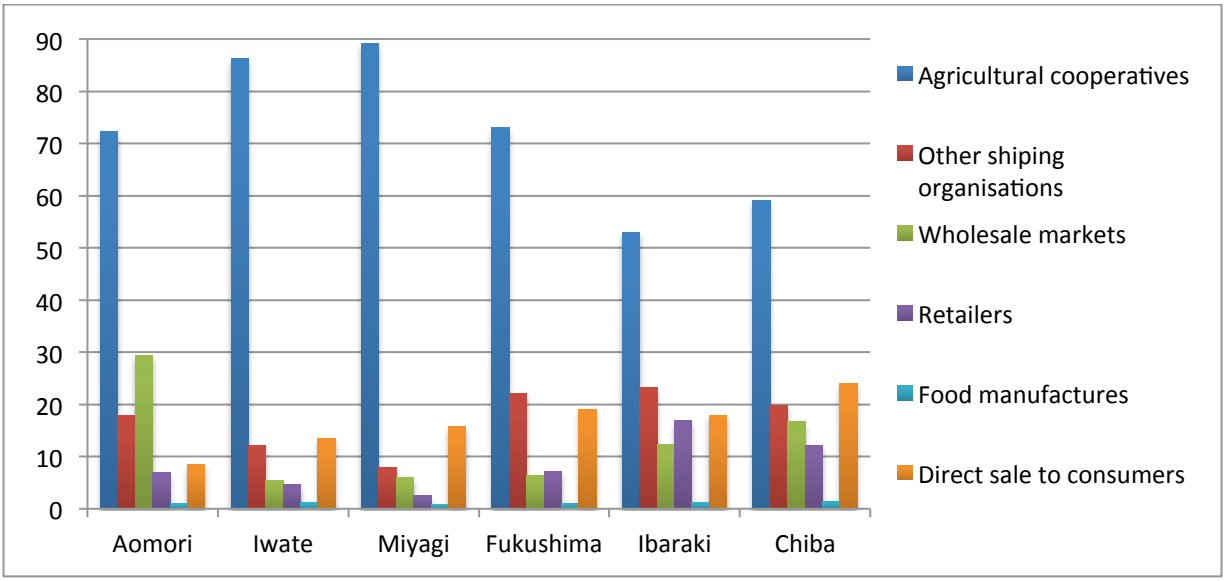
Dynamics of demand has been a result of lack of sufficient capabilities in the inspection system, inappropriate restrictions (initially covering all shipments in a prefecture rather than from contaminated localities), revealed rare incidences of contamination in generally safe origins, low confidence in the official "safety" limits and inspections, lack of good communication, harmful rumors ("Fu-hyo"), and in certain cases not authentic character of traded products [Bachev and Ito, 2013]. The "reputation damage" has been particularly important factor for the big agri-food producing regions like Fukushima, Ibaraki etc. which products have been widely rejected by consumers [Futahira, 2013; Fukushima Minpo News, May 11, 2014; Koyama, 2013; Watanabe, 2013].

Consequently, the demand for many traditional farm produces from the affected by nuclear disaster regions (such as rice, fruits, vegetables, mushrooms, milk, butter, beef etc.) significantly declined while prices considerably decreased. For instance, regardless of the good result from the MAFF emergency inspection for radioactive contamination of rice[62] the circulation of all rice produced in Fukushima prefecture stopped in 2011-2012 [Koyama, 2013].

The marketing problems of farms in the most affected areas has been further enhanced due to the fact that a large number of them (used to) practice direct trade at wholesale markets and direct sells to consumers, retailers, and processors (Figure 49).

[62] Product with levels exceeding safety limits accounted merely for 0.3% of the total rice produced (2.3% for new standard of 100 Bq/kg).

**Figure 49. Share of Agricultural Management Entities by shipping destination of agricultural products in most affected regions in 2010 (percent)**




Source: Statistical yearbook of MAFF

Since autumn 2011 and 2012 radiation measurement tests for radiation level in all beef and package of rice have been carried out in Fukushima prefecture. Until April 30, 2013 more than 10.3 million bags of rice were checked by JA Fukushima, and detected radiation in 99.78% of them were less than 25 Bq/kg while in only 71 bags (0.0007% of the total) it was above 100 Bq/kg (JA Fukushima Prefecture, 2013). Intensive safety checks have been also carried out on a great range of agri-food products by the authority, farmers, agricultural organizations, processors, retailers etc.

Despite all safety checks many consumers in the big cities and in the region alike continue to avoid Fukushima products [Takeuchi and Fujioka, 2013; Koyama 2013]. In the end of March 2013 the rice sales from Fukushima was almost half of what it had been before the disaster while rice prices considerably lower. Even now, a very popular across Japan for 18 years organic rice of a agricultural corporation from Nihonmatsu (customer base of 4,000 people) has got no orders from 60 % of their customers [NHK World, March 10, 2014].

Similarly, sales of vegetables as ingredients for school lunch in Fukushima have decreased; only 3 out of 16 JA farmers market recovered the sales (positive trends are mostly for markets in the South part of the prefecture), most have their sales decreased by 30%, some (like in Date) still struggle at 40% of the pre-disaster level, and one was closed; sales of meat started to recover but it is still bellow the pre-disaster level etc. [Nagashima, 2013].

Fukushima labels and brands for agri-food produce which once representing top quality and safety after the accident brought rejections and significantly less than usual market value[63].

[63] in fact Fukushima products continue to top different competition and inspections. For instance, two farmers from the prefecture won gold awards while other participants other awards in the annual international rice tasting competition held in Shichikashuku, Miyagi Prefecture [Fukushima Minpo News November 25, 2013]. Similarly, 3 brands of rice grown in the prefecture (Koshihikari and Hitomebore varieties from Aizu region and Hitomebore from Nakadori area) were among 38 brands

The same has been experienced by some food processors in the affected regions. For instance, manufacturers of natto[64] from Mito were seeking compensation from TEPCO because their sales in April–August 2011 fall by 50% and losses risen up to 1.3 million dollars [JAIF, August 13, 2011]. According to one of the interviewed by us experts - Mr.Kishi, running a small company for frozen desserts (ice creams, puddings, and jellies) in Fukushima city "for school lunch there are still harmful rumors. Factories in Fukushima are unable to join the tender in some areas. Inspection and showing the results are needed to breakthrough this situation. His company is doing well since it supplies all ingredients outside prefecture and has a proper safety control system put in place (June 5, 2013).

Some popular food chains such as Sukiya have introduced "no Fukushima beef" policy in their restaurants around the country, including in Fukushima prefecture.

Likely wise, before the nuclear accident Fukushima prefecture had been a favorite tourist destination both for local and outside visitors. After the accident the number of total and local tourists sharply declined (Figure 47). For instance, after March 2011 the number of visits by local tourists dropped more than a half and all visits more than 40% comparing to the same periods in 2010. That has been a severe blow for related farming and food products supplying tourists with numerous local specialties. The (agri and rural) tourism started to recover in 2012 but it is still struggling to reach pre-disaster capability.

Research has proved that consumers' attitude toward the agricultural products from the affected by the nuclear disaster regions has changed dramatically [Burch, 2012; Ujiie, 2011, 2012, 2013]. Almost 38% of the surveyed in 2012 consumers indicated that they do not purchase fresh foods produced in the affected by accident areas, and only 8.4% said they buy [Japan Finance Corporation, 2012]. A different survey has found out that a half of consumers in Tokyo and Osaka would not buy Fukushima and Ibaraki products with "contamination less than the official criteria" and another 30% said they would not buy if products were "not contaminated at all" [Ujiie, 2012]. However, a follow up 2013 survey reviles that while consumers still maintain the high risk conscious, the "origin of product" factor is playing less important role is their choice.

Even residents and producers of Fukushima prefecture tend to avoid buying local products, and local produce has not been used in school lunches[65]. A 2013 consumer survey shows that this is particularly true for some segment of population (e.g. family with children) as well as for certain products (such as mushrooms and seafood) in general (Interview with Prof.Komatsu, June 17, 2013).

One of the interviewed by us farmer Mr.Takahashi said: "As a producer in Fukushima, I am suffering to find the way to promote consumption of Fukushima products to local citizen. While the consumption in Fukushima do not return, there is no meaning to promote safeness

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designated as the top level "Special Grade A" in the Japan Grain Inspection [Fukushima Minpo News, February 14, 2014]. Likely wise, for the second straight year Fukushima-brewed sake brands got the top award at the Annual Japan Sake Awards [Fukushima Minpo News, May 21, 2014]. In the latest contest, 17 out of submitted 39 brands from Fukushima prefecture were awarded the Gold Prize, marking the largest number together with Yamagata Prefecture.

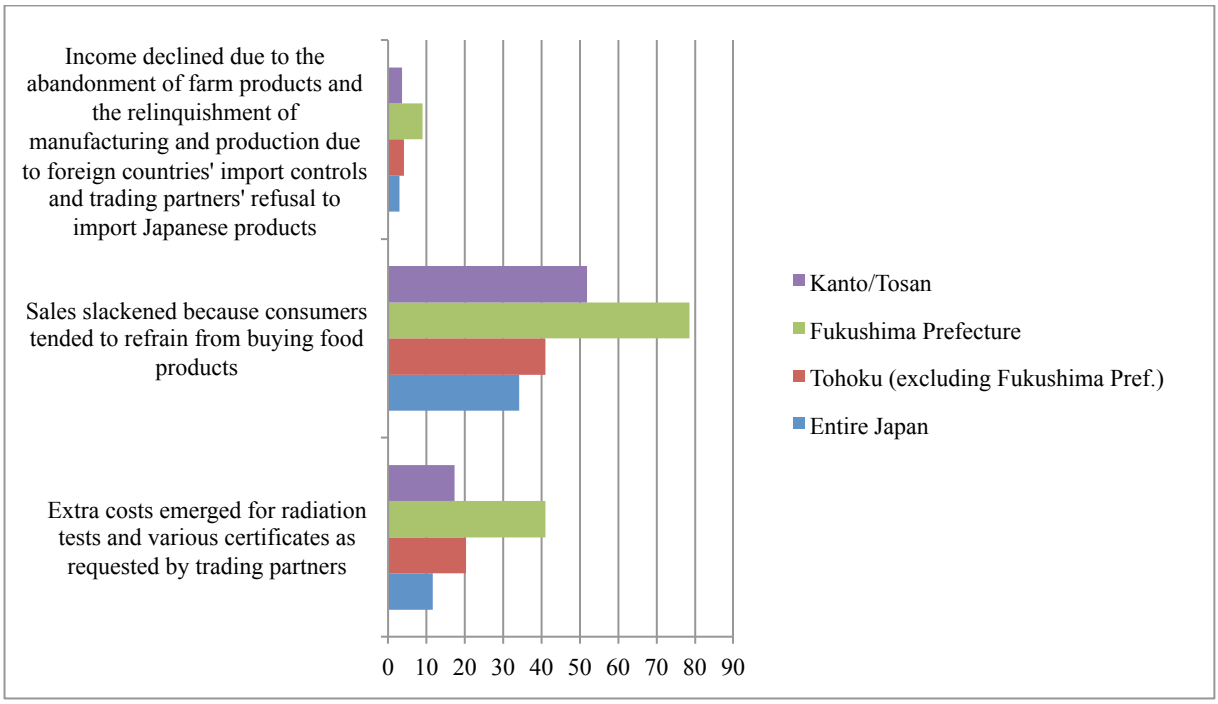
[64] fermented soybeans normally packed in rice-straw.

[65] Insofar the "grow local, eat local" movement not taken off in Fukushima Prefecture, and it is difficult to sell agricultural produce outside the prefecture [Koyama, 2013].

and trustworthy of Fukushima products to other prefectures. Is time the only way to solve this problem?" (June 14, 2013).

Countrywide survey of MAFF found out that more than a third of surveyed Japanese farmers (Figure 50) and almost of 38% of food industry personnel (Figure 51) indicate that "Sales slackened because consumers tended to refrain from buying food products". The later figures are much higher for the most affected by the disaster regions. Moreover, a substantial number of food industry companies point out that they "switched from agriculture, forestry and fisheries products in areas with radioactive contamination fears to those in other areas (in Japan) for our purchasing" and that amounts for more than 57% in Fukushima prefecture (Figure 51).

**Figure 50. Effects of TEPCO nuclear plant accident on farmers (%)***



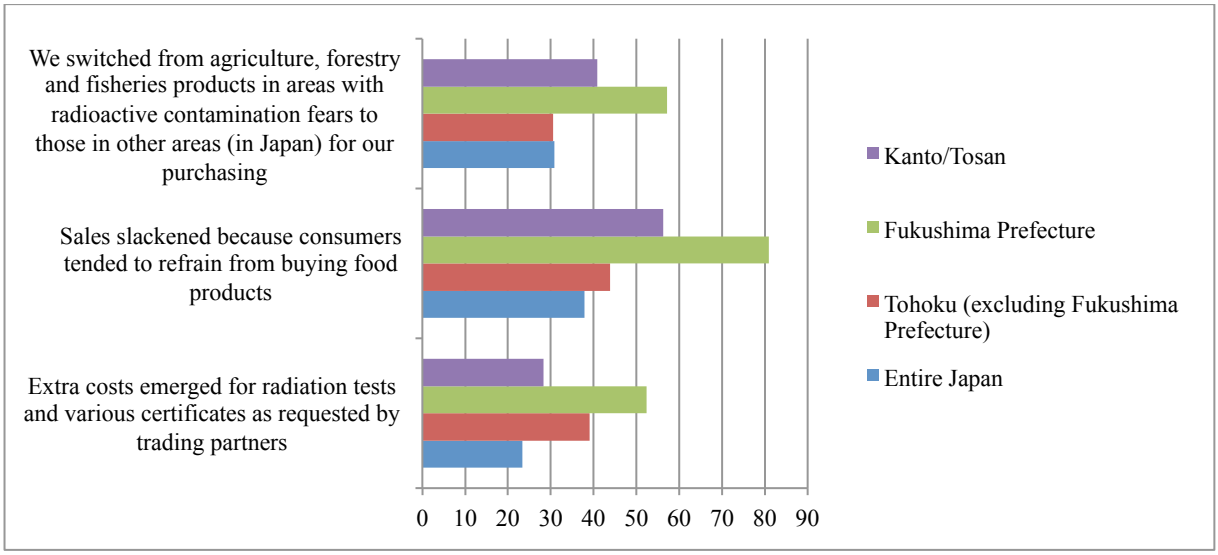

Source: MAFF, 2013 *multiple answers

After the nuclear accident, there was a considerable decline in absolute and relative prices of affected farm products and products from the contaminated regions. Fukushima prefecture has lost its comparative advantage to other farming regions. For instance, in 2011 the price of peaches from Fukushima dropped 100 to 200 Yen, and asparagus around 300 Yen compared to the same products from other regions [Murayama, 2012]. Wholesale market shipment prices of vegetables grown in Fukushima prefecture in summer-fall 2012 were 20-30% lower in absolute terms than for 2011 [Watanabe, 2013]. At the same time, new rice in 2011 was 10-20% more expensive than 2010 crop due to the efforts of wholesalers to purchase rice free of radioactive substances [MAFF, 2012].

Farm products prices have not recovered yet in the most affected regions. For instance, in September 2014 farmers in Soma "were shocked by the price" that a local agricultural cooperative offered to pay when it took possession of his rice saying they would not be able to

make a living" [The Japan News, October 28, 2014]. Cooperative offered ¥6,900 per 60 kg for Koshihikari brand rice harvest ranked as the highest grade in quality which was about 40% lower than last[66]. According to JA agricultural cooperative official "We're still suffering from unfounded fears, even at the same prices as other prefectures buyers don't choose our products. The tentative payments in Fukushima Prefecture are dropping at a greater rate than elsewhere, despite all possible efforts".

**Figure 51. Effects of TEPCO nuclear plant accident on food industry (%)***




Source: MAFF, 2013 *multiple answers

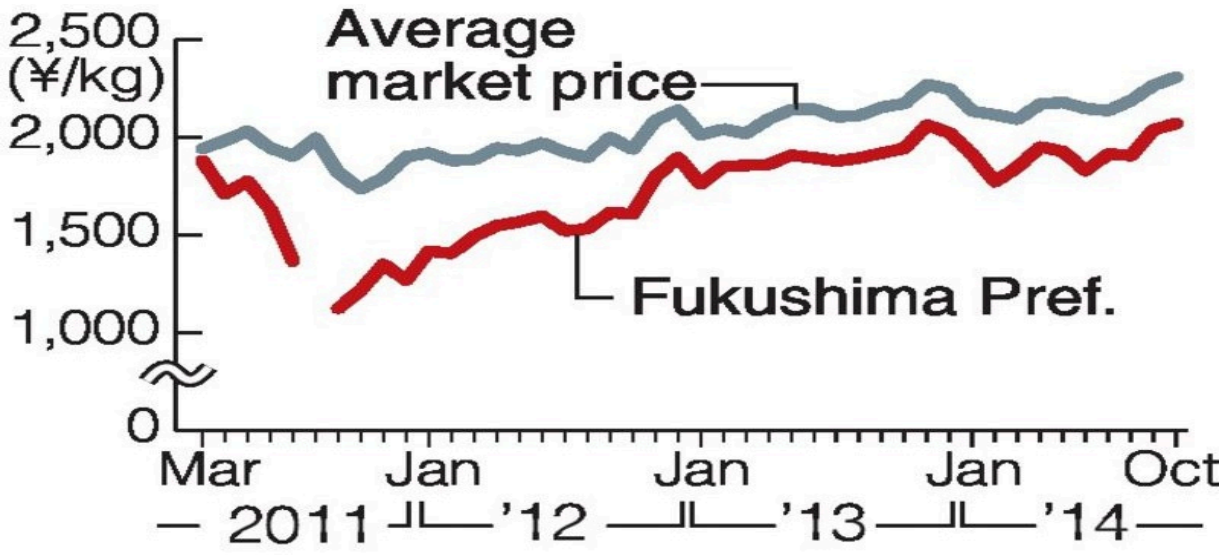
The effect of the nuclear disaster on price levels can be well seen by comparing the dynamics of wholesale prices of major farm products from Fukushima and other regions.

There was a considerable decline in the wholesale prices of beef cattle in Fukushima prefecture and in Japan after the accident (Figure 52). The prices in the country have been recovered and there has been gradual recovery of beef prices in Fukushima prefecture as well. Nevertheless, prices for different categories of beef are still 12-13% lower in Fukushima comparing to Japan.

Similarly, at the Tokyo Metropolitan Central Wholesale for the period July-December 2011 the average prices for wagyu (Japanese beef cattle) bullock carcasses for all producing regions were 19% lower than for the same period the year before (with a dramatic year-on-year drop of 25% in October) [Watanabe, 2013]. The price of wagyu bullock carcasses from Fukushima prefecture declined by 50% in October 2011 compared to the same month of previous year, and stayed more than 30% lower than the average price for all producing regions. Since the beginning of 2012 prices for all producing regions gradually recovered and until the end of the year returned to their level of three years ago (although under 2000 yen/kg). The price of Fukushima bullock carcasses has been recovering but it remained more than 10% lower than the average for all producing regions.

[66] Rice prices have been generally low nationwide due to abundant harvests and falling consumption in 2014. In neighboring Ibaraki Prefecture ¥9,000 was offered for 60 kg of rice which is about 20% lower than in 2013.

**Figure 52. Evolution of wholesale prices of beef carcasses for Wagyu steers, Grade A5 at Tokyo Central Meat Wholesale Market**




Source: Central JA Union for Fukushima Prefecture

Nevertheless, at the first 2014 auction in Fukushima Prefecture 873 calves put up for sale fetched an average of Y551,893 per head, 23% up from a year earlier, higher than the prefecture's average price (Y446,914) before the disaster, and close to the to nationwide levels [Kachi, 2014]. Likely wise, the price for a Japanese Black Cattle calf stood at Y548,776 per head on average in the nation's cattle market (113 locations) in December, 2013[67] which was 24% up compared with December a year earlier, and the highest price since 1994 when the Agriculture and Livestock Industries Corporation organization started keeping records [Agriculture & Livestock Industries Corporation, 2014].

According to the experts falling supply rather than growing demand drives beef cattle prices up nationwide and Fukushima prefecture alike [Kachi, 2014]. Aging population and a lack of successors has cut the number of domestic cattle growers while high prices for cattle feed have pushed others out of the market.

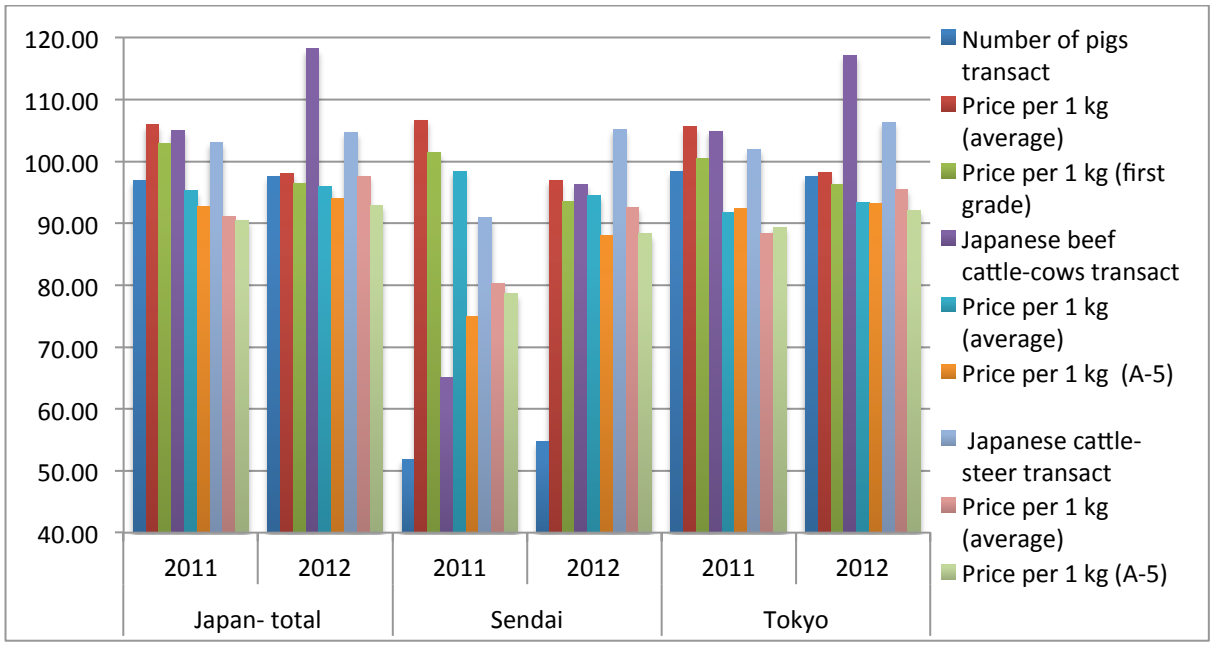
Fukushima farmers were strongly hurt by the March 2011 disaster (calf prices falling to Y308,628 per head in August 2011), which derived out cattle breeders and lead to the closure of two out of the three prefectural cattle markets. Due to low demand and low prices for Fukushima beef and delays in decontaminating grass on river banks supplying calves' feed the number of cattle breeders in Fukushima prefecture has decreased by roughly 30% (120 farms went out of business) after the nuclear accident[68] to 324 in February 2014 [MAFF, 2015].

There has been the same tendency at the Sendai central wholesale meat market in the badly hit by the 2011 disaster Miyagi prefecture. There has been significant decline in the number of transacted pigs and Japanese beef cattle in 2011 (Figure 53). However, while pig wholesale prices were increasing with the same nationwide tendency, the average and the first

[67] December is typically when the prices are the highest for the year.
[68] The prefecture worries that all producers may soon disappear [The Japan News, January 20, 2015].

grade beef cattle prices decrease considerably. Moreover, the plummeting of the later was bigger than the overall price reduction across the country.

**Figure 53. Dynamics of number of transacted animals and wholesale prices at the central meat wholesale markets (2010=100)**




Source: Statistical yearbook of MAFF

In 2012 there was a nationwide recovery above 2010 numbers for Japanese beef cattle transactions but wholesale prices were still bellow the pre-disaster level. In Sendai, recovery in the numbers and prices of traded animals was slower than in the rest of the country.

Fukushima is Japan's forth biggest rice-growing prefectures with rice accounting for about 40% of the prefecture's agricultural output[69]. After the nuclear accident the price of Fukushima rice fell in both absolute and relative terms [Watanabe, 2013]. In 2012 rice prices in Fukushima prefecture bounced back in absolute terms, with a pace of recovery varying between major prefectural regions. However, Fukushima rice continues to stay relatively lower comparing to rice grown elsewhere (Figure 54).

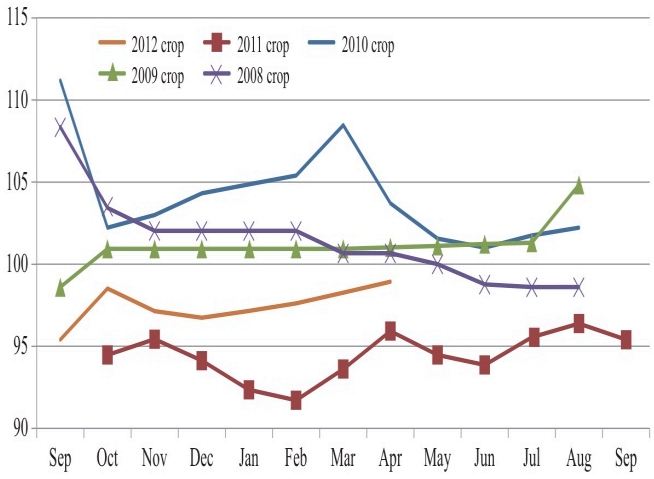
For instance, before the period before the nuclear accident (2005 - February 2011) Koshihikari brand grown in Nakadori region was traded between Tokyo dealers for more (on average 3.3% higher) than that in Kanto region (Ibaraki, Chiba, and Tochigi prefectures) [Watanabe, 2013]. For the 2011 crop it was priced on average over 5% lower (falling down over 8% in February 2012) while for the 2012 crop remaining almost 3% inferior.

Fukushima Prefecture was also a leading producer of summer-fall cucumbers and tomatoes. Before the nuclear accident, the Fukushima variety sold for about 10% more than the average for all producing regions at the Tokyo Metropolitan Central Wholesale Market (Figure 55). Price of Fukushima cucumbers fell more than 2% below the average in 2011 and

[69] Fukushima is divided into three regions (Hamadori, Nakadori, and Aizu) with extensive rice farming and local rice brands.

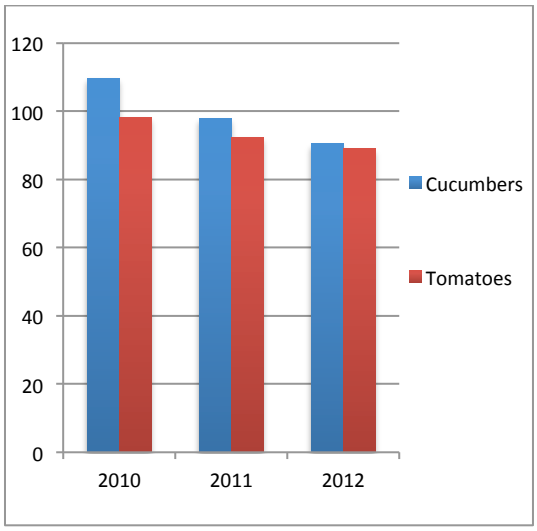
almost 10% in 2012. Likewise, tomatoes priced somewhat less than 8% below the average in 2011 and over 11% below in 2012.

**Figure 54. Relative price of rice in Nakadori, Fukushima prefecture (Kanto rice price = 100)**




Source: Watanabe 2013

**Figure 55. Relative prices of Fukushima vegetables (average wholesale price = 100)**




Source: MAFF, TMCWM

According to experts the prices of fruits in Fukushima prefecture (mostly bought for gifts) largely recovered since consumers choice is not determined by the price but the "origin of product" factor (2013 interview with Prof.Komatsu).

Many consumers in the affected regions and throughout Japan have seen their direct procurement (e.g. prices) and transaction (information, search, assurance etc.) costs for supply of needed safe agri-food relatively from alternative regions, countries or guaranteed sources increased [Bachev and Ito, 2013]. However, there are no detailed studies on these effects of the nuclear disaster yet.

Nevertheless, some research proves that a major way to minimize the transaction costs for supply of radiation safe product from a big number of costumers is to use "origin of product" selective governance [Uijie, 2012]. A segment of consumers went even further to purchase only from the "guaranteed sources" like some Tokyo residents using direct sales contract to buy rice from Kyushu farms [Kakuchi, 2013]. On the other hand, some Fukushima farmers see growing new crops (like cucumbers) and opting for direct sales to customers (rather than supermarkets) as a way to recover operations.

Some experts argue that both producers and consumers are victims of the "reputation damage" [Koyama 2013]. According to 2013 survey 26.1% of the consumers do not even know that inspections of radioactive contamination are being conducted [Consumer Affair Agency, 2013].

In order to facilitate communication with consumers, promote and recover Fukushima agricultural products numerous initiatives have been undertaken by farmers, agricultural organizations, NGOs, authorities, business, retailers etc. such as: direct sells by farmers, on spot radiation tests, recovery markets, Farmers' Document and Farmers Café events, government "Eating for support" initiative, joint ventures with shops, promotion complains with participation of top officials, celebrities, journalists, and farmers in big cities,

international fairs etc. [Fukushima Minpo News, January 27, 2014; Inoue, 2014; The Japan News, March 8, 2014; Koyama, 2013; NHK World, May 17, September 21, 2014; MAFF, 2014].

For instance, the fast-food chain Yoshinoya has set up a joint venture to produce and market food from the Fukushima prefecture to help region's recovery [Thompson and Matsutani, 2013]. Company provides funds (investment of Y10m or $102,000) through a joint venture (Yoshinoya Farm Fukushima Co) held with local farmers who will grow rice, onions and cabbages in the region, produce which could then make it on to the tables of the 1,175 restaurants the chain operates in Japan. The anticipated production volume of 35 tones is about a thousandth of what the chain needs annually to produce its meals[70]. Farmers in Fukushima had already been exploring the possibility of a similar link-up before 2011, but that project was put off following the nuclear accident.

Fight against "harmful rumors" that led to plummeting prices and sales of farm products have been also a high priority for local and national authorities. For instance, Fukushima prefecture is spending about 1.7 billion yen ($16.6 million) this fiscal year to fight rumors about radiation - fourfold budget increase over the previous year [Inoue, 2014]. In 2012 the prefecture hired popular idol group Tokyo for commercials to appeal its agricultural produce in Tokyo area. In this year's survey of before-and-after results from the commercials the ratio of respondents who said they "do not want to buy" Fukushima produce dropped by about 10 points from 27% after viewing.

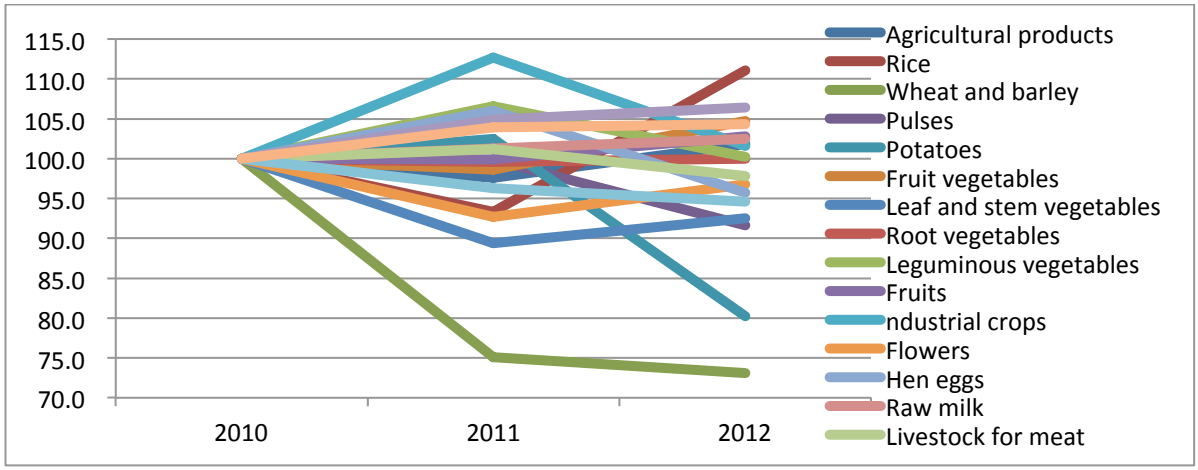
The central government also plans to do more to help revive industries suffering from groundless rumors following the nuclear accident. The Reconstruction Agency compiled new guidelines for helping local businesses which say that: the government will continue releasing the results of radioactivity tests on agricultural products from Fukushima prefecture; officials will continue to urge foreign countries to ease or abolish import restrictions on farm and fisheries products; they call on member companies of the Japan Business Federation (Keidanren) to use farm products from Fukushima prefecture as gifts and offer them at in-house sales events; officials will work to attract tourists, including students on school trips, from inside and outside Japan; and urged the related agencies to lead the way to help give the industries a boost [NHK, June 23, 2014].

Recent data suggest that demands for Fukushima (Ibaraki and Northern Honshu) agricultural products (e.g. rice, beef, vegetables) have been recovering fast while the farm-gate and wholesale prices in the most affected regions (Fukushima, Ibaraki) are still lower than in other part of the country. That is consequences of a number of factors: reduction of radioactive contaminations, improving consumer confidence on inspection and safety, "forgetting" the contamination issue by some part of population, preferences to lower prices regardless the quality by some segment of consumers, changing marketing strategies of processors and smaller shops (not promoting/labeling anymore some farming and processed products as "Fukushima origin"), increasing procurement by restaurants and processors of safe and cheap produces from the region etc. Consequently, despite negative impact on local producers in affected region some actors in the food chain (restaurants, food stores, middleman) have been profiting enormously getting a higher margin.

[70] Yoshinoya is already involved in a similar project in Kanagawa.

In 2011 there was registered a decrease in the overall prices of agricultural commodities in the country (Figure 56). Prices of rice and vegetables declined more than the overall reduction (with 2.4% and 4.7% accordingly) while prices of fruits and pulses prices diminished a little (only 0.1% and 0.2% accordingly). On the other hand, potatoes and livestock prices slightly increased (2.5% and 1.2% accordingly) while that of industrial crop grown significantly (11.7%).

**Figure 56. Price index of agricultural commodities in Japan (2010=100)**




Source: Statistical yearbook of MAFF

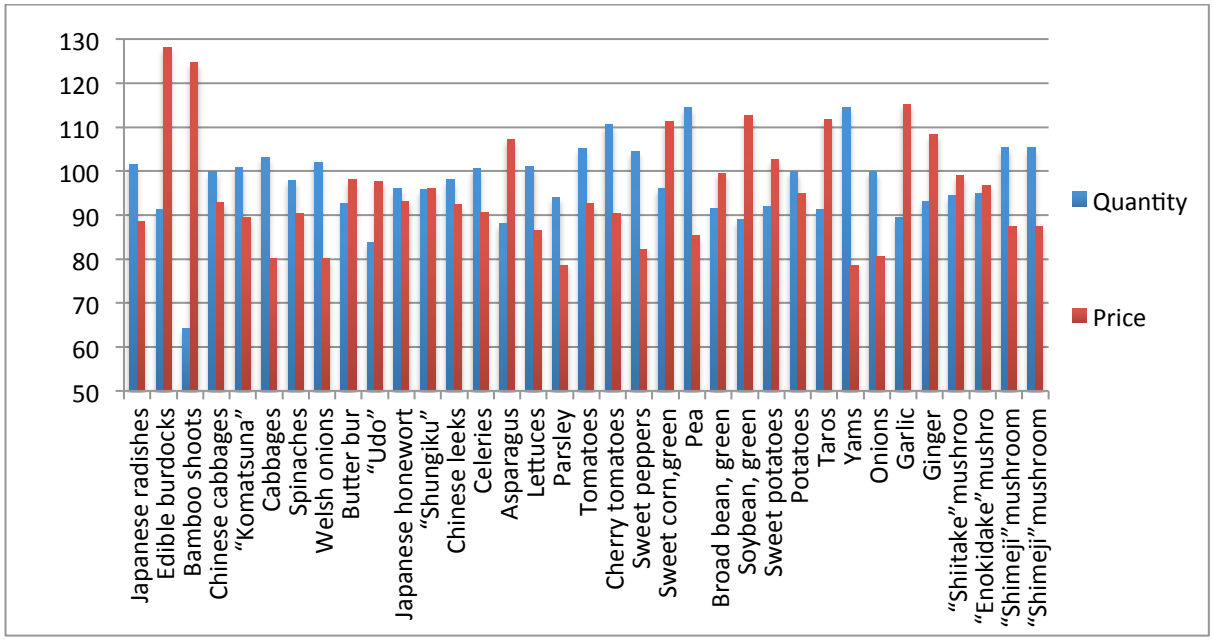
Diminution of the prices of Wheat and burley, Miscellaneous cereals and Leaf and stem vegetables was the highest, while that of Leguminous vegetables, and Hen eggs, and Young livestock increased the most.

Furthermore, there was a significant dynamics in traded quantities and wholesale prices of individual agricultural products. For instance, in 2011 there was a slight increase (0.36%) of wholesale traded domestically produces vegetables [MAFF, 2012]. At the same time there was a considerable decline in the traded value (7.52%) and wholesale prices (7.93%). Figure 57 shows the individual vegetables with the highest change (decrease or increase) in the wholesale quantities or prices. The most adversely affected in terms of traded quantities were Bamboo choots and in terms of price Parsley. On the other hand, the highest augmentation of amount was achieved by Yams and of prices by Edible burdocks.

In 2012 there was a rebound of the agricultural products prices above pre-disaster levels. The rice price demonstrated the highest growth, followed by the Young livestock and Fruit vegetables.

Nevertheless, the significant dynamics in the wholesale quantities and prices of individual agricultural products persisted. For example, there was a small decrease (0.85%) in the wholesale traded domestically produces vegetables [MAFF, 2013]. Simultaneously, significantly lower that the pre-disaster year levels of traded values (7.37%) and wholesale prices (7.84%) sustained. The greatest reduction in traded volume continued for Bamboo choots (20.68%) while potatoes showed the biggest decline in 2010 prices (43.67%). On the other hand the Cherry tomatoes registered the greatest augmentation in traded quantities (11.54%) and “Shungiku” in traded prices (21.69%).

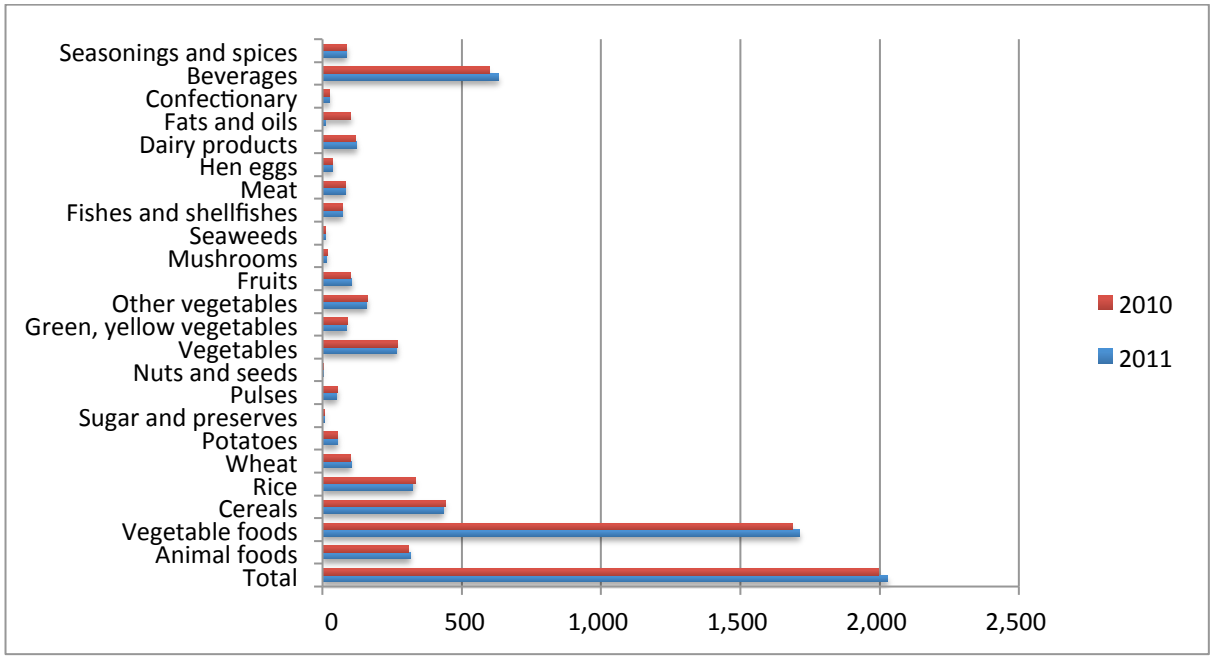
**Figure 57. Dynamics of wholesale quantities and prices of domestic vegetables with more than 5% change in traded volumes or prices in major cities in 2011 (2010=100)**




Source: Statistical yearbook of MAFF

Data show that in 2011 the daily intake per person for some of the most likely affected by the nuclear disaster food groups decreased comparing to the period before the accident (Figure 58). For instance, consumption of mushrooms dropped by 12.5%, seaweeds by 5.4%, pulses by 6.5%, etc. That change in the national consumption pattern is probably a consequence of the newly emerged consumers risk concern, higher procurement costs or other (unspecified) reasons.

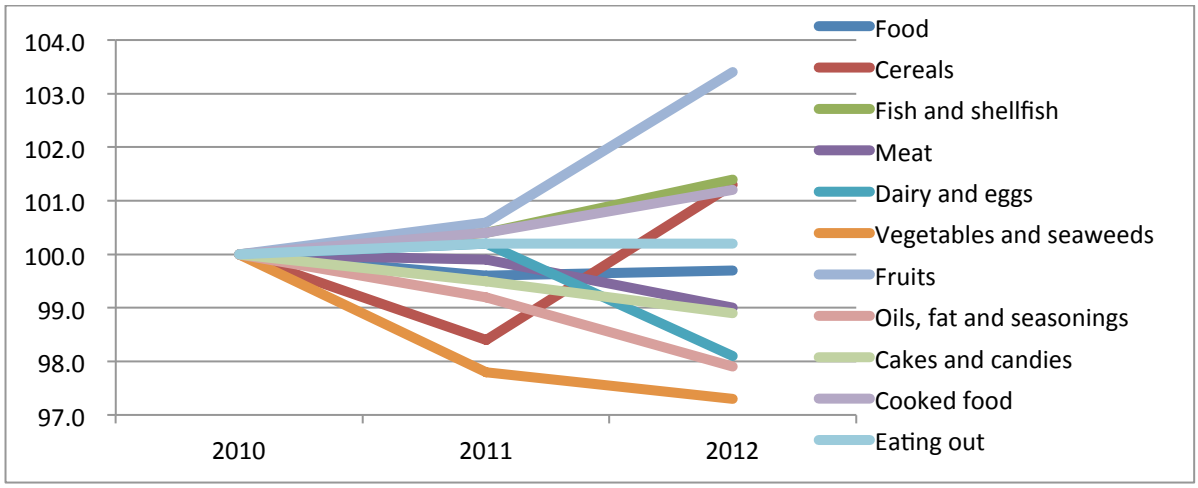
**Figure 58. Daily intake per person by food groups in Japan (grams)**




Source: Ministry of Health, Labor and Welfare

What is more, the consumer food prices declined slightly in post disaster years following the trend from the past (Figure 59). The biggest retail price diminution was marked for Vegetables and Seaweeds, while for Fruits, Fish and Shellfish the prices were increasing.

**Figure 59. Consumer food price index in Japan (2010=100)**




Source: Statistical yearbook of MAFF

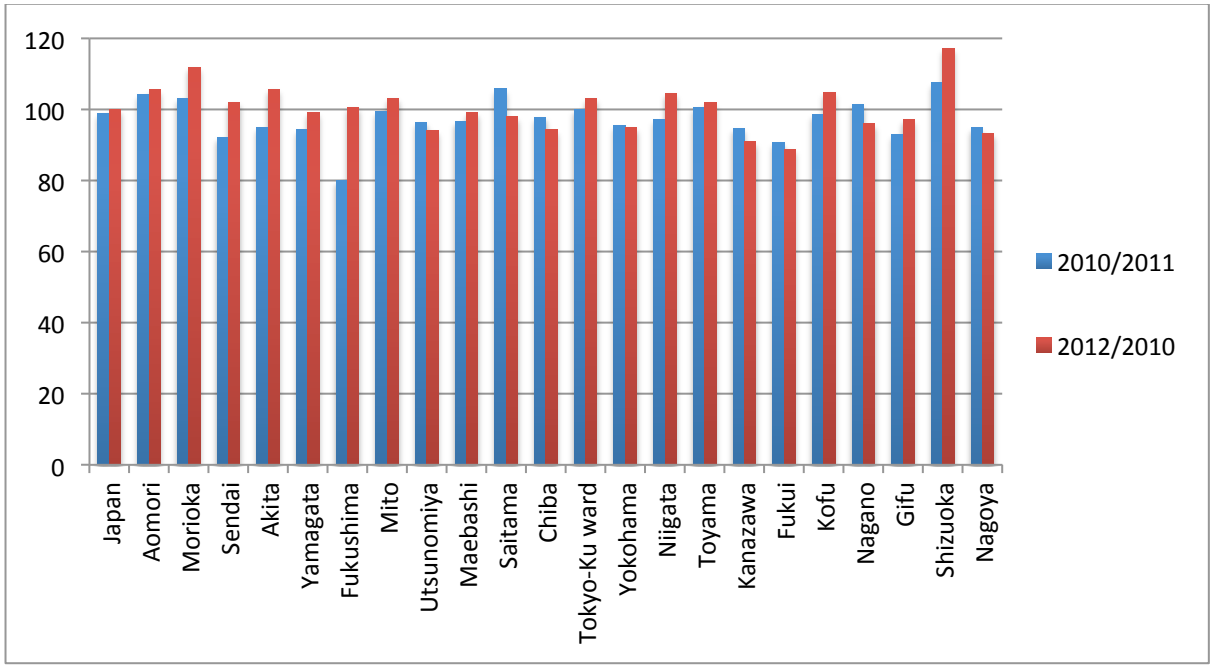
Consequently, the annual household member food expenditures in the most of the biggest cities around the affected regions and nationwide declined in 2011 (Figure 60) following the downsizing trend in the past several years [MAFF, 2013]. Contrary, that year it was registered a food costs rise in Aomori and Morioka as well as a considerably higher than the national enlargement of that figure in the most badly affected prefectures (Aomori, Morioka, Sendai, Akita, Mito) in the following year.

The 2011 disasters also affected considerably the international trade with agricultural products. Around 40 countries imposed restrictions on agri-food import from Japan after the nuclear accident, including major importer such China, United States, Indonesia, Malaysia and South Korea. The European Union required food and animal feed from 12 prefectures to be checked prior the export to prove that radioactive iodine and cesium levels do not exceed EU standards. In addition, agri-food items from 35 other prefectures had to be shipped along with a certificate of origin to verify where the products were produced.

Few months after the nuclear crisis some countries (like Canada, Thailand) lifted or eased restrictions on Japanese food imports. Rice exports to China with government-issued certificates of origin and produced outside the prefectures Chiba, Fukushima, Gunma, Ibaraki, Niigata, Nagano, Miyagi, Saitama, Tokyo, Tochigi and Saitama became possible in April 2012. In October 2012, EU also substantially eased import restrictions from 11 prefectures but kept restrictions for products from Fukushima prefecture. Radioactive material tests certificates are usually required [MAFF, 2014].

By March 1, 2013 as many as of 10 countries completely lifted radionuclide related restrictions on food products from Japan including Canada, New Zealand, Malaysia, Mexico, Peru, Chile, Columbia, Guinea, Myanmar, Malaysia and Serbia (Reconstruction Agency, 2014).

**Figure 60. Dynamic of Annual Food Expenditures per Household Member* in prefectural capitals of affected regions (2010=100)**




Source: Statistical yearbook of MAFF * in households of 2 or more persons

Various initiatives have been undertaken to promote food-safety among major importers of Japanese agri-food products (Hong Kong, Singapore, Taiwan, etc.) like fairs, information etc. Recently,

Chiba[71] governor has called on Taiwan to lift the ban on imports of food and agricultural products imposed in the aftermath of nuclear disaster requesting Taiwanese inspectors be dispatched to Chiba to see the inspection process[72] [NHK World, October 27, 2014].

On August 18, 2014 it was announced that for the first time that Fukushima rice has been exported since the accident at the nuclear power plant (60 bags of 5kg of "Koshihikari" variety harvested in Sukagawa for high-end supermarket in Singapore) [Fukushima Minpo News, August 19, 2014].

Due to the foreign countries' import restrictions and the experienced damages, the value of Japan's farm and livestock product exports declined substantially - in April-December 2011 the export plunged by 40.9 billion yen (11%) from the year before [MAFF, 2012]. Furthermore, in January-March, 2012 the value of country's export of agricultural products was 89 million (12.77%) lower than for the same period before the disaster (Figure 61).

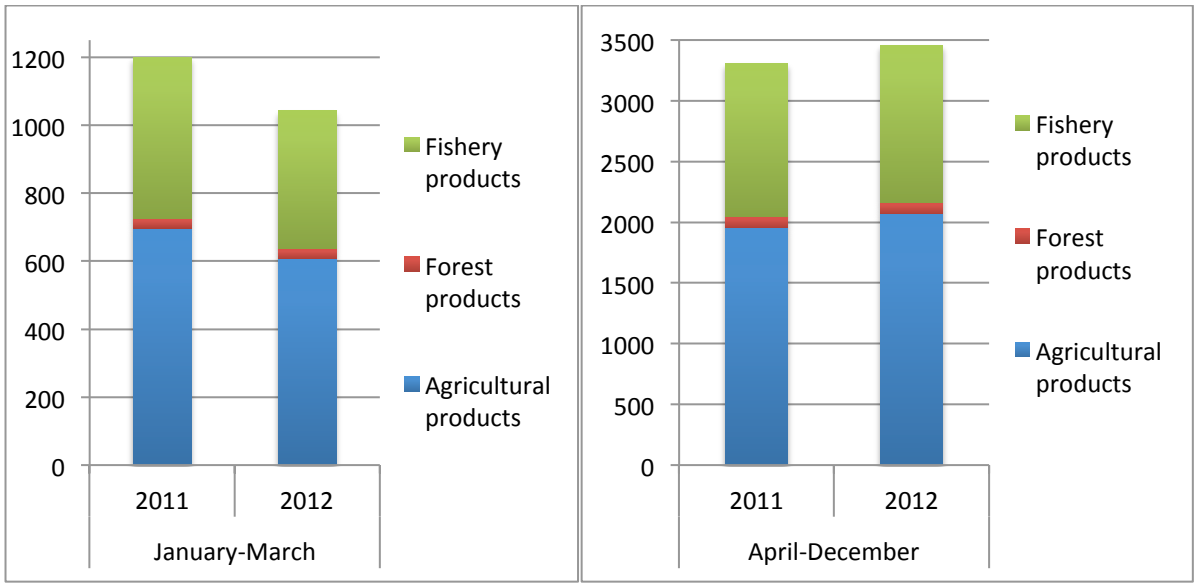
Consequently, there was a considerable decease in the overall agricultural (including fields crops and livestock products) as well fishery products export in 2011 (Figure 62). At the same time, there was a significant increase in the import of agricultural, forestry and

[71] Fukushima and Chiba are among the 5 prefectures with food and agricultural products blanket ban in Taiwan.

[72] According to the Taiwan's liaison commission with Japan a dispatch of Taiwanese inspectors will be the most convincing step to take.

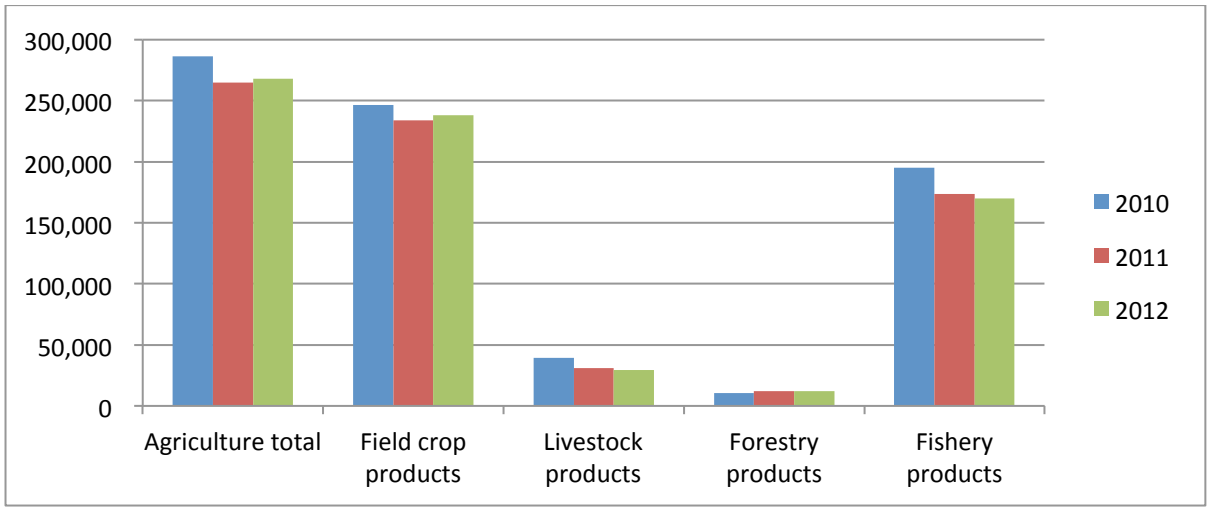
fishery products as imports of farm products jumped 16% to 5.58 trillion yen in 2011 (Figure 63).

**Figure 61. Value of agricultural exports before and after March 2011 disaster (hundred millions of yen)**




Source: Ministry of Agriculture, Forestry and Fisheries

**Figure 62. Dynamics of agricultural, forestry and fishery export of Japan (million yen)**



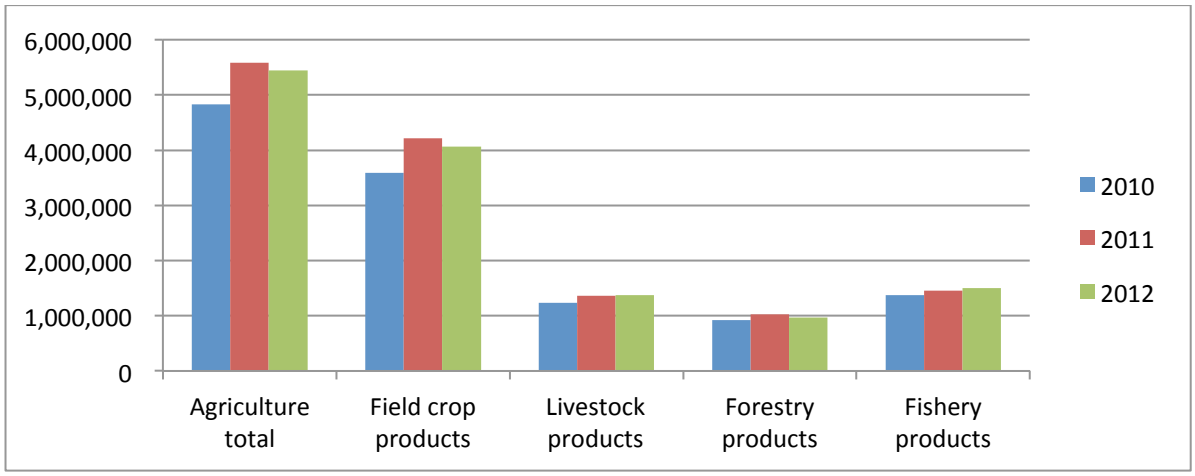

Source: Statistical yearbook of MAFF

In April-December 2012 it was registered a 5.98% growth in the export of agricultural products of the country (Figure 60). Moreover, a slight augmentation of the annual exports of agricultural and field crops products was reported but the export value was still bellow 2010 level (Figure 62). The overall import of agricultural and crop products decreased but it was still above the pre-disaster levels. At the same time fish products exports continue to enlarge.

Recent data indicate that Japan's exports of agricultural, forestry and fishery products (like marine products, beef, processed foods and sake) are expected to hit a record in 2014 for the second consecutive year [The Japan News, December 27, 2014]. Exports of such products

totaled ¥489.3 billion in January-October 2014, up 10% from the same period of 2013. The later is due to demonstrated safety as well growing popularity of Japanese cuisine worldwide coupled with a weaker yen. For instance, beef exports jumped 43% to ¥6.3 billion and demand for high-grade Japanese beef is expected to grow further as the European Union has lifted a ban on beef imports from Japan.

**Figure 63. Dynamics of agricultural, forestry and fishery import of Japan (million yen)**



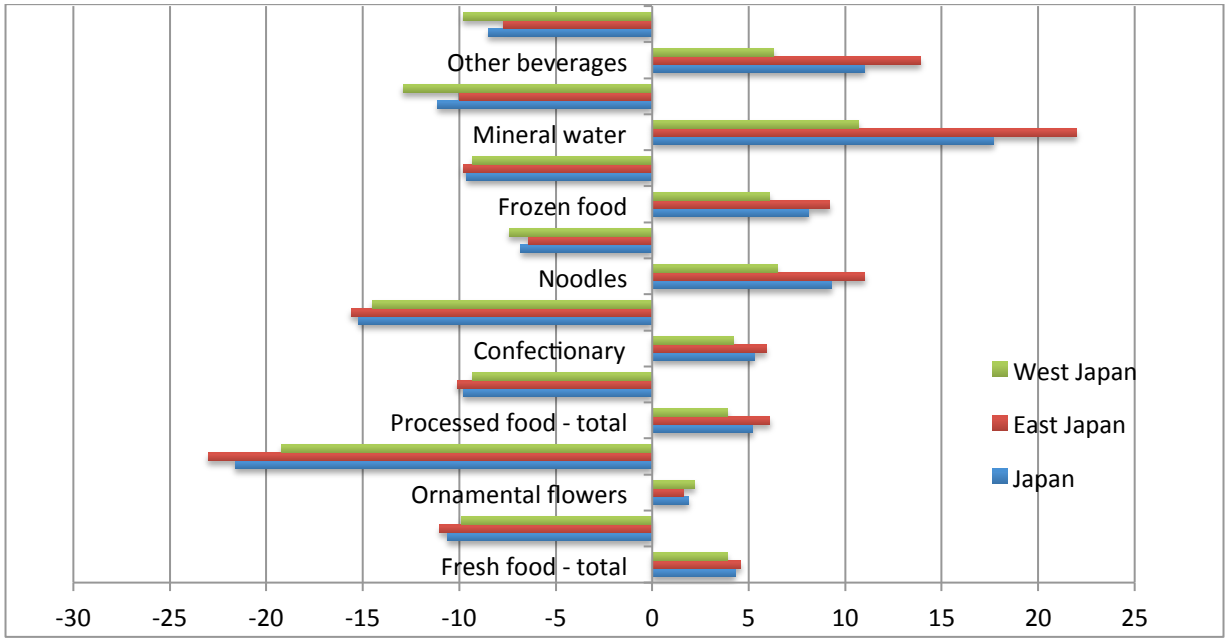

Source: Statistical yearbook of MAFF

There has been significant change in the purchase behavior of a great number of consumers after the March 2011 disasters. The July 2011 survey found out that a good share of consumers decreased the purchased amount of fresh (10.6%) and processed (9.8%) food, ornamental flowers (21.6%), confectionary (15.2%), etc. (Figure 64). On the other hand there is an increase in purchase mineral water (17.6%). These changes were more dynamic in the worst affected East Japan than in the other parts of the country.

In the months after the earthquake, the item most emphasized by the consumers at the time of purchase of fresh food was “production location” and for processed food the “origin of raw materials” (Figure 65). However, for the majority of consumers there was not change of the place to buy fresh (88.5%) and processed (89.1%) food comparing to the pre-duster period [Japan Finance Corporation, 2011].

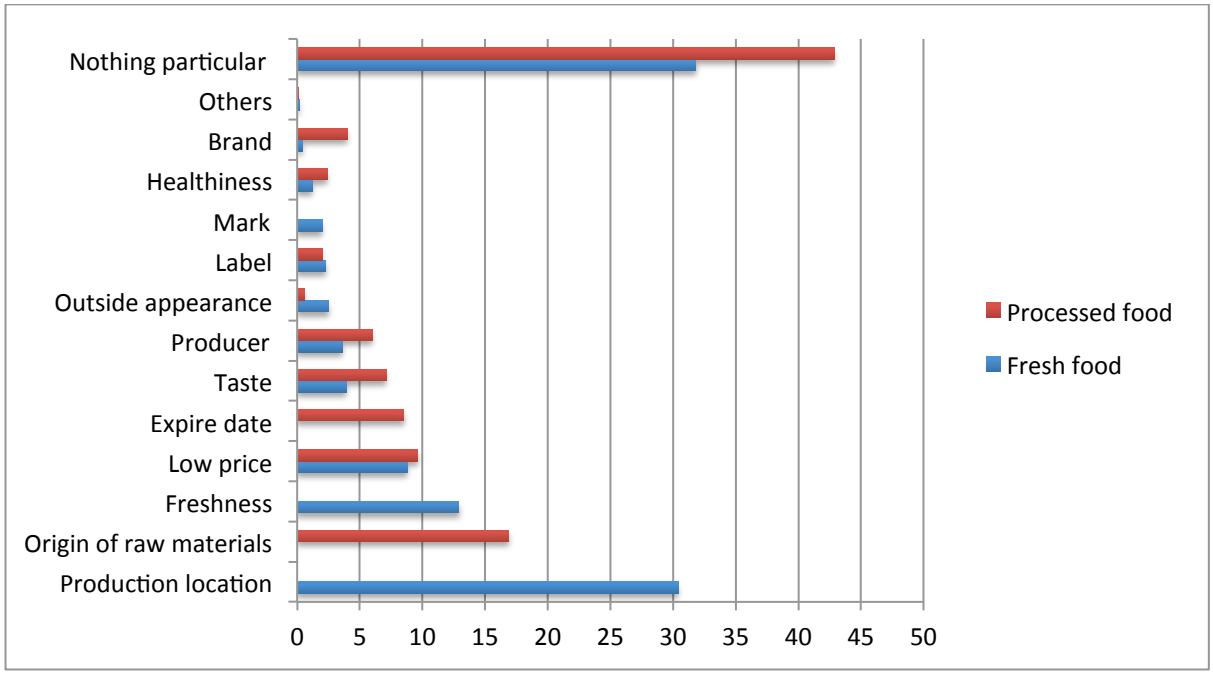
The consumer attitude to purchase food products from the affected by the nuclear disaster regions has evolved in post disaster years (Figure 66). Currently, relatively more and more consumers do not mind the impact of the nuclear disaster when purchase agri-food produce. Nevertheless, still significant share of consumers do not buy fresh (31.8%) and processed (28.3%) products from that regions because of the impact of the nuclear disaster.

**Figure 64. Change in purchase amount of different category of food after Great East Japan Earthquake (July 2011)**



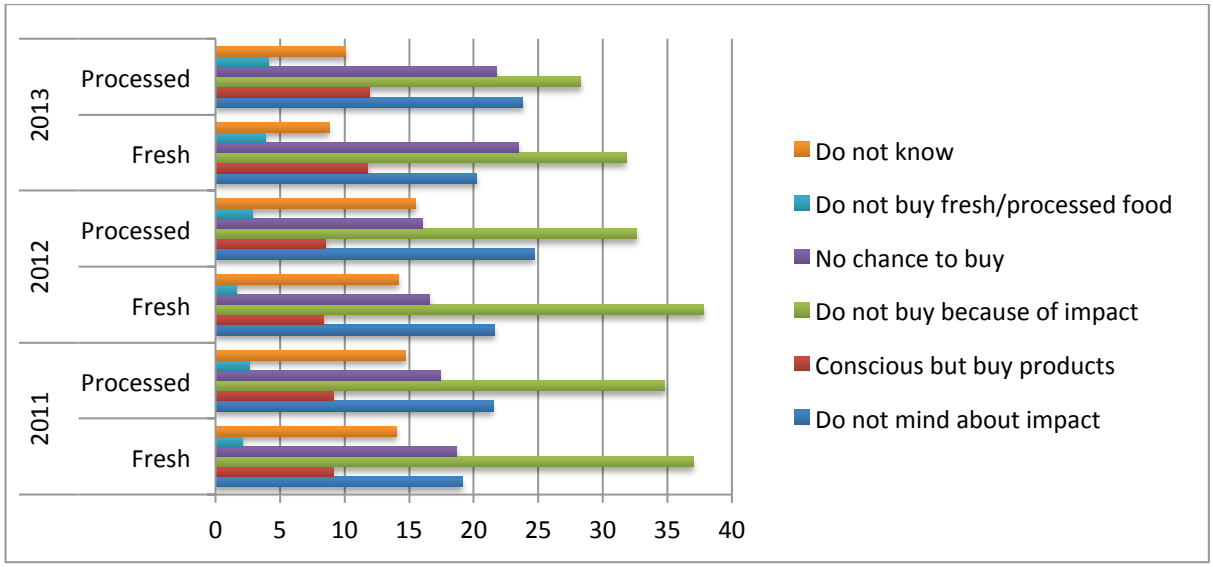

Source: Japan Finance Corporation

**Figure 65. After the earthquake, items to be emphasized at the time of purchase of fresh and processed food in Japan (July 2011)**




Source: Japan Finance Corporation

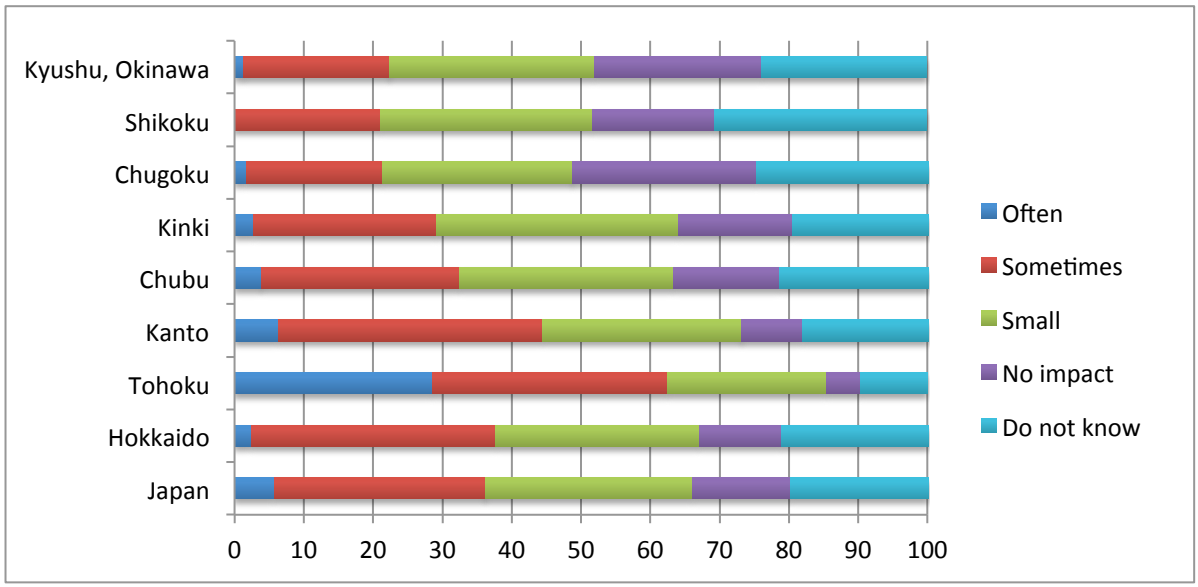
**Figure 66. Awareness when purchase fresh and processed food from the region after Fukushima nuclear power plant accident (July 2011, January 2012, January 2013)**




Source: Japan Finance Corporation

Recent data indicate that a good portion of Japanese consumers (36.5%) "often" or "sometimes" purchase purchase foodstuffs from affected by the 2011 disasters areas (Figure 67). The latest figure is much higher in Tohoku region then in the other parts of the country.

**Figure 67. Purchase of (processed goods and agricultural products) foodstuffs produced in areas affected by the Great East Japan Earthquake (including eating out) (January 2014)**



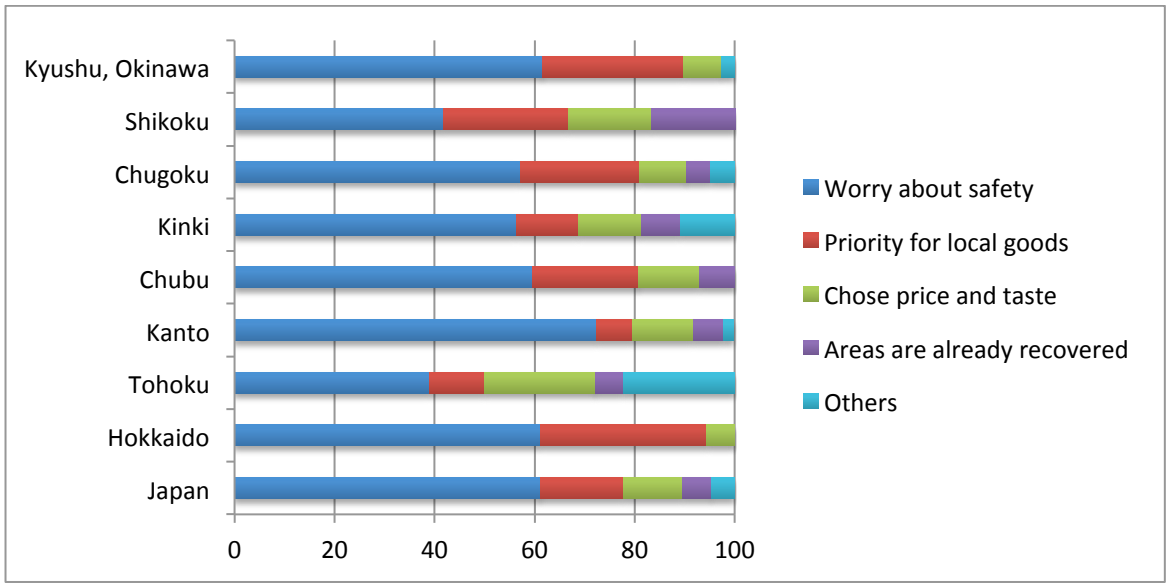

Source: Japan Finance Corporation

There are also gender and age differences in willingness to buy from the affected regions. For instance, older generation and women tend to buy more from the affected regions than the younger generation and men [Japan Finance Corporation, 2014].

Nevertheless, for a great proportion of the consumers it is important to select the region of agro-food products and they purchase “rarely” or “not at all” from the affected regions.

Diverse promotions about produce safety etc. increase consumer willingness to purchase products from the affected regions (Japan Finance Corporation, 2014). For most Japanese consumers who do not want to purchase food stuff from the effected regions even if there is promotion the main reasons is “worry about safety” (Figure 68).

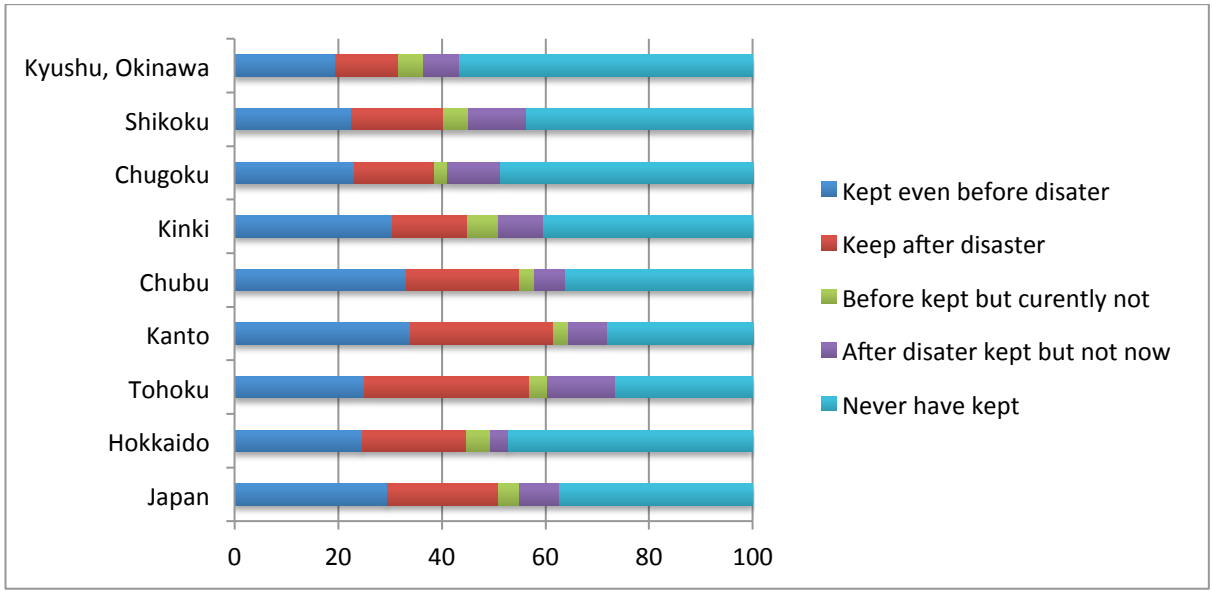
**Figure 68. Reason do not want to purchase even there is a promotion (January 2014)**




Source: Japan Finance Corporation

All surveys show that there is increased awareness of the needs to keep foodstuff at home after the 2011 disasters [Japan Finance Corporation, 2014]. Furthermore, around 29.5% of consumers report they kept food stockpiles at home event before the disaster, 21.5% are keeping such piles after the disaster (much higher percentage in worst affected Tohoku and Kanto regions), while 7.9% kept after the disaster but currently not (much higher in Tohoku region) (Figure 69).

**Figure 69. Stockpiling of food (incl. drinking water) at home after Great East Japan Earthquake (January 2014)**




Source: Japan Finance Corporation

## VII. Effects on food regulation and inspection system

Up to the Fukushima nuclear plant accident there had been no adequate system for agri-food radiation regulation and inspection to deal with such a big disaster [MAFF, 2011]. On the wake of the accident a number of measures were taken by the government to guarantee the food safety in the country.

Widespread inspections on radiation contamination were introduced and numerous shipment and consumption restrictions on agri-food products imposed.

Within a week from the nuclear accident (March 17, 2011) Ministry of Health, Labor and Welfare introduced Provisional regulatory limits for radionuclides in agri-food products[73] (Table 15).

**Table 15. Provisional regulatory limits for radionuclides in agri-food products (Bq/kg)**

| Products | I-131 | Cs-134 + Cs-137 |
|---|---|---|
| Drinking water | 300 (100)* | 200** |
| Milk/Milk Products | 300 (100)* | 200** |
| Vegetables/Fish | 2000 | 500** |
| Cereals/Meat/Eggs | - | 500** |

*for infants ** values take into account the contribution of radioactive strontium

Source: Ministry of Health, Labor and Welfare

On 29 March 2011, the Food Safety Commission of Japan drew up a report guaranteeing that the ongoing measures based on provisional regulation values are effective enough to ensure food safety for consumption, domestic distribution and exportation. On 4 April 2011 MHLW decided to use the ongoing provisional regulation values for the time being and set up provisional regulation value for radioiodines in seafood on the next day.

In order to meet growing public safety concerns since April 1, 2012 new[74] official limits on radioactive cesium[75] in food items have been enforced in the country (Table 16). Four categories of Drinking water, Infant foods and Milk, and General foods are distinguished. New safety standards are more stringent than in international ones – e.g. maximum allowed radioactive substances in EU and USA in grains are accordingly 1250 Bq/kg and 1200 Bq/kg, in vegetables 500 Bq/kg and 1200 Bq/kg, in drinking water 100 Bq/l and 1200 Bq/kg, etc.

For some raw materials and processed food (like rice, beef, soybean) were set transitional measures and longer periods (until December 31, 2012 or "the best before date") for complete enforcement of the novel safety standards. The reason is that producers of such commodities need more time for preparation to prevent any confusion in distribution at the time of shift to new limits for radionuclides in food (Figure 70).

[73] based on intervention exemption level of 5 mSv/y and 50% contamination rate [MHLW, 2011].

[74] annual maximum permissible dose from radioactive cesium in foods reduced from 5mSv to 1mSv - the same level as Codex GLs [MHLW, 2012].

[75] Standard limits are not established for radioactive Iodine, which has been no longer detected (short half-life), and Uranium, which level is almost the same in the nuclear power plant site as in the nature environment [MHLW, 2012].

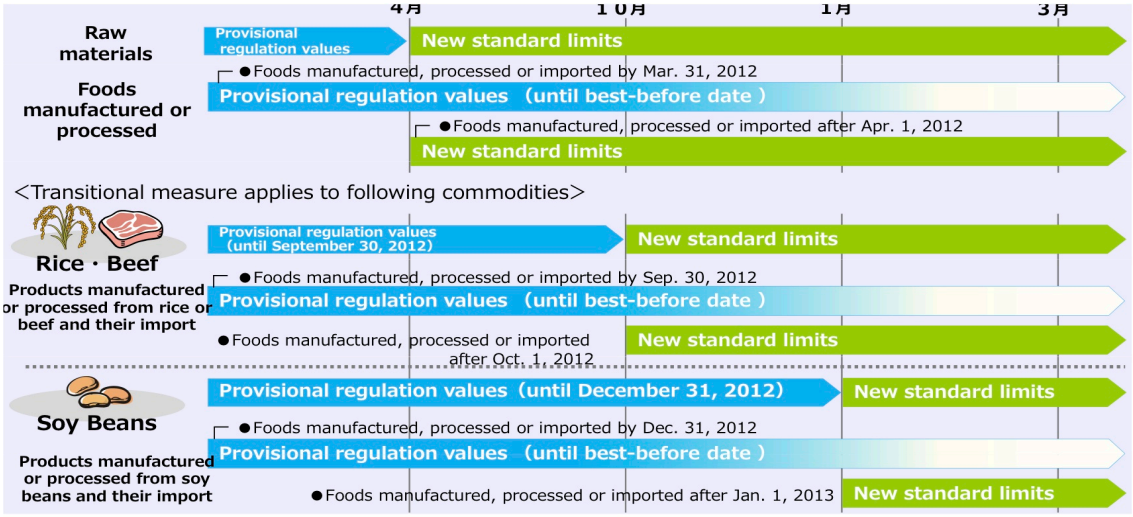
**Table 16. New Standard limits for radionuclides in food in Japan (Bq/kg)**

| Food item | Cs-134 + Cs-137 |
|---|---|
| Drinking water | 10* |
| Milk | 50* |
| General Foods | 100* |
| Infant-food | 50* |

* limit takes into account the contribution of radioactive strontium, plutonium etc.

Source: Ministry of Health, Labor and Welfare

**Figure 70. Transitional measures for enforcement of new standards for radionuclides in food in Japan**




Source: Ministry of Health, Labor and Welfare

In addition, MAFF undertook a number of measures to improve food safety: provided advice on creation of food inspection plans and supporting inspection equipment installations in affected prefectures; commissioned laboratories to analyze agri-food contamination; implemented technical guidance regarding feeding and management of livestock (March 19, 2011); set up provisional tolerable levels for forage for producing milk and beef below the provisional regulation value for food (April 14, 2011); set up provisional tolerable levels for fertilizers and feed for preventing radioactive contamination of farmland soil from expanding and for producing agricultural and animal products below the provisional regulation value for food (August 1, 2011); released a farmland soil radiation level map (August 30, 2011) and updated it covering a wider scope and more details (March 23, 2012); supported emergency radiation inspections for rice in Fukushima prefecture and conducted analysis of factors for radioactive contamination over the regulation level (November 2011); implemented restrictions on rice planting (April 22, 2011; February 28, 2012; March 25, 2013; March 7, 2014); revised provisional tolerable levels for producing animal and fishery products below the standards limits for radionuclides in foods (February 3 and March 23, 2012); published farmland decontamination technical book (August 2012), publish list of registered administrative and private laboratories for radionuclide inspections (April 1, 2013), etc.

At Fukushima Agricultural Technology Center, in Koriyama city, advance laboratories for emergency radiation monitoring of agricultural produces are equipped with 10 germanium semiconductor detectors and 16 of stuff trained to conduct precision analysis. They work 6 days a week from 8 am to 21 pm analyzing 200 items per day. As many as 461 items have been regularly monitored in the prefecture. Samples of vegetables and fruits are shipped for testing on Monday, Wednesday, and Thursday, beef from Thursdays to Saturday, seafood on Tuesday, raw milk on Wednesdays, grains, mushroom, mountain plant, honey and feed crop on Friday, and irregularly for pork, chicken, horse meat and chicken eggs. The results of analysis are released on the next day through website of the center, published in the regional newspapers and other media. For the period March 19, 2011-March 31, 2013 as much as 81,502 items were analyzed.

Furthermore, since June 2011 regular radiation tests have been carried out on great number of agri-food products[76] in 17 prefectures in Northeastern and Eastern Japan. In addition, since 2012 all rice bags[77] produced in Fukushima prefecture have been checked in the Agricultural Cooperative inspection cites to assure safety.

Furthermore, there have emerged many private and collective inspections systems introduced by farmers and rural associations, food processors, retailers, local authorities, consumer organizations, independent agents etc.

For instance, in Nihonmatsu-shi, Towa town, there was a sharp decline in well-developed before the nuclear accident tourism and agricultural sells. The local Rural Development Association introduced radiation measurement of farm products in June 2011. It has been done in own laboratory by equipment supplied by a private company and costs 500 yen per test for farmers. Due to timely introduction of safety inspection and proper product safety reporting (labeling) the number of costumers visiting that farmer market recovered almost fully as well as 80% of the sells on not restricted items (interview with the Chairman of the Association Mr.Muto, July 6, 2013). Municipality has also introduced 60 points for inspection of food for self-consumption, which is done free for producers.

Similarly, the group Rebuilding a Beautiful Country from Radiation launched an inspection service soon after the nuclear accident through a non-governmental fund and currently supports more than 90,000 farming households who pay a nominal fee to have their produce inspected for contamination and declared safe for consumers [Kakuschi, 2013].

Agricultural Cooperatives in Fukushima prefecture also conduct their own testing using analytical equipment (such as NaI scintillation spectrometer) either purchased or borrowed from a government agency [Watanabe 2013]. Before shipping produce, member farmers bring crop samples to testing sites where measurement is done (about 30 minutes per crop) for free. What is more, many agricultural cooperatives in the prefecture have in place systematic testing regimes covering every farm and item, and all members are required to have their produce tested by the cooperative before shipping.

[76] In late March 2014 the number of items was reduced from 98 to 65 because of low detection rate [Fukushima Minpo News, May 21, 2014].
[77] one baggage is 30 kg.

The Fukushima Consumer Cooperatives Union has also 30 machines around prefecture for food inspection and training of members. In addition, it introduced 35 machines for radiation body check providing free mobile service including in neighboring prefectures.

Many farmers groups and organizations from heavily-contaminated areas have been organizing own tests on soils (detailed maps) and other inputs (water, livestock feeds) as well as screen output to secure safety. For instance, a large scale tests to collect data[78] and find a solution on fighting rice contamination has been carried by a group in Nihonmatsu no comparable with all experiments done by national or local governments [NHK World, March 10, 2014]. Another producer group from Nihonmatsu developed a way to put all information about their products (contamination, beta-carotene and sugar content sugar) as well as details about who grew what, into a QR code, a kind of bar code that people can scan with their cellphones [The Japan News, March 7, 2012].

According to the Fukushima Food Industry Organization many of the member companies bought own equipment for radiation checks of ingredients, water and final produces, or use outside safety checks to avoid risks, and/or deal with harmful humors, and secure customers. Likely wise, practically all heads of cattle are tested at meat processing plants in Tohoku and Kanto regions, and throughout Japan [Wayanabe, 2013].

Furthermore, big retailers (like Aeon, etc.) have also strengthened testing with a goal of selling cesium-free food only. Similarly, a mail-order company based in Tokyo (Cataloghouse Ltd.) allocated space for fresh food from Fukushima in its store in Tokyo in August 2011. It sells only products that clear safety standards and gives an explanation on labels. The store bought a testing machine (for 3.5 million yen) and checks the level of cesium in food in front of customers [Kakuchi, 2013]. A numerous big processors and retailers have been also promoting products from the affected regions nationwide [The Japan Times, March 10, 2014].

Recovery, Sunday, evening, promotion etc. markets, Farmers' Document and Farmers' Café events etc. organized by farmers, authorities, NGOs, food chain partners etc. have been regularly held in Fukushima and around the country, where farmers sell directly their products confirmed as safe through voluntary screening [Koyama, 2013].

On the top of that, various voluntary restrictions on sale have been introduced by farmers, farmers' organizations, food industry, and local communities.

According to some farmers the biggest hurdle they face is the lack of a clear radiation risk standard that can be accepted by all [Kakuchi, 2013]. In order to address consumer concerns on food safety some producers, processors and retailers started to use lower than the official norms for radiation. According to one of the interviewed by us experts – Mr.Nagashima, working at Agricultural Cooperative in Fukushima "Farmers in Fukushima are trying to satisfy the government's strict standard for the radioactive contamination and even to have results below 25Bq/kg ("Not Detected"), which is the limit for inspection by screening method" (June 6, 2013).

Simultaneously, there has been a progress in efficiency of radiation testing devices for farm and food products. For instance, from April, Fukushima prefecture introduces easy to

[78] e.g. they proved that crops at organic farms were free of contamination becouse well-mainatined fertile soil helps immobilize cesium.

use and more accurate radiation detectors at community centers and other public facilities so that residents will no longer have to cut up items into small pieces to check cesium levels and get result faster[79] [Fukushima Minpo News, March 3, 2014].

All theses measures and actions taken at production, distribution and consumption stages have let the Fukushima agri-food products to become one of "most secure in the world" [Fukushima Minpo News, January 27, 2014].

Nevertheless, many concern consumers continue to disbelieve in the existing inspection system and employ other ways to procure safe food (direct sales contracts, origins, imports, etc.) [Kakuchi, 2013; Ujiie, 2012].

There have been a number of challenges with the present system of safety inspection. Due to the lack of personnel, expertise, and high-precision equipment, the water, food and soil tests have not always been accurate, consistent and comprehensive. For instance, quite expensive high-precision instruments are not available everywhere to measure lower radiation levels set up by the new regulation – e.g. for drinking water capable of detecting a single-digit level of becquerels.

Food safety inspections are basically carried out at distribution stage (output for shipment or export)[80], and do not (completely) cover produces for farmers markets, direct sells, food exchanges and self-consumption. Nevertheless, Fukushima prefecture and municipalities have been strengthening their inspections for self-consumed agricultural products since 2013.

Furthermore, capability for radiation safety control in Fukushima prefecture is significantly higher than in other affected regions, while radiation contamination has "no administrative borders". In fact most food is regularly inspected in Fukushima prefecture and it is much safer than in other prefectures where such strict tests have not been not carried out at all.

What is more, many of the privately and collective employed testing equipment are not with high precision, and/or samples are properly prepared for analysis (e.g. by inexperienced farmers). Consequently, some of the sold and consumed products are labeled as "Not detected" despite existing contamination. Some tested agricultural products are further cooked or dried reaching higher levels of radiation at consumption stage. Uptake of radioactive materials with food by local residents increases especially during summer season when most of the fresh vegetables and fruits are consumed.

Moreover, there are untested wild plants and/or produced food, which are widely consumed by local populations. For instance, radioactive contamination in forestry trees leaves has been found far away in Nagano prefecture[81].

Furthermore, there are considerable discrepancies in measurements of radiation levels in air and food done in a specific location. For instance, in Nihontatsu-shi laboratories of the NGO and the Government are located across the street (50 m of each other) but they often register different radiation in environment and food.

[79] Currently, residents can test home-grown vegetables and edible wild plants at community centers but detectors require cutting 500 grams of food into small chunks, and about 30 minutes to get results.

[80] Cropping itself has not been restricted and inspection carried at ex-post production- shipping stage.

[81] Some people dispute that the radiation was there even before the accident, when inspections were not carried due to natural or manmade (e.g. nuclear tests in neighboring countries) radiation.

Agri-food inspections, regulations and countermeasures are conducted in vertically segmented administration with "own" policies and not well-coordinated procedures. For instance, soil contamination surveys and inspection of agricultural produce is conducted by MAFF, monitoring of air radiation levels by MEXT, regulations on food safety standards and value determination by MHLW, decontamination and waste disposal by the Ministry of the Environment, training associated with food safety by Consumer Affairs Agency, and promotion of restoration plans and decontamination programs under the Reconstruction

Similarly, there are no common procedures and standards, nor effective coordination between monitoring carried out at different levels and by different organizations (national, prefectural, municipal, farmers, business, research etc.). Neither there is common framework for centralizing and sharing all related information and database, and making it immediately available to interested parties and public at large.

Officially applied area based system for shipment restrictions have been harming many farmers producing safe commodities. For instance, recent screenings of shiitake mushrooms grown on logs in two municipal areas of Fukushima prefecture have found that samples taken at cultivation facilities of four farmers do not contain radioactive substances above the national upper limit[82]. Consequently basis instead of a municipal area wide blanket lifting and permit mushroom shipments by selected farmers [Fukushima Minpo News, June 11, 2014].

Last but not least important, there have been on-going discussions among experts about "safety limits" and that lack of agreement additionally confuses producers and consumers alike.

One of the interviewed by us experts – Mr.Satou, working at prefectural government agricultural department said "I regret to have easily believed the "myth of safeness of nuclear power plant" and not having prepared enough for the disaster - not having made safety standards of restriction for radioactive contamination, enough machines to inspect radiation in agricultural organization, and research about technologies for preventing radioactive contamination. Floods of information confused both producers and consumers after the accident. People did not trust government's information which was caused from the government's attitude after the accident, such as not announcing the data SPEEDILY" (June 6, 2013).

Nevertheless, there has been attempt to improve coordination and cooperation between different agencies. For instance, analysis on contamination of agri-food products is one of the major working areas of the Fukushima Future Center for Regional Revitalization. When unsafe food items are found the FATC is informed and the later take decision for ceasing shipments. Similarly, Soil screening project in Fukushima is coordinated by FCCU with participation of number of regional agencies and volunteers from the entire country.

Experts suggest existing system to be further improved by creating uniform inspection manuals and standards, enhancing coordination and avoiding duplication between different organizations, establishing inspection framework that cross prefectural borders, and a new management system that extend random sampling tests of circulating produce (shipment

[82] Out of 65 shiitake samples harvested from greenhouses, 52.3% were measured below lowest detectable limit and the rest were far below the upper limit, showing a maximum reading of 6.6 Bq/kg [Fukushima Minpo News, June 11, 2014].

level) with management/control at production "planning" stage [Science Council of Japan, 2011; Koyama, 2013].

The later is to be based on detailed contamination maps of each agricultural field based on soil analysis, farmland certification system (similar to the local certification system based on "Guideline to indicate specially cultivated agricultural products") targeting to establish production practices (crop selection, land decontamination, inputs control) preventing contamination of agri-food products. Consequently, depending on the degree of radiation dose effective decision could be made whether to restrict cropping (high level), decontaminate (medium level), or encourage certain type of crops combined with further reduction measures (low level).

Another challenge associated with current inspection system is the costs. Fukushima prefecture costs for food testing, including sample purchases, amount to about 150 million yen each year [Fukushima Minpo News, May 11, 2014]. Local government uses money withdrawn from its fund for residents' health management for food monitoring. When it began conducting tests (June 2011), the money in the fund that could be used for the screening process totaled about 2 billion yen while now (May 2014) they are about 600 million yen. Money is also used for projects and it is expected to be depleted in several years unless central government extends support. The prefectural government plans to maintain the number of tested items but it is unclear how much support it will get from the health ministry, which is moving toward decreasing the number of items subject to screening.

The Fukushima prefectural government is poised to continue the current practice of checking all packs of rice harvested in the prefecture for radioactive contamination after fiscal 2014 ending next March [Fukushima Minpo News, July 5, 2014]. In addition, the prefectural government recently announced that it will screen for radioactive contamination all logs used for "shiitake" mushroom cultivation[83] as blanket log test will start with the Aizu region[84] [Fukushima Minpo News, September 26, 2014].

According to the Governor (Yuhei Sato) "we have yet to gain full understanding of the blanket checking program". The program costs about 700 million yen a year and the prefecture obtained the central government's agreement to continue until fiscal 2017 a national subsidy program for decontamination work associated with the nuclear accident. Nevertheless, the fund for financing the radioactivity-checking program is running short and that it has no idea how long to continue the program in its present form. It will review the program by taking into account the realities facing rice farmers and ongoing measures to dispel harmful rumors and other factors.

Producers have also expressed dissatisfaction over the MHLW's guidelines to reduce testing underlying that government perception is very different from that in the field [Fukushima Minpo News, May 11, 2014]. According to official from the crisis management center of Fukushima Japan Agricultural Cooperatives "Effects of unfounded rumors are still strongly rooted. It is inconceivable to say we have a choice of not conducting the testing just

[83] .It will be the third time for the local government to check all products and materials prior to shipment following rice and persimmons.

[84] It is plan to put the equipment into full operation in time for 2015 year's harvesting season in fall. New testing method will gradually expand in the rest of the prefecture to restore the prefecture as the largest producer of mushroom growing logs.

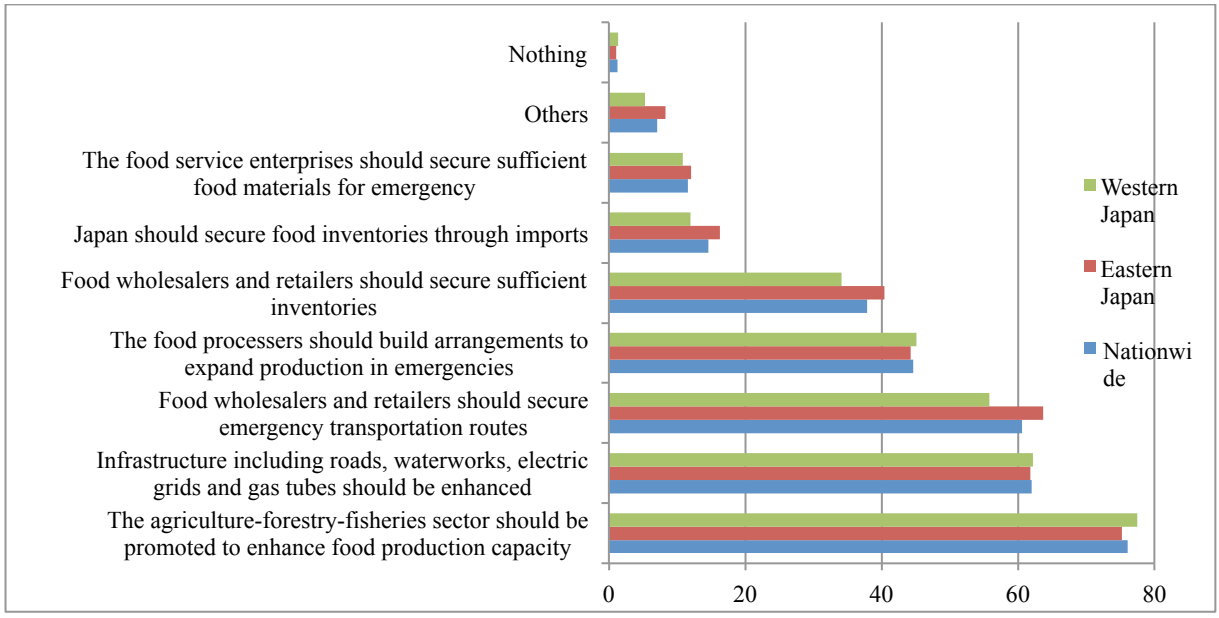
because radioactive substances have not been detected. We need to carry out the testing at least until the stage in which trouble at the nuclear plant, including the contaminated water issue, does not occur at all".

What is more, some farmers started to be nervous about the efficiency of the applied methods. In some places they discuss to cease inspections, which are associated with significant costs (time for preparation of samples, shipment, payments for tests) with no adequate compensation received or recovery of farming progressing.

An interviewed by us expert – Mr.Sunaga, retired officer from the prefectural government put it that way: "Cultivation management and inspections to secure safety is needed despite they are imposing heavy burden in short terms. However, there are worries how long we should continue these works. Farmer's willingness to continue is also declining because it is unclear when they can recover consumers trust (June 4, 2013).

Last but not least important, the public food safety policies have been also positively affected. For instance, the Great East Japan Earthquake and following nuclear disaster considerably impacted citizens' consciousness on food security in Japan. This disaster has prompted more 34.3% of the consumers to "become conscious of need of food storage" on the top of another 34.5% who "remained conscious with that need" [MAFF, 2012]. A great part of the surveyed consumers have also strongly recognized the importance of different food supply arrangements (Figure 71).

**Figure 71. Measures considered to be required for stable food supply in Japan (percent)**




Source: MAFF, 2012

There have been a number of challenges in public support response as well. Most important among them are: delay in establishing Reconstruction Agency (February 2012) for coordinating multiple recovery efforts in affected areas; lack of clear government guidelines for the nuclear disaster recovery, lack of detailed contamination map for all affected agricultural lands, using extension officers for obtaining samples for monitoring tests while

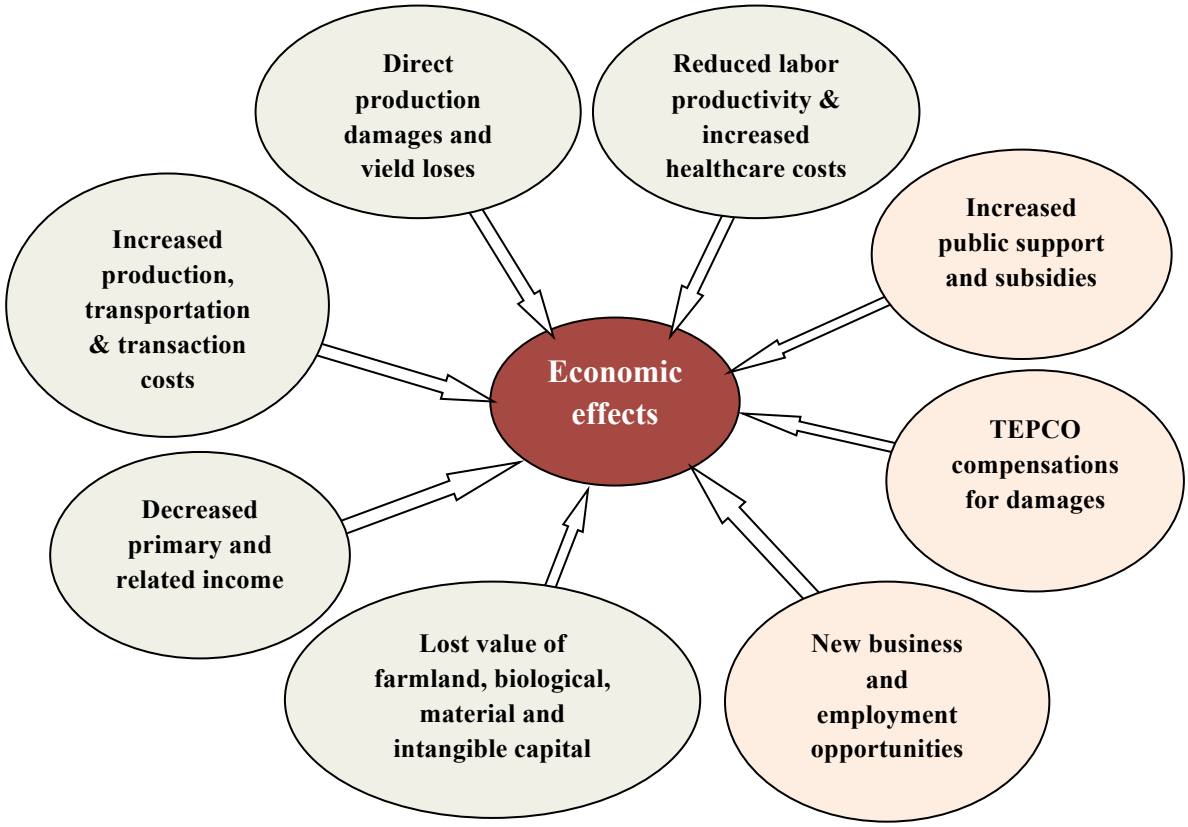
suppressing their ability of management consulting, introducing technology, and forming areas of production badly needed by farmers in affected areas, etc. [Koyama, 2013].

## VIII. Farms and agri-businesses damages from the Fukushima nuclear accident

It is quite difficult to access the enormous economic damages from the Fukushima nuclear disaster on Japanese farms and agri-businesses. The scale and directions of the negative effects have been huge. What is more, some of the economic impacts could hardly be measured in quantitative (e.g. monetary) terms such as: the lost livelihood and accumulated with many generations capital (community relations, permanent crops, livestock herds, established brands, networks etc.), degradated natural resources (farmlands, waters, crop and livestock varieties, biodiversity, landscape), labor health implications (reduced productivity, increased healthcare costs etc.) etc. [Bachev and Ito, 2013].

Principally the immediate and shorter-term negative effects on farms and agri-business have been in a number of directions (Figure 72):

**Figure 72. Economic effects from Fukushima nuclear disaster on farms and agri-business**




1. Direct production damages on crops and livestock products due to the radiation contamination. A large amount of yields of crops (mostly vegetables) was lost since it was not safe to consume or process. Furthermore, as a result of the government sale bans farmers from a large territory had to dump millions of liters of milk, and tons of ripe vegetables and fruits. For instance, Kenzo Sasaki milking 18 cows on a farm outside Fukushima city was reported losing nearly $31,000 every month from the sales ban not including the cost of feeding the

herd (Wines, 2011). Similarly Shoichi Abe, grazing 30 cows was unable to sell his 1,100 pounds of daily production (costing 70,000 yen a day or about $860) after March 11 because earthquake damaged the local co-op milk-processing plant and the indefinite government prohibition.

2. Decreased production and income due to production and/or shipment restrictions and low market demands for local products and services. In early April 2011, government restricted planting of rice and other crops in soil with more than 5,000 Bq/kg of cesium. Similarly, there was a ban or delays of shipment of beef and other major agri-food produces. What is more, as a result of voluntary restrictions, declined consumer demands, reduction in the number of local population (evacuation and/or outmigration) and tourists, and "harmful rumors" many farmers and business lost significant markets and income after the accident.

For instance, a considerable ha of rice paddies in Fukushima Prefecture have been subject to a planting ban and other restrictions (Table 17). In 2012 there were planting ban on 7,600 ha located in the exclusion zone, and around 400 ha elsewhere in the prefecture, being paddies where more than 500 Bq/kg of radionuclides were detected in the 2011 rice crop [Watanabe, 2013]. In addition, several municipalities independently decided to call for voluntary restraints on planting of paddy rice over a total area of 5,600 ha. The combined total area of rice paddies subject to restrictions was almost 13% of the area of paddy fields[85] in the prefecture in 2010.

Furthermore, numerous shipping restrictions have been imposed on agricultural products in the prefecture. Despite the area subject to restrictions has gradually diminished most of the affected products are local specialties and important cash source. Therefore, the impact on the income of farm households has not been negligible [Wanatabe, 2013]. What is more, there has been important items subject of voluntary restraints on processing such as ampo-gaki and dried persimmons. Unusual technique for producing ampo-gaki originated in the northern part of the prefecture, and before the accident this was a popular local brand specialty generating impressive revenues. However, since 2011 voluntary restraints on processing have been imposed in seven municipalities in the north part of prefecture.

Similarly, roughage such as grass and rice straw cannot be produced, used (fed to livestock), or distributed by livestock farms, unless they are proven to be within safety standard during monitoring inspections[86]. The use and distribution of compost are also prohibited unless monitoring inspections on each farm find radioactivity to be under the standard limit[87]. Nevertheless, collaborative efforts between crop and livestock farmers to recycle resources locally (e.g. livestock farmer using compost on own land or supplying it to crop farmers, or growing feed as alternative crop and sell out fodder) have lost momentum even when radioactivity has been within safety norms [Watanabe, 2013]. Consequently, livestock farmers' ability to supply own roughage or source it locally has been reduced, and

[85] production targets equivalent to approximately 45,500 tons in volume or 8,300 ha in area (547 kg, the average yield per 10 a in 2012) were reassigned to agricultural cooperatives etc. elsewhere in the prefecture [Watanabe, 2013].

[86] provisional maximum level for fodder fed to cattle and horses is 100 Bq/kg.

[87] provisional maximum level for radioactive cesium is 400Bq/kg.

serious difficulties with disposing livestock manure and compost application and circulation created.

Likely wise, leaf tobacco is grown throughout the prefecture (especially the Nakadori area) but voluntary restraints were imposed on tobacco planting in 2011. Meanwhile, farmlands under contract to sell leaf tobacco plummeted from two thirds (from 992 ha in 2010 to 320 ha in 2012), partly because of the imposition of more stringent safety standards by Japan Tobacco Inc. [Watanabe, 2013].

Before the disaster Fukushima prefecture was known as "Tokyo's vegetable basket" and it was Japan's second largest producer of peaches, third largest producer of Japanese pears, fourth largest producers of rice, fifth largest producer of apples, twelfth largest producer of grapes, etc. Orders of all these major produces plunged after the nuclear plant crisis due to fears about radiation even though radiation levels have been well below the safety limits.

According to a survey 88.5% of the farmers in Iwate, Miyagi and Fukushima prefectures suffered from the consequences of the 2011 disasters, and most of them (71.4%)[88] were still suffering in 2012 [JFC, 2012]. The downslide of selling price and the harmful humor were the main cause of the negative impact on farms in these regions.

After the nuclear accident, the Gross Agricultural Product in Fukushima prefecture shrunk by 47.9 billion JPY [MAFF]. Furthermore, there has been agriculture-related damages amounted to 62.5 billion JPY (by May 2012). The annual loss from the nuclear accident in the prefecture is estimated to be around 100 billion JPY [Koyama, 2013]. However, that is only a calculation of damages based on flow of agricultural output (production and sells). In addition, there has been significant damage to farmland, and rural organizations and personal relationships ("social capital") important for the Japanese agriculture.

The great majority of surveyed by the Fukushima Food Industry Organization companies also report lower income due to the decline in sales after the accident [FFIO, February, 2013]. Likely wise, popular agri and rural tourism and other related businesses and services in affected areas have been badly damaged after the disaster.

The same has been true for Ibaraki prefecture famous with the highest production of melon, lotus roots, and blades like potherb mustard, chingen-sai (pakchoi) and mitsuba (honewort), the second highest production of rice in the country, well developed agri-processing, etc.

On August 5, 2011, the government released interim guidelines for determining nuclear losses [MAFF, 2011]. On September 12, it established the Nuclear Damage Liability Facilitation Fund to support nuclear damages payments. In addition, Dispute Reconciliation Center for Nuclear Damage was established in order to encourage conflicts resolution. By March 2012, agricultural damages payments regarding the nuclear disaster totaled about 106.2 billion yen [MAFF, 2012].

Some of the direct damages to farms production and marketing have been specified with the compensation claims of farmers to TEPCO. In order to assist producers through the procedures for claiming damages from TEPCO councils were set up around the JA Group in 18 prefectures in eastern Japan. Until the end of September 2011 the compensation for

[88] 17.1% "had suffer but no anymore", while 11.6% "not suffer".

damage to agricultural and livestock produce from the nuclear disaster demanded by 14 prefectures reached 70.9 billion USD (Table 17). The biggest claims for damage were for months after June, as Fukushima and Ibaraki prefectures accounted for the three quarters of all group agricultural claims to TEPCO.

**Table 17. Claims for damage to agriculture and livestock produce from nuclear accident as end of September 2011 (million yen)**

| Prefectures | April | May | June | July | August | September | Total |
|---|---|---|---|---|---|---|---|
| Iwate | | | | | | 29 | 29 |
| Miyagi | | | | | 222 | 367 | 590 |
| Akita | | | | | | 102 | 102 |
| Yamagata | | | | | 63 | 202 | 265 |
| Fukushima | | 478 | 2559 | 6527 | 8070 | 9905 | 27539 |
| Ibaraki | 1846 | 6619 | 7609 | 5702 | 2870 | 1633 | 26279 |
| Tochigi | 1108 | 1344 | 1298 | 1239 | 313 | 295 | 5595 |
| Gunma | | 1607 | 2301 | 383 | 74 | 185 | 4550 |
| Saitama | | | | | 857 | 2 | 859 |
| Chiba | | 298 | 1554 | 1495 | 704 | 204 | 4254 |
| Kanagawa | | | 142 | 176 | 53 | | 371 |
| Nigata | | | | | 16 | 48 | 64 |
| Shizuoka | | | | | 94 | 11 | 105 |
| Shimane | | | | | | 36 | 36 |
| Total | 2952 | 10346 | 15464 | 15522 | 13338 | 13018 | 70640 |

Source: JA-ZENCHU, 2011

The provisional payments actually dispersed during the same period by TEPCO were 20.2 bunion yen or less than 30% of the total claims [JA-ZENCHU, 2011].

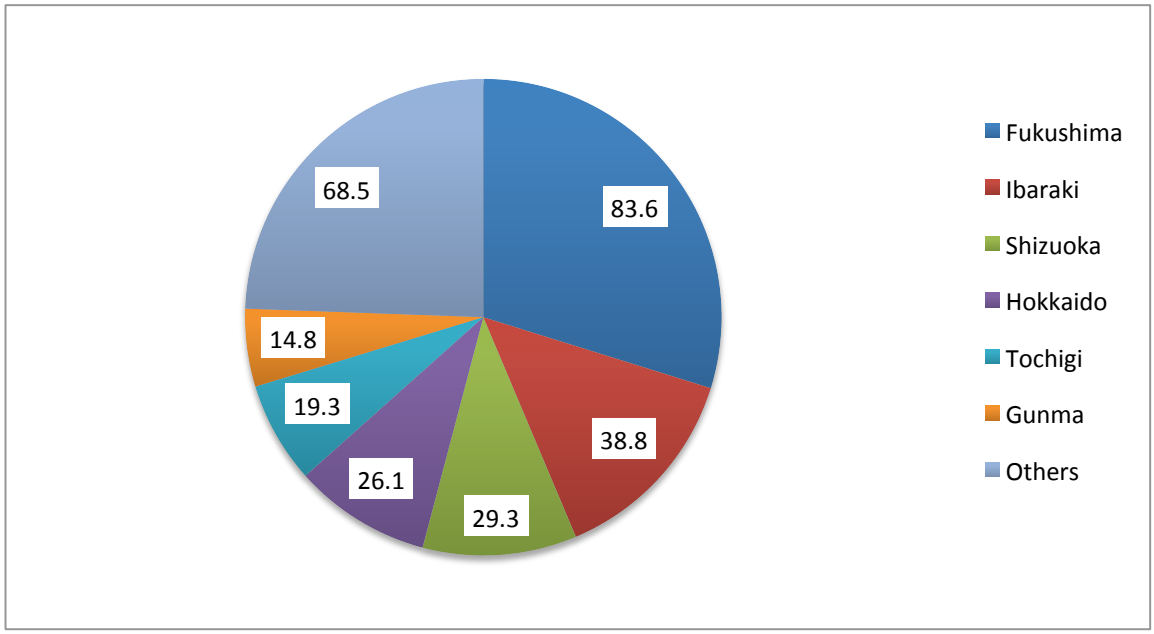
According to JA almost 100,000 farmers lost about 58 billion yen ($694 million) by March 1, 2012 or 25% of production [Takada and Song, 2012].

Published information for TEPCO payments to Groups Representing Victims for 2011 -2012 shows that Agricultural Cooperatives received 280,400 million yen ]Nomura and Hokugo, 2013]. The greatest share of the groups agricultural payments went to Fukushima (29.8%), Ibaraki (13.8%) and Shizuoka (10.4%) prefectures (Figure 73).

Food industries companies have also lost hundreds of millions from canceled orders, reduced demands and prices, and increased costs. Some of their losses have been recovered by TEPCO.

Furthermore, agriculture and agri-business have been major employers for family and non-family labor in many of the affected regions. After the accident a great number of workers lost temporary or permanently employment (and income) opportunities in these important sectors. The later effect of the nuclear disaster on the local agri-food economy is very difficult to quantify.

**Figure 73. TEPCO compensation payments to Agricultural Cooperatives (billion yen)**




Source: Nomura and Hokugo, 2013

4. Increased production, transportation and transaction costs in the agri-food chain. Many farmers and business have seen their costs associated with post-disaster recovery, destructed and safe inputs supply, marketing (delayed, restricted and cancel shipments, safety control, certificates, and guarantees), shifting to new suppliers from other regions or countries, decontamination of crops, farmlands, material and biological assets etc. increased.

A number of appropriate technologies have been tested and recommended for farmers to decontaminate the farmland and crops such as: removal of the thin layer of topsoil, inversion tillage, high pressure washing fruit trees without rough bark, removal of rough bark for fruit trees with rough bark, tea trimming, application of potassium to inhibit plants from absorbing radioactive matters and zeolite as adsorbent to radioactive matters, changing crop pattern, etc. [MAFF]. In addition farmers and agricultural organization have been trying own methods to deal with production and marketing problems associated with the nuclear accident [Nagashima, 2013].

Some experts[89] argue that organic farming is the way to revitalize Fukushima agriculture, but it is similarly associated with increased costs[90].

All these measures and methods have been accompanied with additional production and learning costs to farmers and their organizations.

Furthermore, there have been additional costs to protect labor and clean equipment used in contaminated environment, to adapt new structure of products and technologies with

[89] On June 6, 2013 we attended a crowded public lecture at Fukushima University of such expert Prof.Hasagawa who himself set up organic farm and advocating it as a way for reconstruction of Fukushima agriculture. A documentary about organic farmers facing Japan's nuclear crisis can be seen at http://uncannyterrain.com/blog/

[90] Most organic products in Japan have been (self)certified by the farmers organization while independent organic certification is still insignificant part (0.02%) of the overall production.

reduced radiation absorption, partial and complete dislocate business, etc. Likely wise, there has been costs to destroy contaminated (by radiation), or unsold (due to the shipmen restrictions or lost markets) agricultural output.

Many livestock farmers had to buy forage from other locations to feed animals because their own grass was contaminated, and that occurred significant extra costs. In May 2011 about 20,000 livestock farmers in seven prefectures were asked by MAFF to refrain from grazing cattle for the time being because radioactive substances in excess were found in pastures. That affected 700,000 head of cattle and cost an additional 50 billion yen a year in forage [Yomiuri Shimbun, May 2011].

Similarly, disrupted supply for agricultural and food produces within and from the affected regions have to be met with additional costs for food-chain businesses, public authorities, and consumers alike. For instance, most surveyed by the FFIO companies report lower income due to higher costs of alternative supply of ingredients from other prefectures[91] [FFIO, February, 2013]. Nevertheless, the overall amount of the costs for the initial emergency supply and continuing alternative food supply is hardly to be estimated.

Moreover, there have been considerable transaction costs for adaptation to new more strict official safety standards, and voluntary restrictions imposed by the professional organizations and authorities, for multiple safety tests and certifications of inputs and output, for "additional" relations with public authorities, TEPCO, farmers organizations and other (e.g. research) institutions, for inputs supply, product promotion and marketing, for providing guarantees, for communications with counterparts and consumers, for alternative supply trough import from other regions and/or countries etc.

For instance, radiation levels in all baggage of rice and beef have been checked by the JA Fukushima since autumn 2012 and September 2011 accordingly, and huge testing programs have been going on farmlands, numerous agri-food products, etc. Public authorities have covered some of these costs, others have been claimed by TEPCO, some have been invested by agricultural organizations, processing and retailing businesses, and the rest have been carried by farmers or consumers.

Similarly, there have been significant individual and collective costs associated with the negotiation, application, disputing etc. of claims for damages from TEPCO etc. Most of the surveyed by the FFIO companies also report "additional costs and efforts" to deal with food safety risks and harmful humors such as: performing radiation checks on new acquired equipment, outside tests by other organizations, consumers and clients information, "hard working", products safety promotions through meetings, website, labeling, etc. [FFIO, February, 2013]. What is more, some of the surveyed companies indicate they stopped using "Fukushima made" label in order to facilitate transactions.

Last but not least important, there have been huge increase in "public relation" costs of prefectural and local governments aimed at improving the damaged image of Fukushima products.[92] However, the precise scale and impact of all these private, collective and social transaction difficulties and costs are impossible to quantify.

[91] One company even moved its factory to another prefecture.

[92] For instance, the "public relation" item accounts a sizable portion of the overall budget of Fukushima prefectural government and it has been increasing.

5. As a result of the contamination, dislocation, institutional restrictions, and/or reduced markets for regional products, many farmers and agri-businesses have lost a significant portion of the value of their farmlands, livestock, orchards, material assets, and intangibles such as established relations, reputation, brands, labels, product origins etc. The total amount of these long-term damages is quite hardly to clarify. For instance, highly popular Fukushima brand products such as Iidate beef and Anpo gaki (persimmon) has been immensely destructed.

6. There has been unspecified effect on the reduction of labor productivity, increased healthcare and recreation costs etc. due to the nuclear accident. The extent of these kind of economic damages has not been fully studied yet.

Diverse negative economic implications have been quite unlike for the different agents and various regions. The greatest negative impacts on costs and sales have been experienced by farms and businesses in Fukushima and neighboring regions. For instance, more than 41% of the farmers and 52% of the food industries in Fukushima prefecture report "extra costs emerged for radiation tests and various certificates as requested by trading partners" while these figures are much higher than in other regions of the country [MAFF, 2013].

Similarly, 3% of surveyed Japanese farmers indicate that "Income declined due to the abandonment of farm products and the relinquishment of manufacturing and production due to foreign countries' import controls and trading partners' refusal to import Japanese products" as a result of TEPCO accident. The later share for farmers in Fukushima prefecture is almost three times higher.

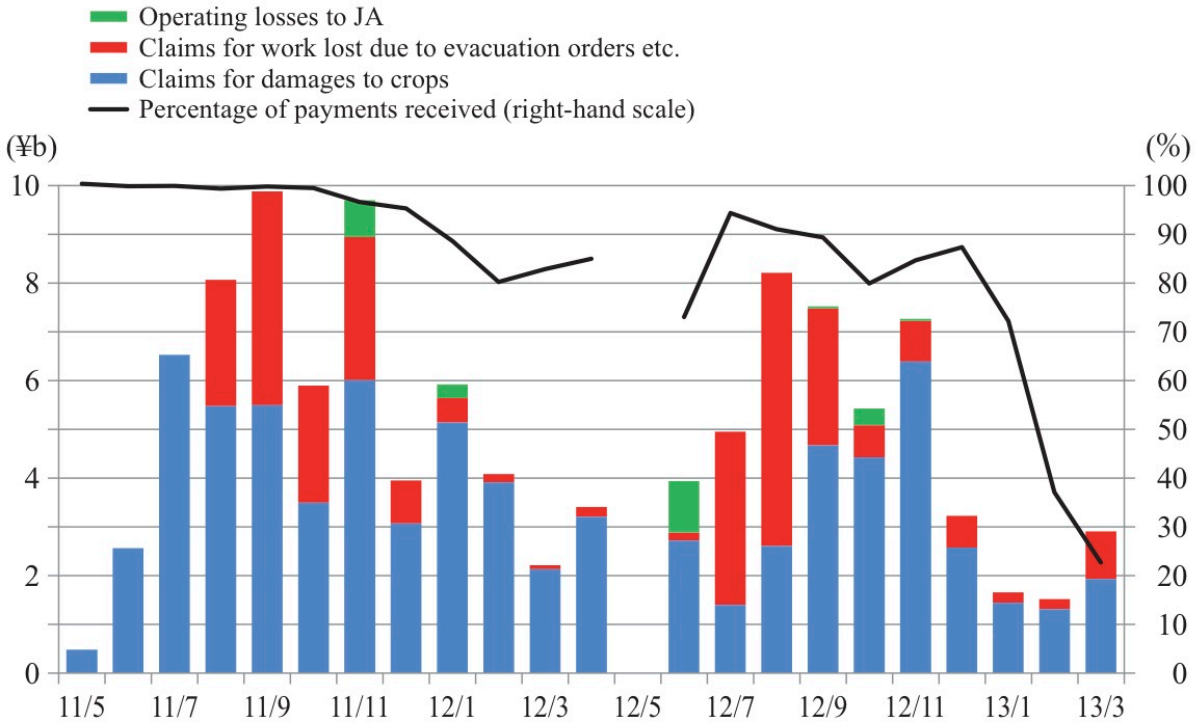
On the other hand, some farmers and agri-businesses from non-contaminated regions have got positive effects on their businesses due to increased prices, and better production and sales opportunities on the wake of Fukushima disaster.

"JA Group Tokyo Electric Co., Ltd. Nuclear Accident Agriculture and Livestock Damage Compensation Countermeasures Convention of Fukushima Prefecture" was established in May 2012 to deal with the compensation problems. It comprises all JA within Fukushima prefecture and 35 other organizations including All-island Prefectural Headquarters, Prefectural Dairy Association, Livestock Recovery Association, Prefectural farm managers organization Liaison Assembly, and Prefectural Mushroom Promotion Assembly. General meeting have been held monthly to decide on the amount of demands for compensation and bring it to TEPCO.

As of mid April 2013 demanded compensation though the Fukushima Taskforce was 109,3 billion yen, while the received compensation were 97,2 billion yen or 89% of the demand (Figure 74). Most of the claims have been for lost work due to evacuation orders and for crops damages.

Until May 2012 the amount of compensation demands reached 62.5 billion yen with a greatest portion of claims being for the untilled land (compensation for suspension of work) horticulture and livestock damages (Table 18). The amount of money received as compensation for the same period accounted for 73% of the claimed damages.

**Figure 74. Claims for damages against TEPCO by the Fukushima Prefecture JA Group**




Source: Fukushima Prefectural Union of Agricultural Cooperatives

**Table 18. Breakdown of Fukushima Prefecture Union Compensation Claims (100 million yen)**

| Claims | On May 1, 2012 | | On May 1, 2013 | |
|---|---|---|---|---|
| | Value | Share in total (%) | Value | Share in total (%) |
| Rice | 11 | 1.8 | 32 | 2.9 |
| Horticulture | 130 | 20.8 | 264 | 24.2 |
| Fruit | 62 | 9.9 | 75 | 6.8 |
| Milk | 18 | 2.9 | 20 | 1.8 |
| Livestock disposal | 99 | 15.8 | 100 | 9.2 |
| Other livestock damages | 85 | 13.6 | 162 | 14.8 |
| Pasture | 27 | 4.3 | 50 | 4.6 |
| Untitled land (for work suspension) | 163 | 26.1 | 325 | 29.8 |
| Business damages | 30 | 4.8 | 64 | 5.8 |
| Total | 625 | 100 | 1,092 | 100 |

Source : Central JA Union for Fukushima Prefecture

Progress in compensation payments has been slow and uneven due to the delays in TEPCO's review process and demands for further documentation, lack of sufficient funds for satisfying all claims, multiple disputes, etc.

According to the experts compensation payments to farmers in neighboring prefectures has been at lower rate - e.g. 50% in Miyagi prefecture.

TEPCO is supposed to advance half the amount of each claim the next month after it was filed, but it takes considerable time (almost a year) to pay the full amount [Watanabe,

2013]. Meanwhile, farmers have been facing cash-flow difficulties as they struggle to pay production and household expenses. In January 2013 TEPCO established a new organization within the company (Fukushima Revitalization Headquarters, headed by a vice president) in order to improve compensation procedures and payments. Nevertheless, there has been no amelioration in the payments of compensation due to the lack of funding and multiple disputes.

In order to alleviate cash-flow difficulties certain agricultural cooperatives in Fukushima Prefecture started offering interest-free loans by subsidizing the interest and some established own substitute payment programs [Watanabe, 2013].

TEPCO continues to receive claims for damages of farmers and agri-food business from around the country. However, up to date total amount of claims received by and paid to different affected agents is not easy to find.

There have been many problems related to the compensation of damages from TEPCO. For farmers and agriculture cooperatives in Fukushima prefecture the major issues can be summarized as: three month to almost a yea delays in payments; not paying the full amount that was claimed; disputing nuclear accident origin of damages; denying claims when people restrain production and distribution voluntarily; claims related to farmland and farming property damage; compensation for discontinuation of business; the closing date issue is not decided yet (how long the compensation will last); insufficient amount of compensation to restart farming; additional (inspection, administrative, radiation map preparation etc.) costs and damages of organizations such as JA are not compensated yet; support for damages not clearly specified in the Dispute Reconciliation Committee for Nuclear Damage Compensation guidelines [Koyama, 2013; Nagashima, 2013].

Difficulties experiencing by some older age farmers associated with the paper works in compensation procedures is also pointed out as a problem (Ishii, 2013). According to experts the efforts of farmers who did not market their products through cooperatives are particularly big (interview with Prof.Komatsu, June 17, 2013). We have also found that some of the "safety tests" costs currently incurring by farmers (e.g. for voluntary and self inspections) and consumer associations (e.g. Consumer cooperatives) and due to be compensated in unclear future, are also a problem.

The important issue how certain claims will be compensated is still disputed by parties and unspecified. For instance, JA Union, Fukushima prefecture, and Central Federation of Societies of Commerce and Industry have established a zero interest fund (Farmers Management Stability Funds) to support farmers with immediate needs. There are also funds for compensating beef distribution restrictions to help projects support emergency management of national companies raising cattle for consumption, support measures for emergency rice straw provisions, and measures to allow undisturbed distribution of cattle and programs sponsoring free rice straw in Fukushima prefecture.

In areas where restrictions are placed on planting, a standard compensation "per 10 are" is guaranteed. However, there are problems with uniform compensation, including differences in the amount of products per 10 are, discrepancies in farming method (e.g. organic, conventional farming), unlike value added of produce etc.

Furthermore, compensation claims negotiations are conducted individually and it is quite difficult for an individual farmer to negotiate effectively with TEPCO. For example,

compensation for areas with new planting restrictions in 2012 was 59,000 yen per 10 are while there were cases of people purchasing rice for own consumption and falling into a deficit [Koyama, 2013]. The later amount is not recognized for compensation as well as the value of left property in evacuation areas.

Food processing companies also are receiving compensation on lost income according to the Government guidance. Nevertheless, according to the expert procedures are quite costly and associated with great paper works, hiring layers, lengthily negotiation etc.

The negative consequences could be summarized by the statement of one of the interviewed by us experts – Mr.Nagashima, Agricultural Cooperative in Fukushima: "There are still harmful rumors for Fukushima products, the decontamination of farmlands is slow, and insufficient compensation is paid by TEPCO. People are also starting to forget the disaster. Under these conditions, farmer's willingness to work is decreasing, decline in new farmers is accelerating and abandoned farmlands are increasing. De-industrialization of agriculture in Fukushima is a major concern" (June 6, 2013).

## IX. Overall impact on farms and agricultural resources

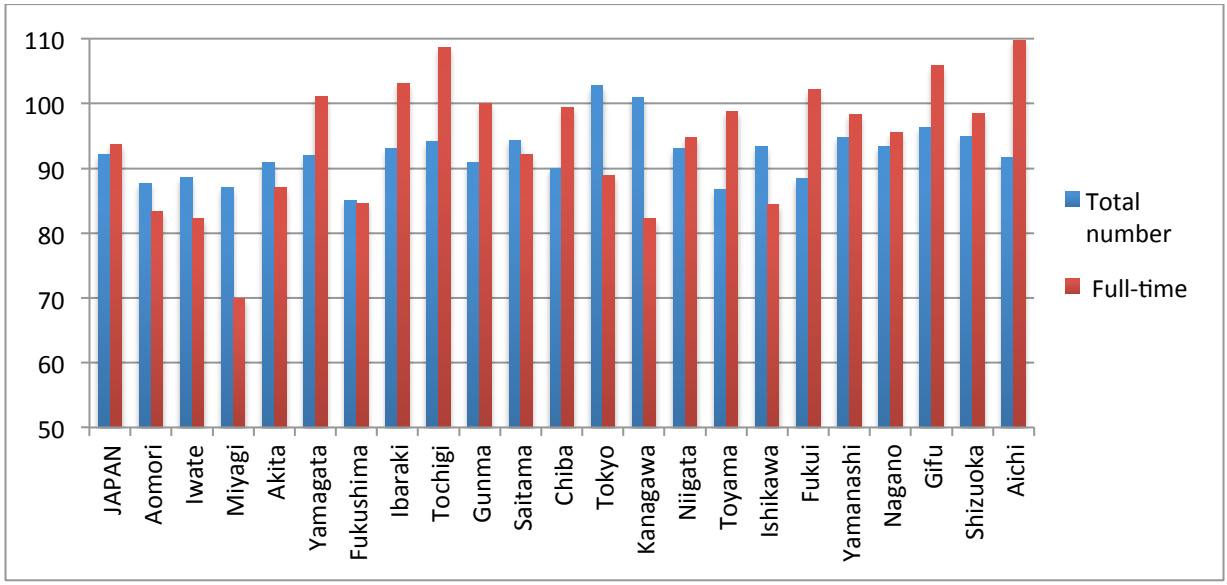
The triple 2011 disaster affected significantly Japanese agri-food sector. The most adversely impacted by the earthquake and tsunami has been farmers from the six coastal prefectures of Tohoku and Kanto regions - Aomori, Iwate, Miyagi, Fukushima, Ibaraki and Chiba. The negative effect of subsequent nuclear accident mostly damaged Fukushima farmers but also has spread to other producers in Tohoku, Kanto and Chubu regions. Therefore, we will analyze the aggregate impact of the 2011 disasters on farming sector in the later three regions and the country as a whole.

In 2010 Tohoku, Kanto and Chubu regions accounted for 55.18% of the Agricultural Management Entities in the country, including 46.83% of the Juridical Entities and 55.29% of the Non-juridical Persons in agriculture. What is more, 55.32% of the Management entities with sales of the country were located in these three regions, including 18.88% in Tohoku, 16.22% in Kanto, and 20.21% in Chubu region [MAFF, 2011].

Furthermore, in these regions 55.3% of the county's commercial farm households were operating, including 44.7% of the full-time and 59.4% of the part-time commercial farm households [MAFF, 2011]. Thus, the 2011 disasters affected directly or indirectly a significant number of agricultural farms and organizations in Japan.

After 2011 disasters the number of commercial farm households in the most damaged prefectures declined substantially (Figure 75). For instance, by 2012 the total number of Tohoku farmers decreased by 11.8% and the full time farmers by 15.93%, which was much bigger then the national average reduction of 7.8% and 6.4%. The strongest post disaster decline of commercial farms in Japan was registered in Fukushima prefecture (almost 15%) and of the full-time farmers in Miyagi prefecture (more than 30%). Consequently, Tohoku share's in the total market farmers in Japan dropped from 18.7% to 17.9%.

**Figure 75. Dynamics of commercial farm households in 2012 comparing to 2010 (percent)**




Source: Statistical yearbook of MAFF

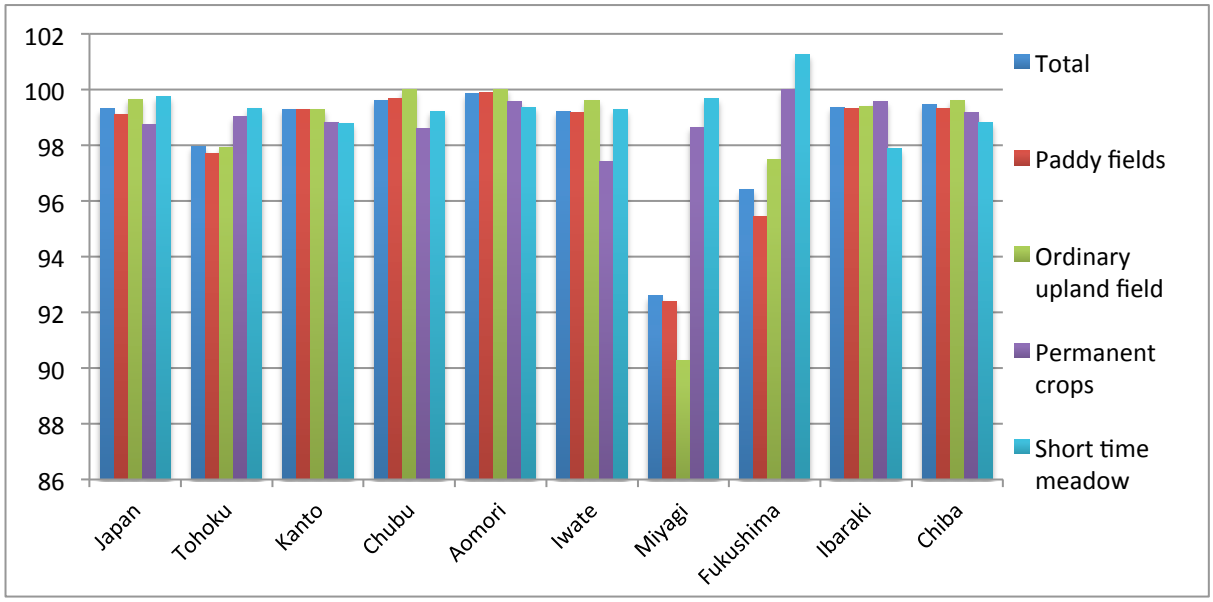
In other two regions there was above (but close to) the national average reduction of commercial farm households. In some prefectures (Yamagata, Ibaraki, Fukui, Gifu and Aichi) there was even increase in the number of full time farmers during that period. The later probably was because of the (absolutely or relatively) increased business opportunities (higher demand for agricultural products to compensate reduction in most damaged areas; lack of alternative income sources) and/or increased number of new comers (young farmers, start ups by evacuees from the disaster areas).

In 2013 the decrease in the amount of commercial farm household continued with a slower than national annual rate in Tohoku region (97.4%), higher in Kanto region (95.3%), and the same in Chubu regions (96.7%).

Before the 2011 disasters Tohoku, Kanto and Chubu regions cultivated 46.75% of the agricultural lands in Japan, including 57.46% of the paddy fields, 41.57% of the uplands, 48% of the permanent crops, and 12.62% of the short time meadows [MAFF, 2011]. Tohoku region was with the largest cultivated lands comprising 18.96% of the national, including 24.94% of all paddies[93], 16.11% of all permanent crops, 11.55% of the uplands, and 10.25% of the meadows.

In 2011 Tohoku region saw the higher that the national reduction in cultivated farmlands (including paddy and upland fields) due to the impacts of earthquake, tsunami and nuclear disaster (Figure 76). Subsequently, its share in the national cultivated land slightly contracted (from 18.96% to 18.70%). The greatest decrease in cultivated farmland was registered in paddies and uplands in Miyagi and Fukushima prefectures, permanent crops in Iwate prefecture, and short-term meadows in Ibaraki and Chiba prefectures.

**Figure 76. Dynamics of cultivated agricultural lands in affected regions in 2011 comparing to 2010 (percent)**




Source: Statistical yearbook of MAFF

[93] All rice being paddy rice.

In 2012 the Tohoku region slightly increased its paddy (0.28%) and uplands (0.15%) fields on the background of the overall trend for the reduction of agricultural lands in the country. That was a result of resuming farming in restored previously damaged paddies in Miyagi (1.77% increase) and Fukushima (0.2%) prefectures. Consequently, this region recovered a part of its lost portion in the national cultivate land reaching 18.79% of the total.

At the same time, total cultivated farmlands in other two regions contracted slower than the national average of 0.26%. Nevertheless, there was a higher annual rate of reduction in short-term meadows in Kanto region due to the decreasing size in Saitama (12.66%), Chiba (3.42%) and Ibaraki (2.18%) prefectures.

Farming has been important employment, income and food source for a great number of households members in the most affected regions. Just before the 2011 disasters Tohoku regions had bigger absolute numbers of family members engaged in farming than the country's average – 3.71 (3.54 in Japan).

Furthermore, in Tohoku and Tokai (including Gifu, Shizuoka, Aichi, and Mie prefectures) regions average family member worked more months in farming than the national average – 2.12 and 2.1 accordingly (Japan – 2.08). In Tohoku region the number of family members working in own farm was much higher then the national level – 1.51 (1.34 in Japan). On the other hand, in Hokuriku region (including Niigata, Toyama, Ishikawa, and Fukui prefectures) much smaller number of family members works in own farming and spend less time in farm operations.

There is no statistical data on how the farm households members working status and loads have changed in the post disaster years. Nevertheless, we can suppose that the 2011 disasters have impacted directly the livelihood of a great number of farm households and their members in the affected regions.

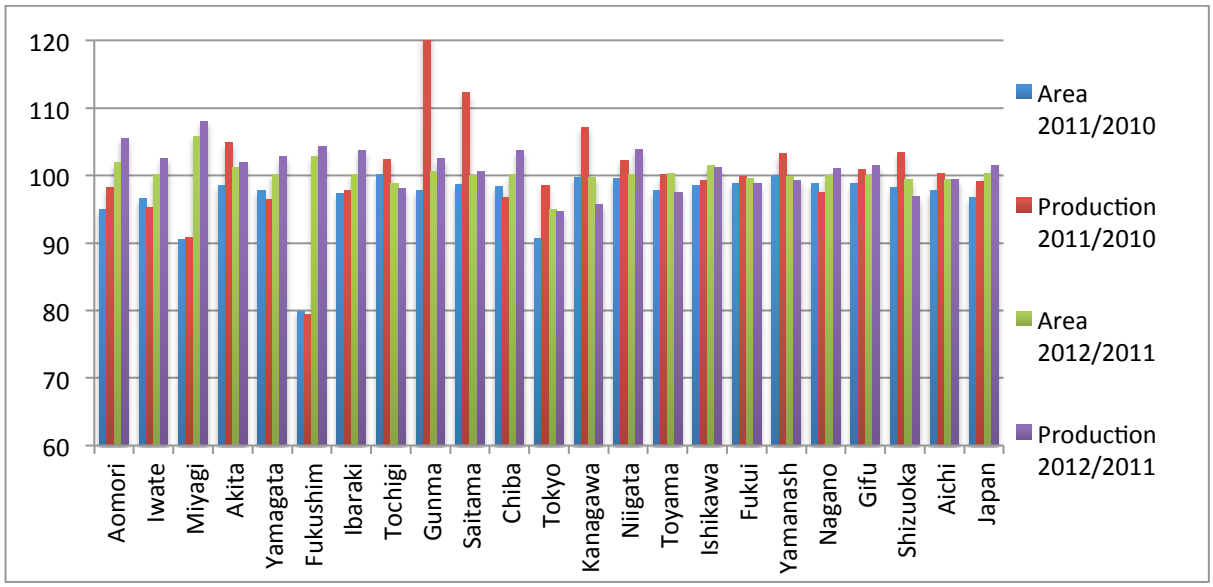
## X. Overall impact on agricultural productions

The affected by the 2011 disasters regions have been large producers of major farm produces such as rice, fruits, vegetables, sweet potatoes, soybean, buckwheat, tobacco leafs, tea leafs, meats, milk, eggs etc. For instance, in 2010 Tohoku accounted for 27.57% of rice production, 93.08% of apple production, 30.27% of tobacco production, 25.21% of poultry, 17.29% of pigs, 14.27% of beef cattle etc. (MAFF, 2014).

Moreover, the most strongly hit by the earthquake and tsunami Tohoku and Kanto regions have been large producers of vegetables, fruits, nuts and flowers in glass houses, vinyl houses, and tunnels. Before the disasters both regions were responsible for 47.68% of the planted vegetables in tunnels, 41.08% in vinyl houses, and 28.2% in glass houses; 37.42% of planted flowers in tunnels, 25.5% in vinyl houses, and 21.03% in glass houses; and for 20.07% of fruits and nuts in vinyl houses [MAFF, 2014].

The 2011 disasters have been severe blow for Tohoku rice sector. Subsequent of the tsunami destructions and the production restrictions the rice planted areas declined by 7.25% and the production by 5.96% comparing to 2010 (Figure 77). The planted areas and production plummeted in Fukushima (more than 20%) and Miyagi (more than 9%) prefectures. In Aomori prefecture planted area declined more than 5% while production reduction was smaller. Consequently region's share in the national rice areas and production dropped to 24.68% and 26.17% accordingly [MAFF, 2012]. The later contributed to a higher than usual decrease in the country's rice acreages by 3,2%. However, due to the higher output in other prefectures the national reduction of rice production was only 0.6%.

**Figure 77. Dynamics of rice planted areas and rice production in Japan (percent)**




Source: Statistical yearbook of MAFF

In 2012 there was some recovery of planted areas in all affected prefectures of Tohoku region and even a higher growth in rice production. Nevertheless, rice planted areas and production in most impacted Iwate, Miyagi and Fukushima prefecture are still bellow the pre-

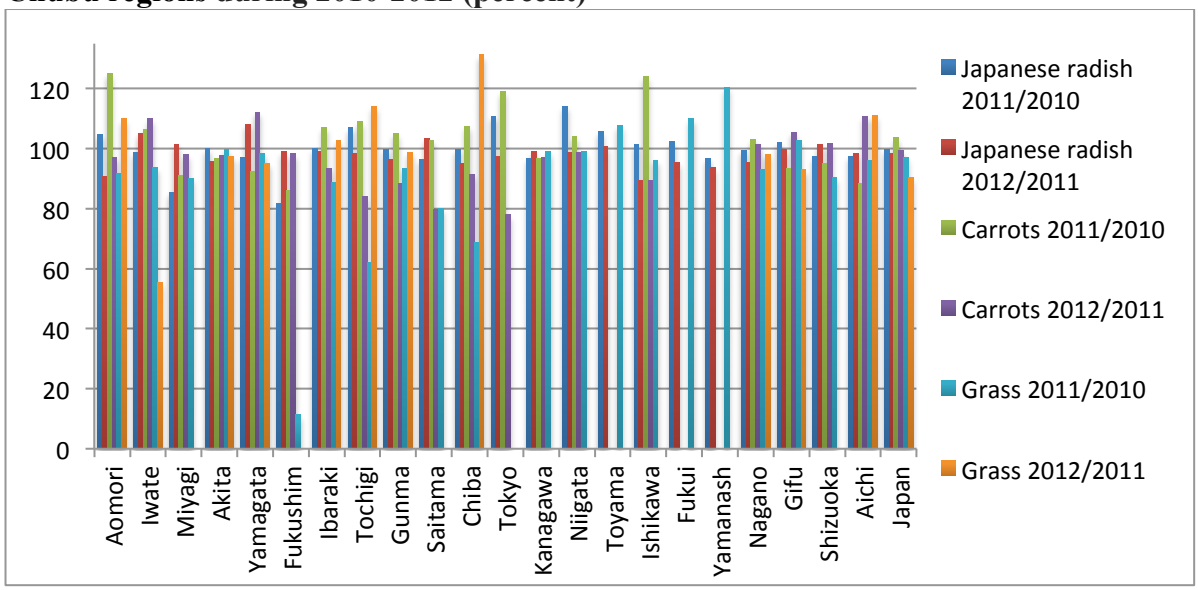
disater levels. Consequently, region importance in national rice areas and rice production increased (to 25.09% and 26.84% accordingly) but it is bellow the 2010 figure.

The combined impact of the 2011 disasters on some other major productions has also been considerable. For instance, in 2011 there was a big decline in the production of important vegetables like Japanese radish and carrots in Fukushima (18.39% and 14%) and Miyagi (14.55% and 8.86%) prefectures due to decreased areas (Figure 78). In some other prefectures production of Japanese radish (Aomori, Tochigi, Chubu region) and carrots (Aomori, Iwate, Nigata, Kanto region) increased.

That evolution was during simultaneous small decrease in national Japanese radish production and augmentation in the carrot production. Consequently, Tohoku and Kanto shares in the national Japanese radish production little decreased (to 15.48% and 27.56% accordingly) while of Chubu region increased (up to 12.69%). Contrary happened in carrot production Tohoku and Kanto importance in the national output improved (up to 7.93% and 30.82% accordingly) while of Chubu deteriorated (down to 6.05%).

In 2012 there was slight rebound of Japanese radish in Miyagi prefecture and further reduction of carrots production. In Fukushima prefecture vegetable productions continued diminishing in 2012 due to the negative impact of the nuclear accident. Contrary there was a good increase of Japanese radish production in Iwate and Yamagata prefectures and Chubu region, and of carrot production in Iwate prefecture and Chubu region. All that evolution was associated with insignificant reductions in both productions in the country as a whole. Consequently, affected regions lost from their previous positions in the national output for both major vegetables with exception of Chubu for carrots.

**Figure 78. Dynamics of major vegetables and grass productions in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

There has been also parallel impact of the 2011 disasters on the shipments of vegetables from different prefectures (Figure 79). For instance, in 2011 there was a huge decline in the shipments of Japanese radishes from Fukushima and Miyagi prefectures. The later was

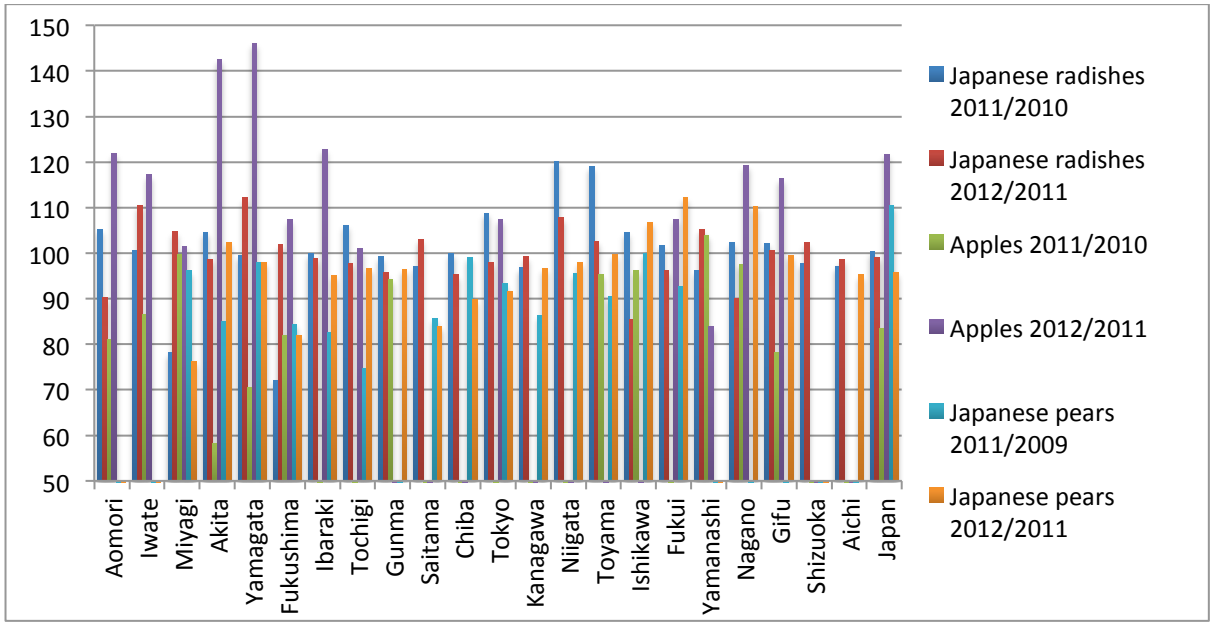
counterbalanced by the increased shipments from other prefectures (like the biggest producer Aomori), and Tohoku region even slightly increased the overall amount and its national share (13.89%). There was also some decline in the shipment from a major producer Kanto region but the national lever was unaffected due to the increased shipments from other regions.

In 2012 the sizable reduction of shipment from Aomori decreased over the national average the shipped amount (5.15%) and the region importance (13.31%).

The dynamics of structure and level of vegetable productions and shipments in the three regions and nationwide strongly depended on the available farmlands (extent of damaged land and pace of its restoration), level of contamination of products, changed market demands due to harmful rumors and consumption preferences as well as the new opportunities to increase production of more profitable crops and/or compensate reduced output and shipments from the other (adversely affected by the disasters) areas.

The same has been true for other important crops for the regions like soybean, buckwheat, sweet potatoes, tobacco, and tea leaves. For instance, Tohoku region accounted for 27.39% of the national soybean areas in 2010 [MAFF, 2012]. In 2011 the areas devoted for soybean declined in all but Aomori prefectures - with 6.65% for the region, including by 27.08% in Fukushima prefecture and 12.43% in Miyagi prefecture. The soybean output decreased in the major producer Miyagi prefecture by 10.16% as well Yamagata (13.54%) and Fukushima (3.61%) prefectures (Figure 82). Nevertheless, due to the increased yields in all but Aomori and Yamagata prefectures, and additional areas in Aomori prefecture, the annual reduction of region's soybean production was just 0.94% and lower than the national (1.76%). Subsequently the region even slightly improved its share (up to 21.79%) in the country's soybean production.

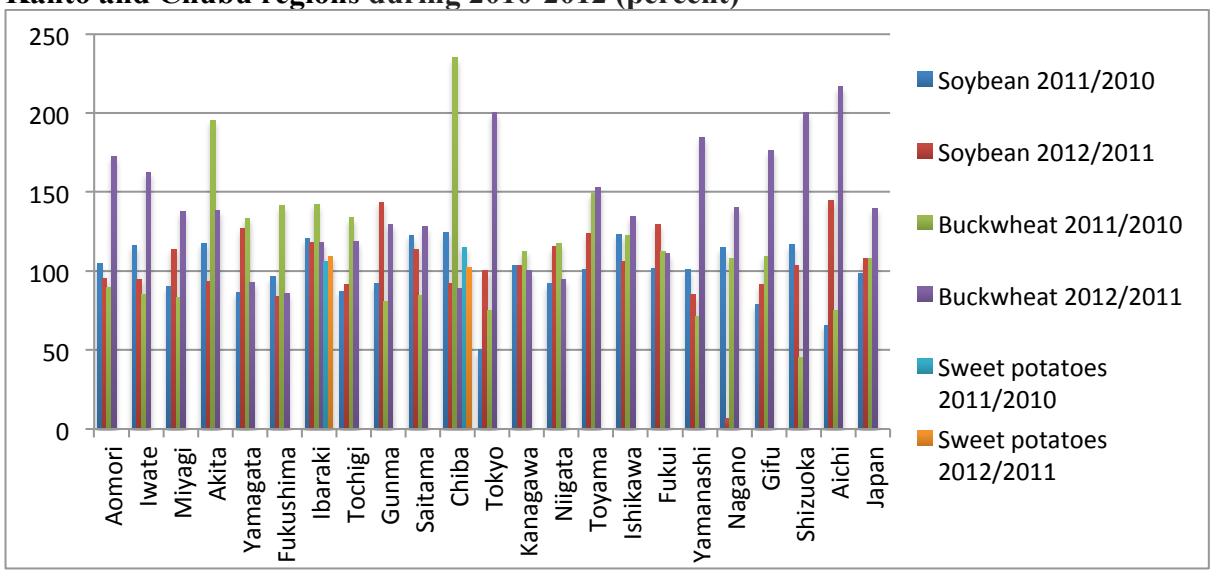
**Figure 79. Dynamics of shipments of Japanese radishes, apples and Japanese pears in Tohoku, Kanto and Chūbu regions during 2009-2012 (percent)**




Source: Statistical yearbook of MAFF

Similarly, in 2011 there was a decrease in the profitable buckwheat production in the tsunami-hit Aomori, Iwate and Miyagi prefectures (Figure 80). However, there was a general (and higher then the national) expansion of buckwheat planted areas and production in Tohoku and Kanto regions which improved their importance (up to 23.45% and 15.16%) in the country's overall production [MAFF, 2013].

**Figure 80. Dynamics of soybean, buckwheat and sweet potato productions in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

Likewise, in 2011 and 2012 the two major producers of sweet potatoes in Kanto region (Ibaraki and Chiba prefectures) enlarged production leading to increased region's share in the national output to 34.19% [MAFF, 2013]. Meanwhile, the country's output of sweet potatoes increased in 2011 and slightly contracted in 2012 staying above pre-disater level.

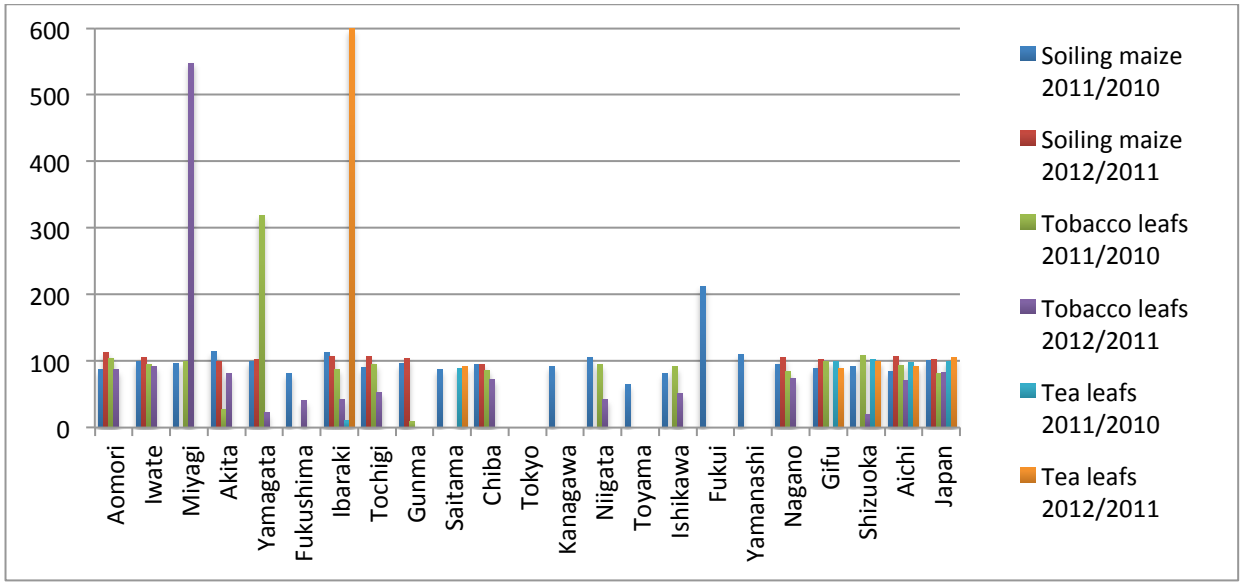
The most affected by the tsunami and the nuclear accident (Aomori, Iwate, Fukushima and Ibaraki) prefectures have been major producers of tobacco leafs as well. The 2011 disasters led to 29.51% reduction in the areas and 20.79% decrease in the production of this important for the Tohoku farmers commodity. In 2011 tobacco production was entirely suspended in Fukushima prefecture and plummeted (by 12.15%) in Ibaraki prefecture (Figure 81).

In 2012 a part of the production resumed in Fukushima prefecture and increased almost 5.5 folds in Miyagi prefecture. Contrary, both tobacco areas and production continued to decline in other prefectures. Nevertheless, due to the faster reduction in the country as a whole Tohoku prefecture enhanced its key position with 36% of the national production [MAFF, 2013].

Similarly, due to the radiation there was a huge decline in the tea leafs production in Ibaraki (89,13%) and Saitama (11.21%) prefectures in 2011. However, the later has been largely compensated by the increased production in the main producer Sizuoka prefecture, and the country's production dropped by merely 0.65% [MAFF, 2013]. The former's share in the national output increased from 38.7% to 39.59%. In 2012 tea leaf production further

declined in Saitama prefecture and partly recovered in Ibaraki prefecture on the background of 5% increase in country's tea output.

**Figure 81. Dynamics of major industrial crop and soiling maize productions in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

Chiba and Ibaraki prefectures comprised 75.92% and 14.13% of the Japanese peanut production in 2010 [MAFF, 2011]. In order to compensate fall downs in other productions, due to the tsunami, radiation and rumor damages, Ibaraki and Chiba farmers enlarged profitable peanut production by 63.42% and 27.64% in 2011 [MAFF, 2012]. In 2012 due to the further reduction in planted areas the peanut production dropped by 19.77% in Ibaraki and 13.38% in Chiba prefecture [MAFF, 2013]. Subsequently, the national production augmented by 25.31% in 2011 and then contacted by 14.78% in 2012 maintaining above pre-disater level.

Feed and fodder crops productions have been also badly affected by the radiation contamination, tsunami damages, and decreased livestock numbers in the region. For instance, before the 2011 disasters the Tohoku region accounted for 12.57% country's grass areas and 11.36% of the national grass production. In 2011 there was a small decrease in the grass areas in Tohoku and Kanto regions (1.99% and 1.42% accordingly) mostly due to the bigger reductions in Fukushima (10.2%) and Ibaraki (3.33%) prefectures [MAFF, 2012]. Nevertheless, the grass production in these two regions declined substantially (17.51% and 24.78% accordingly) with the plummeted by 88.73% output in Fukushima prefecture (Figure 38). Consequently, Tohoku share in the national grass production declined to 9.65%.

In 2012 the reduction of grass areas in almost all prefectures of the affected three regions continued with registered further production drop in most of them and no output in Miyagi, Fukushima, Saitama, Tokyo, Kanagawa, Nigata, Toyama, Ishikawa, Fukui, Yamanashi and Shizuoka prefectures [MAFF, 2013]. Consequently, the Tohoku share in the national grass production contracted to 6.91%.

National wide, there was a slight decrease in grass areas in 2011 (0.53%) and 2012 (0.57%) but considerable reduction in grass production during the period (2.89% in 2011 and 9.48% in 2012).

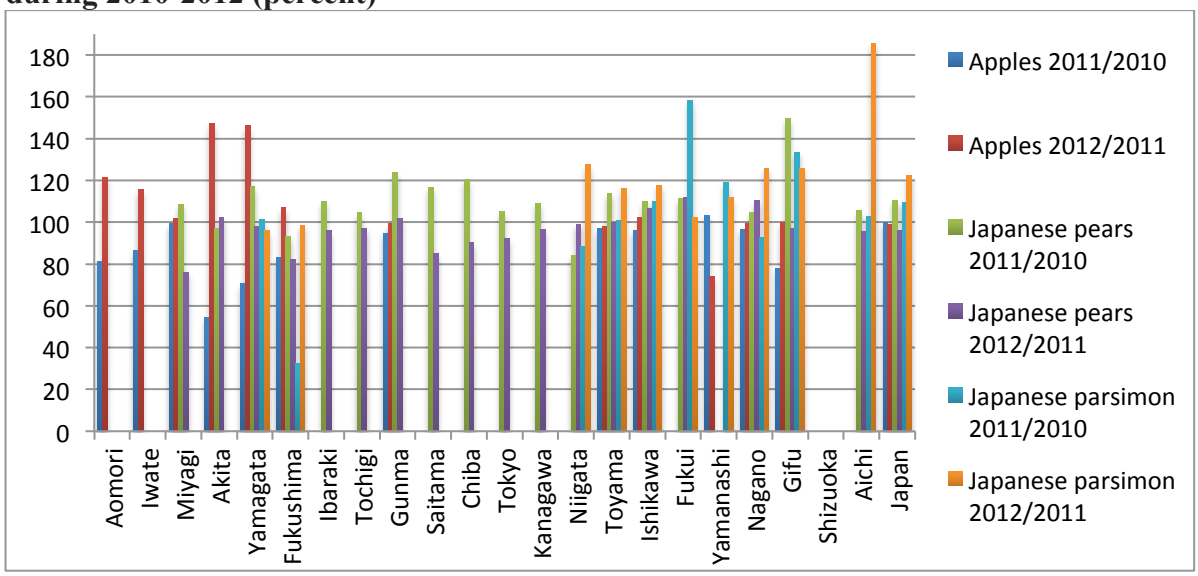
Similar, in 2011 the soiling maize planted areas decreased by 3.68% in Tohoku region and soiling maize production contracted by 6.58% due to reduction in the regional second and forth biggest producers Fukushima (8.7%) and Miyagi (3.53%) prefectures. Consequently the region diminished its share in the national production from 11.52% in 2010 to 10.6% in 2011.

In 2012 there was further slight reduction in the soiling maize areas in the region (1.58%) and a huge contraction in the output (24.98%). There was reported increased production in Iwate, Aomori and Yamagata prefectures but no output for Fukushima and Miyagi prefectures [MAFF, 2013]. Consequently, the region's importance in the national soiling maize production dropped to 7.77%.

In 2012 no soiling maize output was registered in Saitama, Tokyo, Kanagawa, Nigata, Toyama, Ishikawa, Fukui, Yamanashi and Shizuoka prefectures [MAFF, 2013]. Despite (partial or full) recovery (Tochigi, Gunma, etc.) and increase (Ibaraki and Nagano) in production in other major producers, Kanto and Chubu soiling maize output is still bellow the pre-disaster level while their shares in the national diminished (correspondingly from 13.69% and 4.04% in 2011 to 12.8% and 3.1% in 2012). At nationwide scale there has been increasing production of soiling maize throughout the period.

Fruits production in Tohoku region has particularly suffered by the 2011 disasters. For instance, in 2011 there was a little reduction of apple areas in the region (0.87%) due to the decline in orchards areas in all but Aomori prefectures [MAFF, 2012]. Nevertheless, there was a sizable decline in apple production in all prefectures (Figure 82), and the overall downfall by 20.20% in the region as a whole.

**Figure 82. Dynamics of major fruits productions in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

What is more, Chubu (a major producer) and Kanto regions also experienced some decrease in the apple production but due to the higher output in the rest of the country the

national apple production sustain at the previous level [MAFF, 2012]. Consequently, the Tohoku's bulk in the national apple output shrinked to 74.28% and the Chubu's only deteriorated slightly (22.09%).

Furthermore, major apple shipments from Tohoku region plummeted by 25.42% and with the reduced shipment from Chubu led to significant diminuation of national amount.

In 2012 there was a partial recovery of the apple production in Tohoku region and a great progression in Chubu region (18.06%) and country as a whole. Subsequently, Tohoku improve modestly its position in the national output (up to 75.01%) while relative share of Chubu felled to 21.53%.

The apple shipments from Tohoku region rebounded considerably but bellow pre-disaster level. However, enormous progression of shipment from Chubu and other regions let to effective augmentation of shipment over pre-disaster level.

The Japanese pears production experienced another development. In 2011 there was some downsizing in areas and bigger in production in the main Tohoku producer Fukushima prefecture, which leaded to a fall in the region's portion in the national output to 10.46%. Nevertheless, there was an expansion in the Japanese pears production in major producers from Kanto, Chubu and other regions, and the overall augmentation of national output.

Japanese pear shipment from Tohoku and Kanto region plummeted by 17.44 % and 7.33%, and regions share in the national shrinked from 13.78% to 10.29% and 48.22% to 40.42% accordingly. However, increased shipment from Kanto and another regions led to a good overall increase in nationwide shipments.

In 2012 Fukushima prefecture and Tohoku experienced further sizable reduction in the areas and the production of Japanese pears (by 19.4% and 15.57% accordingly) downsizing the region's share in the national output to 9.18% [MAFF, 2013]. That was accompanied by lesser decrease in areas and productions in other regions and the country's level.

Tohoku and Kanto Japanese pear shipment continued plummeting (15.95% and 7.35% accordingly) and regions shares in the national further decreased (to 9.03% and 39.11% accordingly). There was some increase in shipments from Chubu region augmenting its share in the national to 17.88%. Nevertheless, the overall amount of the national shipment further declined.

Japanese parsimon has been important for the farmers in Fukushima and Yamagata prefectures, and Chubu region. The 2011 disasters and consequent production restrictions have led to a huge reduction of Japanese parsimon production in Fukushima prefecture (Figure 41). Subsequently, prefecture's share in the national output dropped from 7.39% to 2.19%. At the same time, there was some increase in the Japanese parsimon production in Yamagata prefecture, higher in Chubu region, and even more elevated nationwide.

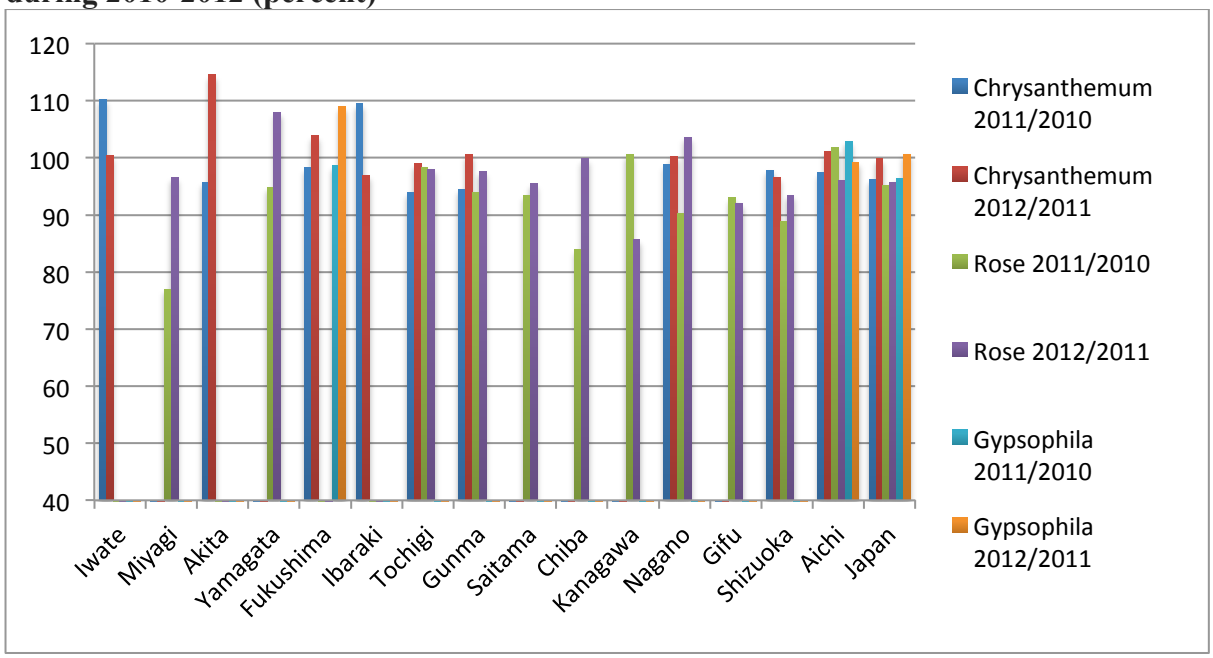
In 2012 there was registered diminished areas and production Japanese parsimon in Tohoku region but a considerable growth in Chubu region and the country as a whole. Consequently, Chubu producers enhanced their portion in the national output from 24.59% (20country 26.66% while Tohoku farmers segment plummeted down from 12.27% to 5.31% (MAFF. 2013).

Flower productions and shipments have been important for many farmers in the affected by the 2011 disasters regions. In 2010 these regions were responsible for the shipments of 58.87% of the roses (including 31.36% Chubu and 18.57% Kanto region), 47.04% of the

chrysanthemums (including Chubu 34.45% and Kanto 6.48%), and 21.07% of the gypsophilas (including Chubu 9.39% and Tohoku 9.63%) in the country [MAFF, 2011].

In 2011 there was a significant (much higher than the national) reduction in flower shipments from the three regions (Figure 83), as a result of which their segments in the national productions diminished. The biggest declined was registered in Tohoku region – 28.15% for chrysanthemums, 24.93% for roses, and 12.92% for gypsophilas. What is more, sizable chrysanthemums shipments from Aomori, Miyagi, Yamagata, Chiba, Saitama and Kanagawa prefectures completely stopped. At the same time Fukushima prefecture decreased only slightly chrysanthemums and gypsophilas shipments and ceased one for roses. Besides, Ibaraki prefecture expended its chrysanthemums shipment.

**Figure 83. Dynamics of shipments of flowers in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**

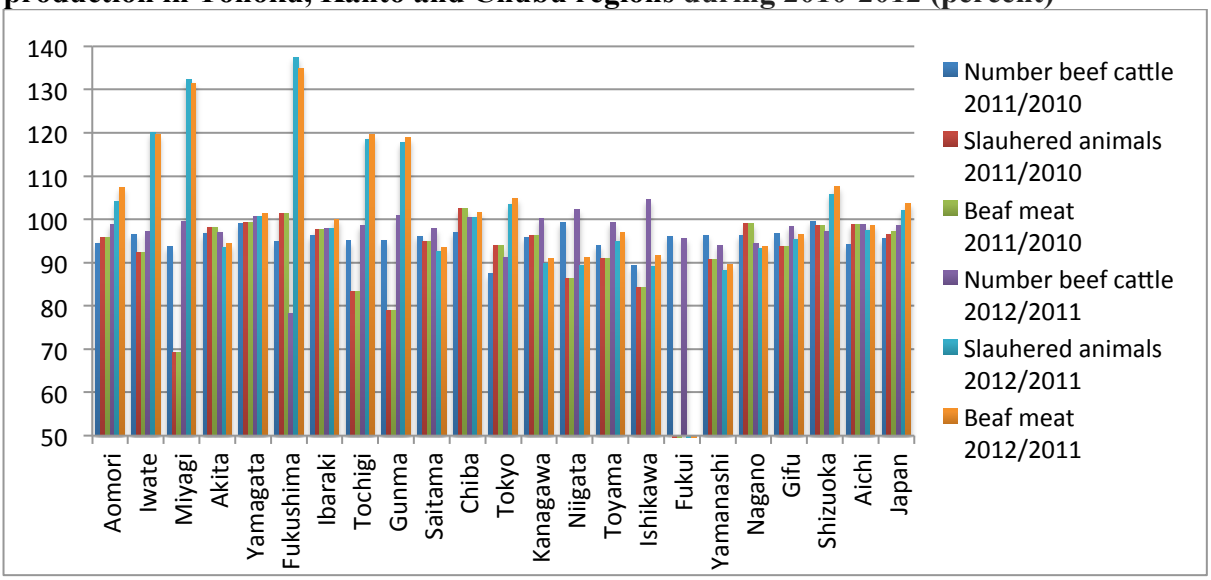



Source: Statistical yearbook of MAFF

In 2012 Tohoku rebounded partially its flower shipments due to above pre-disaster level recovery in Fukushima, Akita and Yamagata prefectures and ceased chrysanthemums shipments from Miyagi and Aomori prefectures. Kanto regions flower shipments continue to decline faster than national average [MAFF, 2013]. All three regions have lost portions of their shares in the national shipments of flowers.

The 2011 disasters have been a severe blow for the beef industry in the most affected regions and beyond. The number of Tohoku beef cattle declined by 9.48% during 2011-2012 with a rate of livestock reduction in all but Yamagata prefectures much higher than the national average (Figure 84). In 2011 the contraction was highest in the tsunami and nuclear accident affected Aomori, Iwate, Miyagi and Fukushima prefectures. Unlike other prefectures, were 2012 decline was low than the national, the Fukushima beef cattle continued to contract sharply plummeting by 25.60% during 2-year period. Consequently, the region's share in the beef cattle of the country fell to 13.72% [MAFF, 2013].

**Figure 84. Dynamics of number of beef cattle, slathered animals, and beef meat production in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

Furthermore, the cutback of beef cattle and adverse impact of nuclear accident led to a decline in the number of slathered beef animals and produced beef meat in Tohoku region in 2011 by 11.89% and 10.60%. Miyagi and Iwate prefectures experienced the biggest contraction in the slathered animals and meat production.

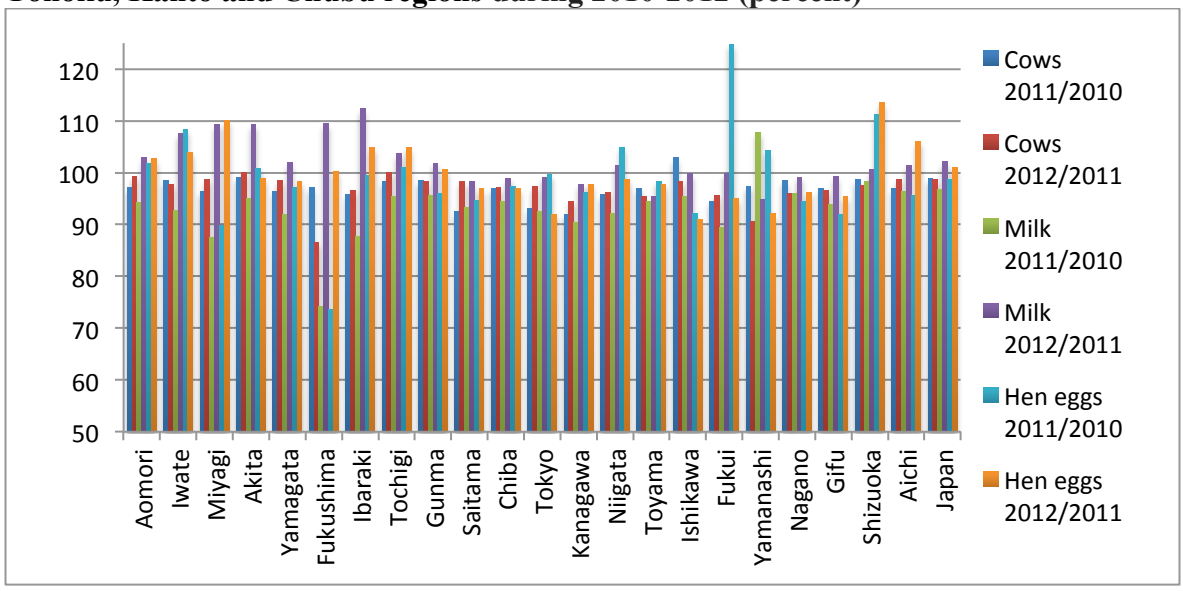
Kanto and Chubu regions beef cattle have also declined but at a slower rate than the national shrinkage of the sector. On the other hand, the fall in the numbers of slathered beef cattle and produced beef meat were higher than the national diminuation.

Likely wise, in 2011 there was a greater than the national reduction in the number of cows in the three affected regions and a significant downsizing of the row milk production (MAFF, 2012). Tohoku milk production declined by 11.09% and region's share in the national milk output dropped to 7.68%. Due to the reduced number of cows and shipment restrictions many prefectures experienced reduction of milk production. Fukushima prefecture registered the greatest contraction in milk production (more than a quarter) followed by Miyagi, Ibaraki, Nigata, and Iwate prefectures (Figure 85).

In 2012 there was a further reduction in the cows in Tohoku region mostly due to the considerable downsizing in Fukushima prefecture. The later saw 15.91% of its dairy livestock reduced in two years. The milk production rebounded in all Tohoku prefectures (which partially regain its share in the national output) and in the country as a whole but far bellow the pre-disater level [MAFF, 2013]. However, the three affected regions have seen their portions in the country's cows and milk production wakened after the disaster.

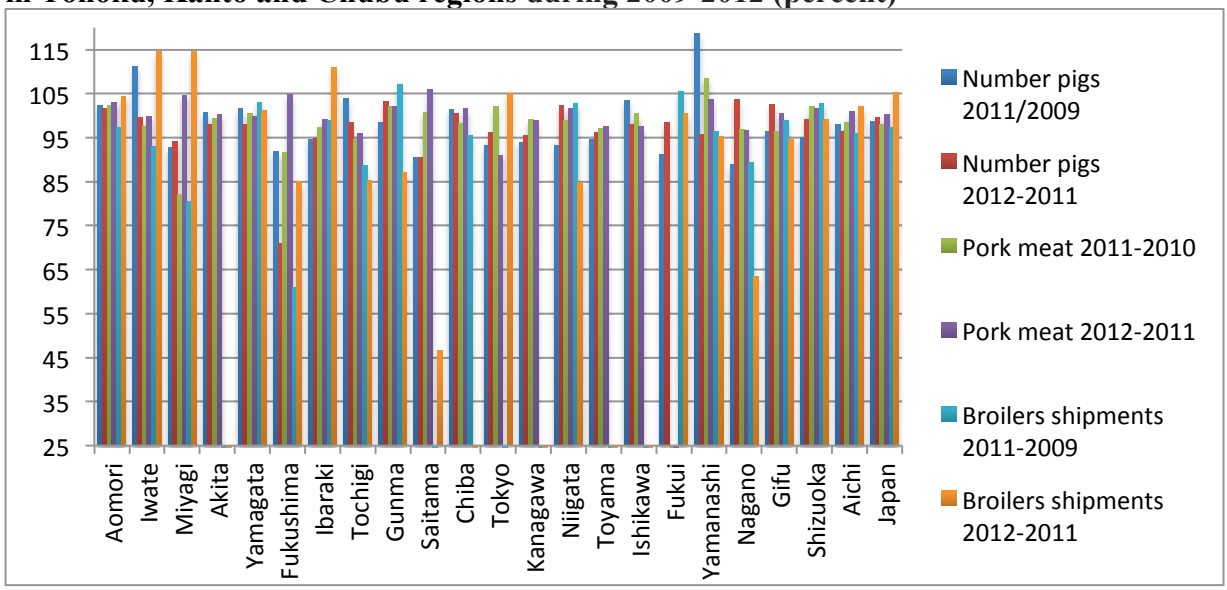
Similarly, there was a significant reduction of pigs in Miyagi prefecture in 2011 comparing to 2009 (Figure 86). Nevertheless, it was compensated by increased number of animals in other prefectures, which resulted in a rise of overall number of pigs in Tohoku region [MAFF, 2012]. At the same time there was a diminuation of pigs in other two regions and in the country as a whole. Consequently, Tohoku share in the overall pig number of the country augmented to 17.81%.

**Figure 85. Dynamics of number of cows, milk production, and eggs shipments in Tohoku, Kanto and Chūbu regions during 2010-2012 (percent)**




Source: Statistical yearbook of MAFF

**Figure 86. Dynamics of number of pigs, pork meat production, and broilers shipments in Tohoku, Kanto and Chūbu regions during 2009-2012 (percent)**




Source: Statistical yearbook of MAFF

In 2011 the number of slathered animals and produced pork meat in Tohoku region declined a good deal compering to previous year with a faster rate than the national. The later was due to considerable reduction in meat production in Miyagi and Fukushima prefectures. Reduction in meat production in other two regions was slower than the national [MAFF, 2012].

In 2012 the number of pigs in Tohoku regions shrinked due to further reductions in Fukushima and Miyagi prefectures, and some regression in all but Aomori prefectures. Comparing to 2009 Fukushima pig farms diminished their animals by 44.78%. There was also

further reduction in other two regions with a slower rate n Kanto than the national [MAFF, 2013].

What is more, in 2012 there was a significant recovery in Tohoku pork production and sustainable levels in other regions and the country [MAFF, 2013]. Consequently, the three regions reduced a little bit their pre-disater shares in the slathered animals and produced pork meat in the diminishing national amount [MAFF, 2013].

Tohoku broilers and hen eggs productions have been also considerably affected by the 2011 disasters. Comparing to 2009 there was a 7.73% reduction in shipped broilers due to contraction in all affected by the tsunami prefectures. Similarly, there was a 5.46% decrease in the hen eggs production due to the considerable contraction in Fukushima and Miyagi prefectures (Figure 79). Consequently, the region's portion in the national broilers shipment and eggs production declined to 23.89% and 13.83% accordingly [MAFF, 2012]. In Kanto region there was lesser then the national reduction in broilers shipment and bigger for the egg production while the vise verse is true for Chubo region.

In 2012 the broiler shipment recovered rapidly in all but Fukushima prefectures of Tohoku region razing above the pre-disater level. The eggs production also rebounded in Miyagi and continued growing in Aomori and Iwate prefectures.

The shipment of broilers was not significant in Kanto and Chubu regions and further declined in 2012 on the background on increasing shipment nationwide [MAFF, 2013]. At the same time major eggs production slightly grow around the national average level.

## XI. Overall impact on agricultural output and income

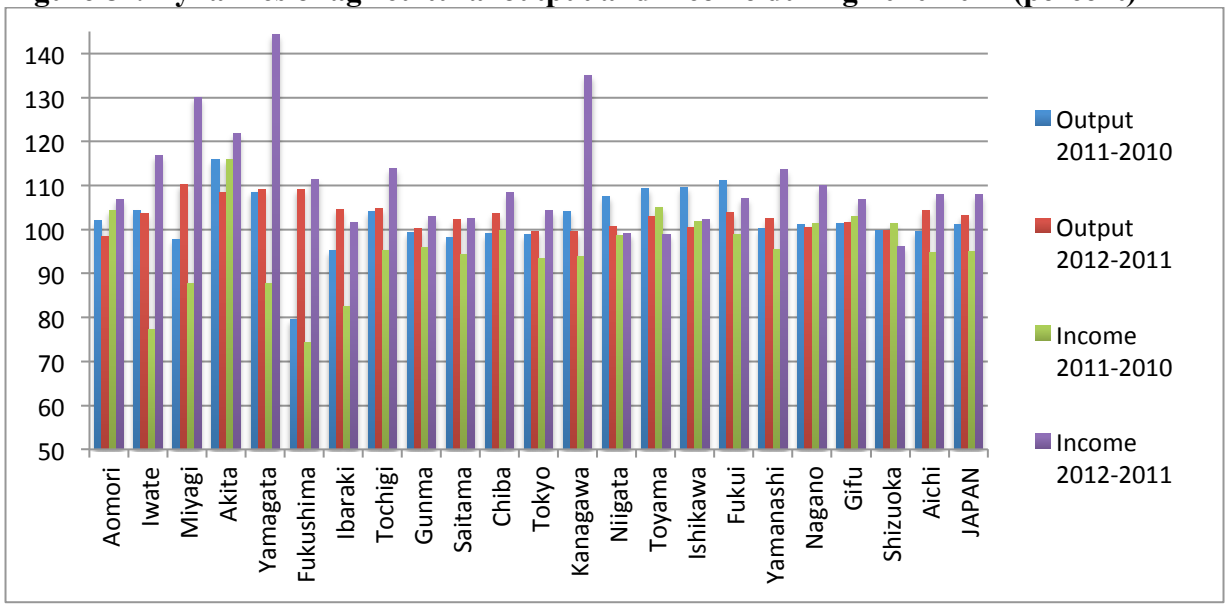
Before the 2011 disasters Tohoku, Kanto and Chubu regions produced above the half of the agricultural output and agricultural income in the country – 16.56%, 19.69%, and 16.25% of the total (MAFF, 2014).

The three regions were responsible for the sizable share of the Japanese rice (63.30%), vegetables (56.06%), flowers (58%), fruits and nuts (54.13%), pigs (54.53%), and hen eggs (54.77%) outputs. The biggest contributor to the national agricultural output and income was Kanto region, followed by Chubu for agricultural output and by Tohoku regions for agricultural income. The most severely hit by the tsunami and nuclear accident prefectures (Ibaraki, Chiba, Fukushima, Aomori, Iwate and Miyagi) have been among the greatest producers of agricultural output and income in that region.

Crops value dominates in all but Iwate prefecture where livestock (chicken and pigs) production is the most important. Rice is the major segment in most Tohoku and a good part of Chubu prefectures while vegetables are the key sector in Kanto region and good portion of Chubu prefectures.

The 2011 disasters have influenced considerably the farm economy in the most affected regions. In times of the overall growth of the national agricultural output, its value declined significantly in the most severely hit prefectures as biggest annual decrease was registered in Fukushima, Ibaraki and Miyagi prefectures (Figure 87).

**Figure 87. Dynamics of agricultural output and income during 2010-2012 (percent)**



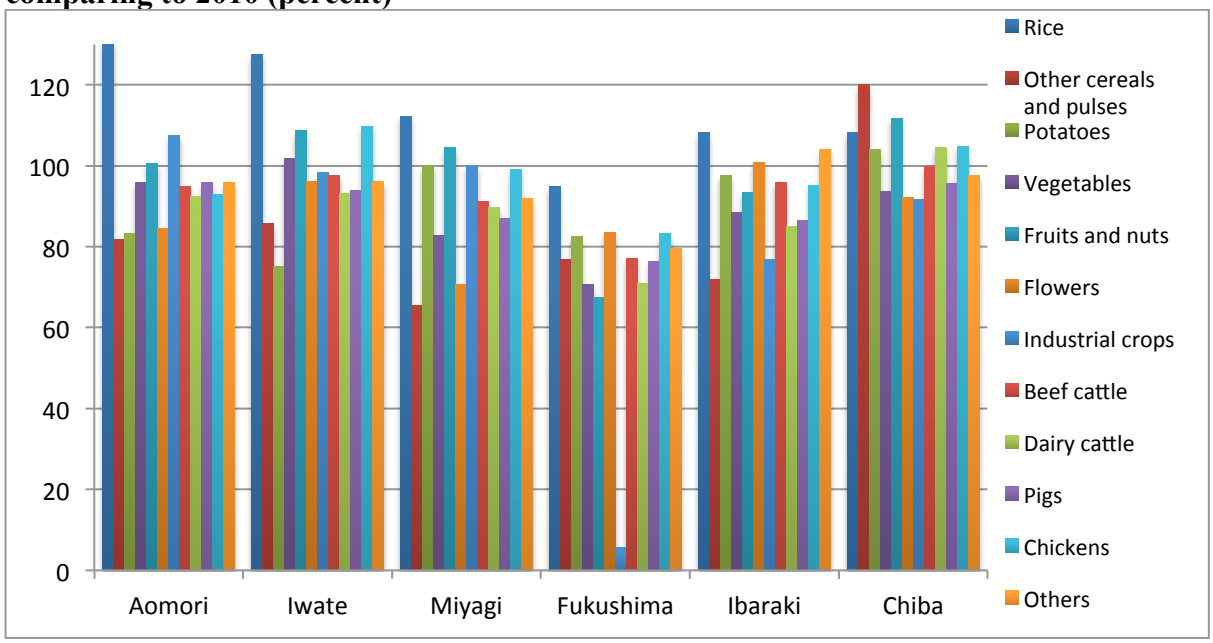

Source: Statistical yearbook of MAFF

Generated value of all agricultural products in Fukushima prefecture contracted enormously comparing to the pre-disater period ranging from over 5% in rice up to more than 96% for the industrial crops (Figure 88, Figure 99).

Similarly, there was a huge decline in the output of pigs, other cereals and pulses in all prefectures, beef and dairy cattle in all but Chiba prefectures, vegetables in all but Iwate prefectures, potatoes of all but Miyagi prefectures, flowers of all but Ibaraki prefectures,

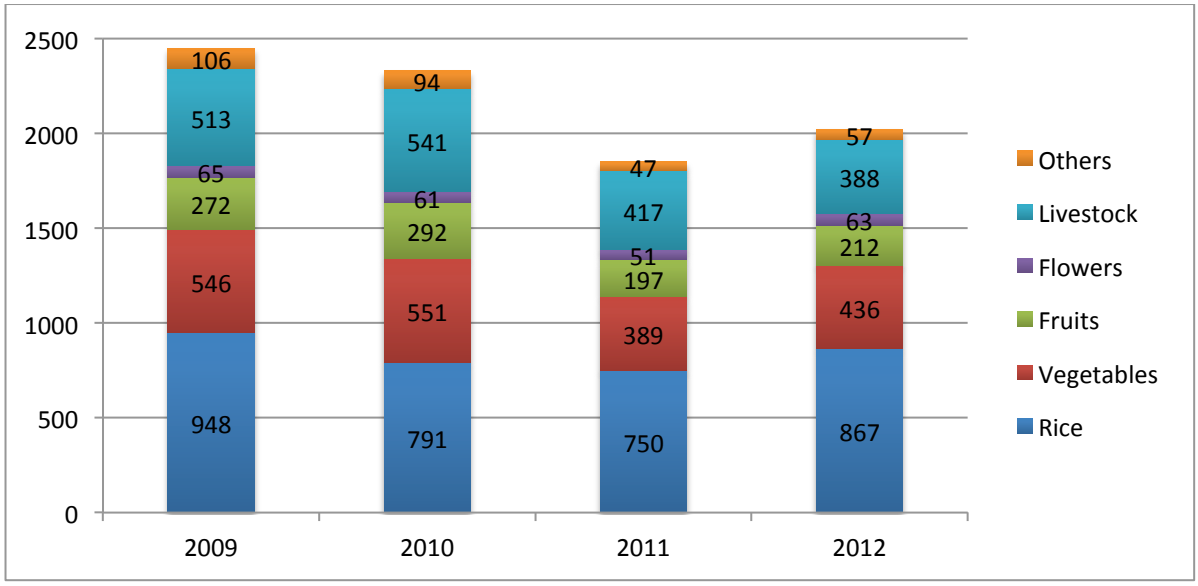
industrial crops in all but Aomori and Miyagi prefectures, fruits and nuts in Ibaraki prefecture, etc.

**Figure 88. Dynamics of value of agricultural products in most affected prefectures in 2011 comparing to 2010 (percent)**




Source: Statistical yearbook of MAFF

**Figure 89. Dynamics of agricultural production value in Fukushima prefecture**

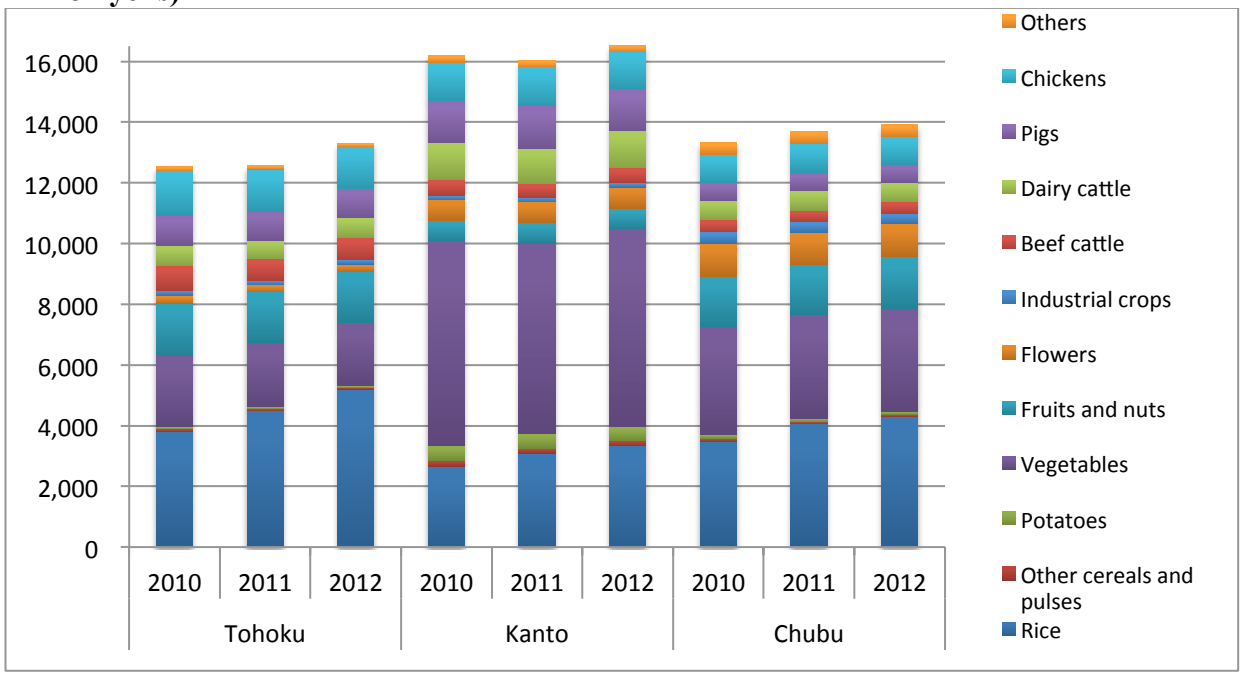



Source: Statistical yearbook of MAFF

At the same time there was a good increase in the rice value in all but Fukushima prefectures, fruits and nuts in Chiba, Iwate and Miyagi prefectures, hen eggs in Iwate prefecture, other cereals and pulses in Chiba prefecture, industrial crops in Aomori prefecture, etc. Consequently, in some of the most affected prefectures like Aomori and Iwate there was even increase in the total value of the agricultural output.

Furthermore, a strong augmentation of the produced farm output was achieved in neighboring Akita and Yamagata prefectures. Subsequently, there was a slight increase in the overall agricultural output of the Tohoku region as a whole (Figure 90).

**Figure 90. Dynamics of agricultural output in Tohoku, Kanto and Chubu regions (100 million yens)**




Source: Statistical yearbook of MAFF

In Kanto regions all but Tochigi and Kanagawa prefectures registered drop in the agricultural output. The most adversely was affected, beef cattle in all but Chiba and Tokyo prefectures, fruits and nuts in Tochigi, Gunma and Saitama prefectures, etc. The sustainable levels or the insignificant augmentation in other productions did not compensate the later, and the overall agricultural output of the region slightly declined by 0.74%.

On the other hand, in Chubu region only Shizuoka and Aichi prefectures registered a little reduction in the agricultural output. The later was compensated by increased output from other prefectures, and the region demonstrated a higher than the national progression in the overall agricultural output (2.78%). The strongest augmentation of the produced farm output was achieved in Toyama, Ishikawa and Nigata prefectures.

Nevertheless, there was a decline in the outputs from potatoes, wheat and burley productions, miscellaneous cereals and pulses in all but Shizuoka and Ishikawa prefectures, fruits and nuts in all but Fukui, Gifu and Shizuoka prefectures, vegetables in all but Nigata, Toyama, Ishikawa and Yamanashi prefectures, beef cattle in all but Ishikawa, Fukui and Yamanashi prefectures, dairy section in all but Fukui, Yamanashi and Aichi prefectures, industrial crops in all but Nigata, Ishikawa, Nagano and Gifu prefectures, pigs in Yamashi prefectures, etc.

At nationwide scale, there was annual reduction of the value of the wheat and burley production (21.03%), miscellaneous cereals and pulses (8.77%), industrial crops (7.42%), vegetables (5.08%), flowers (4.03%), dairy cattle (2.46%), potatoes (1.76%), beef cattle

(0.91%), and processed agricultural products (0.18%) [MAFF, 2012]. Simultaneously, there was a slight progression in the outputs of pigs and chickens, and a good increase in the rice (17. 91%) leading to the overall growth in country's agricultural output.

All this development has been associated with a changing structure of the agricultural output in the most affected regions and nationwide. There was a considerable enlargement of the rice share in the overall value of the agricultural output in the three regions and nationwide (to 22.21%). At the same time, there was reduction in the importance of all other productions but fruits and nuts, pigs and chickens in Kanto region, and pigs in Chubu region.

In 2012 there was a good progression in the agricultural output value in all affected prefectures but Aomori, Tokyo, Kanagawa, and Shizuoka. What is more, the augmentation in the most impacted prefectures and the Tohoku region as a whole was higher than the national average, while in the Kanto region the same as national, and Chubu region bellow the national.

Nevertheless, there was a further deterioration of the output of beef cattle (24.55%), other cereals and pulses (20%), and chickens and eggs (8.03%) in Fukushima prefecture [MAFF, 2013].

Consequently, there was a recovery of the pre-disater levels and the effective growth during the period in all but Fukushima, Ibaraki, Gunma, Tokyo, and Shizuoka prefectures [MAFF, 2013].

Ibaraki prefecture almost achieved the agricultural output level from the pre-disater period (99.42%), producing more (0.86%) crops value and lagging behind (4.44%) for livestock.

However, the situation was still quite bad in Fukushima prefecture producing 15.26% less, including 8.42% in crops and 28.28% in livestock value. The recovery was particularly slower for the important beef cattle farming producing 46.45% of the pre-disater level as well as other cereals and pulses (28.46%), potatoes (7.39%), vegetables 20,87%), industrial crops (55,66%), row milk (17.35%), pigs (8.81%), chickens and eggs (26.73%), and processed agricultural products (85.61%). During the period there was only effective progression in rice (9.61%) and flowers (3.28%) output value.

In a national scale there was three times higher than the overall expansion of the rice output and much higher growth for other cereals and pulses [MAFF, 2014]. On the other hand, there was a modest increase in the value of milk, processed agricultural products, beef cattle, vegetables, fruits and nuts, flowers, and pigs, and contractions for all others. Subsequently, besides for rice output, where there was 29.45% enlargement during post-disater period, and miscelenouse cereals and pulses, beef and dairy cattle, pigs and processed agricultural products, for all other production there was effecting reduction in the agricultural output value.

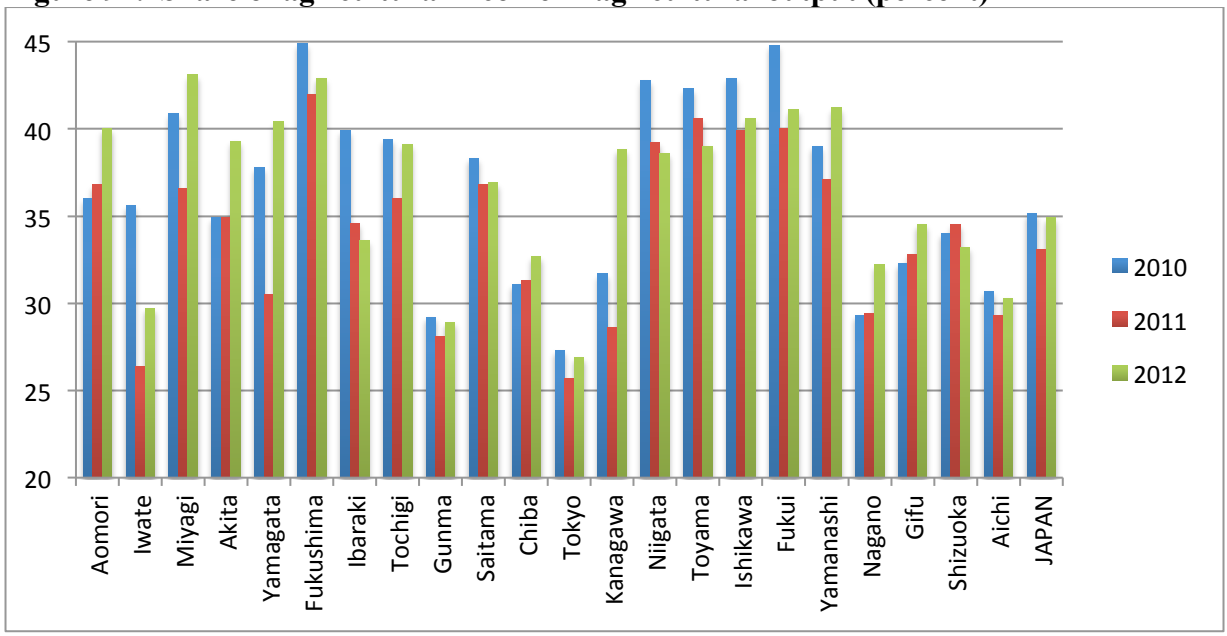
All that evolution was associated with further modification of the agricultural output structure in the three regions and nationwide. The rice share continued to enlarge reaching 39.1% in Tohoku, 30.86% in Chubu, 20.24% in Kanto, and 23.64% countrywide. Furthermore, there was a small (but bellow 2010 levels) expansion of fractions of other cereals and pulses (along with the same nationwide trend), fruits and nuts, flowers and beef cattle in Chubu region, and diminished importance of all other groups.

The 2011 disasters have affected considerably farm income as well. In 2011 there was 10.52% decline in the produced agricultural income in Tohoku region due to a significant drop in all but Aomori and Akita prefectures. What is more, the decrease in the income in Fukushima and Miyagi prefectures was superior then the reduction of the agricultural output. Furthermore, the good agricultural output enlargement in Yamagata and Iwate prefectures was associated with the negative development in produced income.

On the other hand, Akita and Aomori prefecture registered a good growth in the generated income, which in the later case was higher than the output augmentation.

Consequently, the share of agricultural income in agricultural output deteriorated in all but Aomori prefectures as particularly strongly were affected Iwate and Yamagata prefectures (Figure 91). That led to a decrease in the region's ration from 38.4% to 34.23% in the line with the deterioration of the national figure. During pre-disater period farming profitability in Tohoku region and in all but Akita prefectures was higher than the national level. In disaster year, all prefectures but Iwate and Yamagata maintained or improved (Aomori) the superiority over the country's performance in terms of income share.

**Figure 91. Share of agricultural income in agricultural output (percent)**




Source: Statistical yearbook of MAFF

As a result of all this development most prefectures, with exception of Aomori and Akita, decreased their shares in the national agricultural income as the portion of the Tohoku region diminished to 15.59% [MAFF, 2012].

Agricultural income of Kanto region plummeted by 7.71% in 2011. The Ibaraki prefecture was the worst hit while most prefectures had higher decline in the produced income than the national with the exception of Tochigi, Gunma and Chiba with a lesser reduction (Figure 84). Moreover, Tochigi and Kanagawa having outputs grown saw their income contracted while other prefectures registered a higher income reduction that in the output. Only Chiba prefecture had a lesser annual reduction in the income than the output.

All but Chiba prefectures saw the ration of generated income in the output diminished in 2011 leading to decline of the region's one from 35.32% (higher than national average) to 32.92% (bellow the national). Nevertheless, Ibaraki, Tochigi and Saitama continued to maintain higher income generating efficiency than the national.

Consequently, Tochigi, Gunma and Chiba prefectures decreased their portions in the national agricultural income, as regional share slightly declined from 19.69% to 19.12% [MAFF. 2012].

All prefectures in Chubu region but Aichi had a better performance in terms of income than the national one. There was an augmentation of produced agricultural income in Toyama, Gifu, Ishikawa, Nagano and Shizuoka while in the rest the decline was less that the national average leading to a small annual drop (0.7%).

During 2011 all prefectures but Nagano and Gifu saw their income segment in the agricultural output diminished (Figure 84), which led to a decrease of regional from 35.39% to 34.19%. Nevertheless, the number of prefectures with efficiency ration lower than the national decreased by 1 and only Nagano, Gifu and Shizuoka were performing worst than country's average.

Subsequently, Aichi prefecture maintained and all others improved their share in the generated national income, increasing the regional portion to 16.98%.

In 2012 there was registered considerable increase in the produced agricultural income in all prefectures of Tohoku region leading to annual growth of 20.22% in the region as a whole (Figure 84). Moreover, in all but Aomori prefectures the annual rate of income augmentation was higher than the national increase.

Nevertheless, the generated income in Fukushima and Iwate prefectures was still far bellow than the pre-disaster level – 17.39% and 9.69% accordingly. Simultaneously, other prefectures achieved much higher income growth than the national being superior in Akita prefecture (41.19%), followed by Yamagata (26.67%), Miyagi (13.85%) and Aomori (11.53%) prefectures [MAFF, 2013]. Consequently, during the post disaster period the Tohoku efficiency in terms of progression in agricultural income (7.57%) was much higher than in other regions and the country's levels.

All prefectures in the region improved the income-output rations. However, in Iwate prefecture it was much lower than the national level and the pre-disater level. Furthermore, Fukushima prefecture achieved lower than 2010 but much higher that the national efficiency ratio. Consequently, the region's profitability in terms of income generation recovered slightly above the pre-disater level (38.91%).

The contribution of all prefectures to the national agricultural income increased during 2012 (being still bellow the pre-disater level in Fukushima and Iwate prefectures) leading to enlarged regional share of 17.38%.

All Kanto prefectures generated growth in agricultural income being higher than the national in Chiba and Kanagawa prefecture. Nevertheless, the later was not enough to compensate the post-disater declined and the produced agricultural income in Gunma, Saitama, and Tokyo prefectures was bellow 2010 levels while in Ibaraki prefecture far bellow under it (16.14%). On the other hand, Kanagawa and Tochigi prefecture achieved much superior that the national income augmentation.

All prefecture but Ibaraki improved their income-output ration leading to average regional of 34.21%. Furthermore, Ibaraki, Gunma and Saitama prefectures diminished further their share in the national agricultural income, and the region's overall contribution dropped to 19%.

Regenerated agricultural income in Chubu region increased slowly (3.74%) than in the rest of the country. Only Yamagata and Nagano prefectures had higher than the national income growth while in Shizuoka, Nigata and Ishokawa there was contraction (Figure 44). Comparing to post-disater period most prefectures and the region as a whole achieved higher income growth rate than the national. In Aichi expansion of the income was slightly bellow the national while in Nigata and Shizuoka it was still bellow 2010 level.

During 2012 there was a progression of the income-output ratio for all but Nigata, Toyama and Shizuoka prefectures, and the regions figure rose to 34.9%. Nevertheless, the performance for all but Nagano, Shizuoka and Aichi prefectures, and the region as a whole was still bellow the pre-disater level.

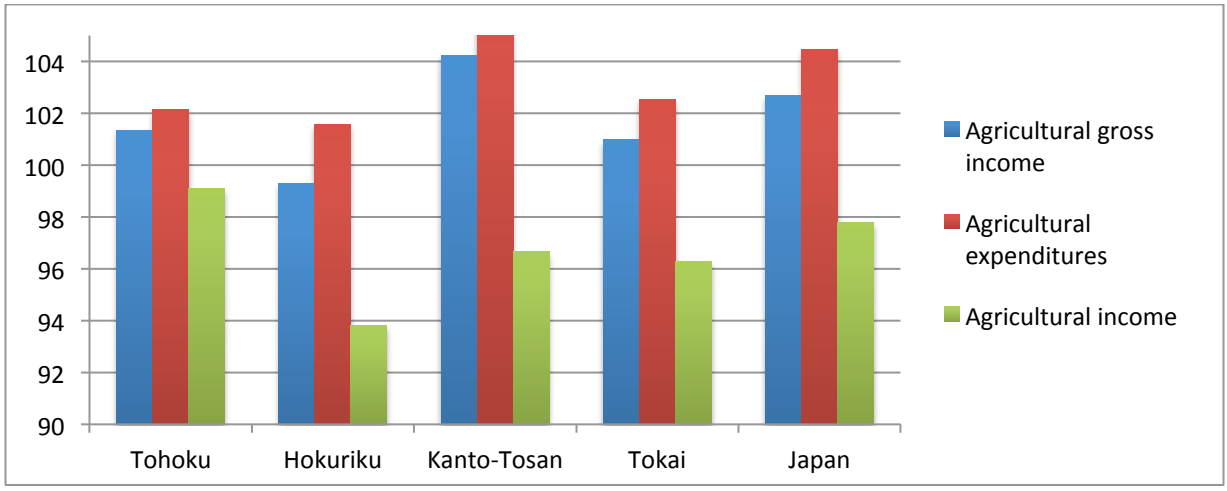
As a result of that development the contribution to national agricultural income of most prefectures and the region as a whole diminished (16.33%) but it was higher than in the pre-disater period.

## XII. Overall impact on farm economy

The integral impact of the 2011 disasters on farm households agricultural and overall incomes and expenditures has been quite divers in different parts of the affected regions and the country.

In 2011 there was an increase in the total Agricultural Expenditures of farming households in all affected regions and nationwide (Figure 92). In Kanto-Tosan region the rate of augmentation of these costs was much higher than the country's average, while in other affected regions lower that the national one.

**Figure 92. Dynamics of farm households Agricultural Gross Income, Agricultural Expenditures, and Agricultural Income in affected regions (2010=100)**



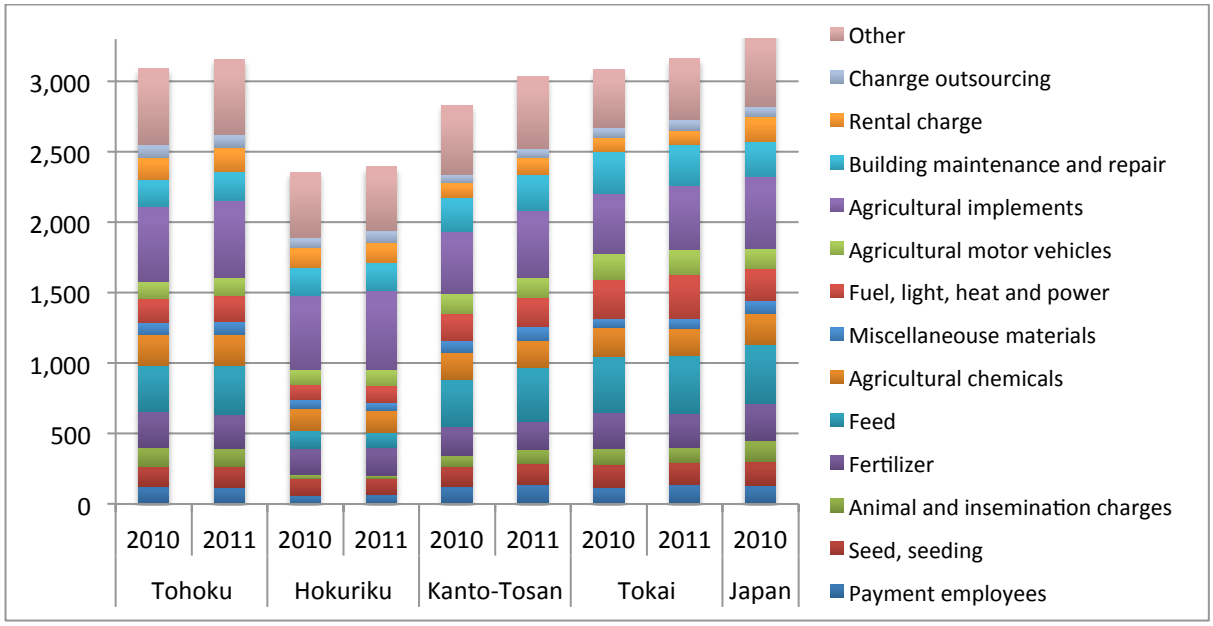

Source: Statistical yearbook of MAFF

The national average Agricultural Cash Expenditures of farm households rose a little bit more (4.5%) then the Total Agricultural Expenditures while that of the Depreciation costs slower (4.12%). Similarly, in Tokai region the Agricultural Cash Expenditures expended faster (3.74%) that the overall agricultural costs, while the Depreciation rise was much lower (1.26%).

On the other hand, in Tohoku and Hokuriko regions the annual rise of the Agricultural Cash Expenditures of farm households was lower (1.78% and 1.5% accordingly) then the growth of the total amount while that of the Depreciation higher (4.27% and 2.42%). In Kanto-Tosan region the Agricultural Cash Expenditures increased (7.31%) almost as much as the total agricultural expenditures, while the Depreciation hike was slower (6.55%).

The highest augmentation was registered in costs "Paid for agricultural employees" in all regions but Tohoku (Figure 93). Similar to the national trend, in all affected regions there was a higher than the overall augmentation of the expenditures for "Fuel, light, heat and power", "Agricultural implements", and "Rental change" (except of Tokai).

**Figure 93. Dynamics of farm households Agricultural Expenditures in affected regions (Thousands yen)**




Source: Statistical yearbook of MAFF

Furthermore, like country's average there was a considerable rise in "Feed" costs in Tohoku and Kanto-Tosan regions and "Animal and insemination charges" in Kanto-Tosan region. There was also registered a significant growth in the costs for the "Maintenance and repair of farm building" in Tohoku and Kanto-Tosan regions, the "Agricultural motor vehicles" expenditures in Tohoku and Hokuriko regions, the "Seed and seeding" costs in Tohoku region, and the "Fertilizer" costs in Hokuriko.

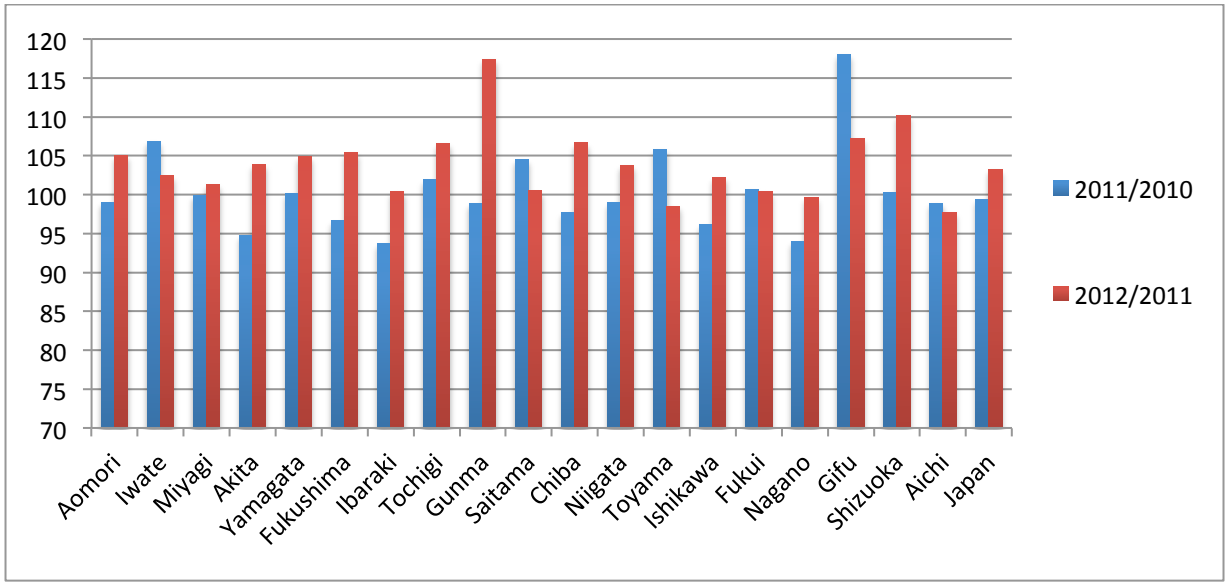
In addition, the "Mutual relief premiums and other contributions" portion in the "Other" expenditures increased a lot in Kanto-Tusan (17.24%) and Tokai (6.9%) on the background of declined figure in other two regions and unchanged national average [MAFF, 2013]. However, the later does not comprise a big share in the overall expenditures of farms households and its dynamic affected little the variations in the total amount.

Consequently, Agricultural implements, Others, and Feed costs retained their dominant shares in the overall agricultural costs of farm households in the affected regions (with exception for Feed costs in Hokuriko region) and nationwide. What is more, in 2011 the relative fractions of the "Agricultural implements" slightly enlarged while that of Others shrinked tiny. Similarly, there was further expansion of the portion of the Feed costs in Tohoku and Kanto-Tosan regions, and Rental charges in Tohoku, Hokuriko and Kanto-Tosan, along with the same trends nationwide.

Unlike countrywide development, in most affected (but Tokai) regions there was increased share of the costs for the Maintenance and repair of farm building, the Agricultural motor vehicles costs in Tohoku and Hokuriko regions, and the Seed and seeding costs in Tohoku region. At the same time, the relative importance of all other items of the agricultural expenditures declined.

Rice production costs data indicate a downsizing trend in the pre-disater period [MAFF, 2013]. In 2011 production year there was a further decrease in the production costs in the most affected regions along with the same nationwide evolution (Figure 94). Nevertheless, some of the most affected by the disasters prefectures (like Iwate) registered a considerable annual growth in the production costs.

**Figure 94. Dynamics of production cost for 10 are* paddy field rice in most affected prefectures**




Source: Statistical yearbook of MAFF *1 a = 100 $m^2$

What is more, there was a significant augmentation of certain costs items in most affected prefectures. For instance, there was much higher than the national rise in the "Building repairing costs" in Aomori (31.46%) and Miyagi (65.84%) prefectures; a substantial increase in the "Machinery repairing costs" in Iwate (30.03%) and Yamagata (16.37%) prefectures unlike the diminuation trend nationwide, etc. The later is likely a consequence of the higher costs associated with the post disaster recovery and reconstruction in respected regions.

In 2012 production year there was a reverse dynamics in the production costs level in the majority of prefectures and countrywide. Moreover, the production costs expansion in some of the most affected prefectures like Aomori, Fukushima, Yamagata, Chiba etc. was higher that the national average.

Furthermore, in most affected by the disasters prefectures there was significantly faster that the national augmentation of costs for "Building repairing" (Fukushima – 143.27%, Chiba 111.85%, Yamagata 107.32%, Aomori - 40.12%, etc.) and "Machinery repairing" (Iwate 39.72%, Miyagi, 23.15%, etc.) [MAFF, 2013].

Summarized nationwide production costs data[94] for major annual upland crops demonstrate continuing downsizing trends for wheat, barley, rape seeds, and buckwheat, 2011 increase and followed reduction for soybean and sugar cane, and 2012 augmentation for

[94] there are no data for the evolution of production costs for individual prefectures and regions.

potatoes and sweet potato use [MAFF, 2013]. All that means that 2011 disasters had no significant impact on the production costs dynamics for most upland crops in Japan. However, there are no indications that the same trends have been applicable in the most affected regions as well.

Likewise, the national production costs data for livestock for the last several years suggest continuing upwards trends for Japanese veal calf, Raising dairy male and hybridize type cattle, and row milk, and 2011 augmentation from the lowest for the period 2010 level for Fattening castrated young, dairy male and hybridize type cattle [MAFF, 2013]. The increasing "Feeds costs" has been mostly responsible for these tendencies. Nevertheless, we can only guess on what extend that development has been affected by the 2011 disasters, and what the regional specificities are.

A MAFF survey on effects of the nuclear plant accident found out that more than 41% of the farmers and 52% of the food industries in Fukushima prefecture report "extra costs emerged for radiation tests and various certificates as requested by trading partners" while these figures are much higher than in other regions of the country.

The 2011 disasters have had a considerable effect on farm households' finance in the most affected regions. For instance, there was a bigger than the national (2.33%) rise in the Deposits and Accounts Receivable of the farm households in Tohoku (2.57%) and Tokai (17.14%) regions (MAFF, 2013). On the other hand, there was a considerable reduction of that amount in Kanto-Tosan (5.84%) and Hokuriko (3.96%) regions.

In the pre-disater year the Deposits and Accounts Receivable of the farm households in Tohoku and Hokuriko regions were much smaller than the national average (with 45.14% and 8.92% accordingly) while in in Kanto-Tosan and Tokai much above that level (28.45% and 21.37%). Therefore, 2011 events positively affected that part of farmers finance in Tokai and Tohoku regions, and relatively deteriorated it in the other two regions.

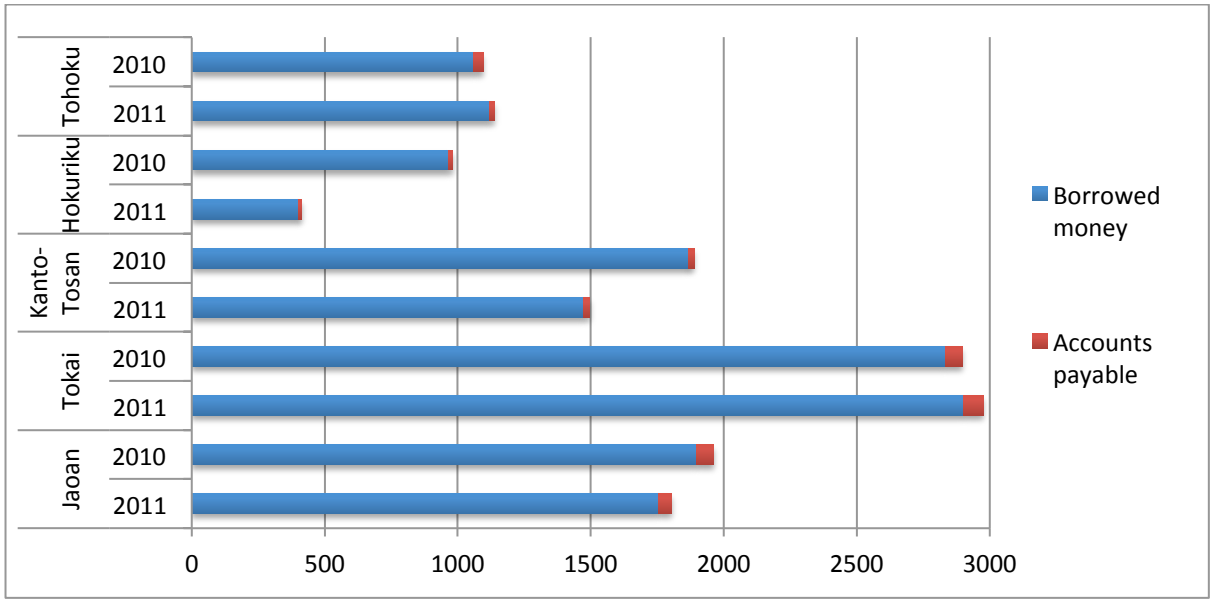
Furthermore, in the pre-disater period there was a tendency for decreasing of the overall amount of borrowed and owned money by the farm households in Japan [MAFF, 2013]. In 2011 there was a further reduction of the average volume of debt of farm households nationwide (Figure 95).

At the same time, in the most disaster affected Tohoku region there was a considerable (5.56%) increase in the Borrowed Money by the farming households. Simultaneously, the amount of money owned to suppliers (Accounts Payable), which usually is a small portion of the overall depth of Japanese farmers, declined by a half. Consequently, there was a good progression in the total debt of farm households. The later dynamic of the borrowed and owned money was a likely consequence of the adverse impact of the disasters on farm households finance.

Similarly, in Tokai region there was some augmentation of the Borrowed Money and a sizable increase in the Accounts Payable of the farm households, while in other affected regions it was registered higher than the national diminuation of the farms depths.

In the pre-disater year the amounts of farm households' debt in Tohoku and Hokuriko regions were only a fraction of the national average (smaller with 44.22% and 49.97% accordingly) while in Tokai region it was among the country's highest [MAFF, 2011].

**Figure 95. Dynamics of farm households Debts in affected regions, end of the year (Thousands yen)**




Source: Statistical yearbook of MAFF

Interest rates have been traditional low in Japan but the increasing amount of borrowed and owned to others money in 2011 put additional burden for many farm households in times of hardship.

Japanese farms finance their activities and investment through a variety of public, cooperative and private sources. The Japan Finance Corporation is a major policy-based financing institution[95], which supports reconstruction after the Great East Japan Earthquake. In 2011 it approved 11,076 cases of agricultural loans worth of 214,533 million yen [MAFF, 2013]. There are no data for the relative importance to farmers of this funding and public support source. Nevertheless, available data gives some idea about the significance of different type of loans through this specific financing institution.

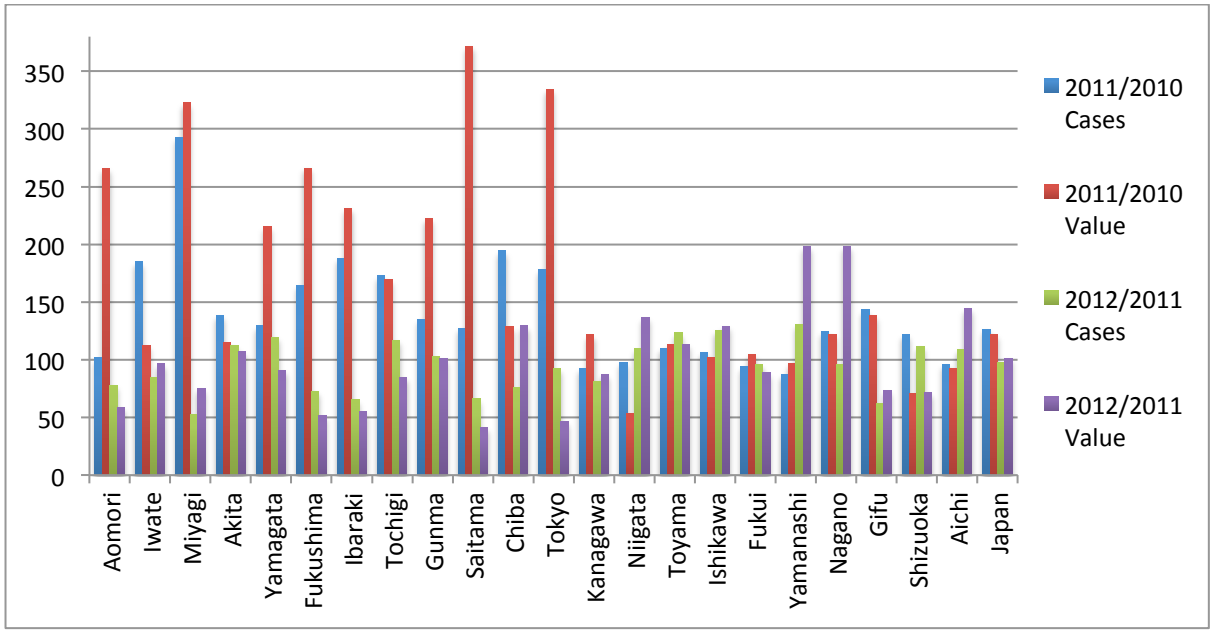
In the pre-disater period there was a trend for decreasing the overall cases of agricultural loans provided by the Japan Finance Corporation while approved 2010 value was the lowest for the past several years [MAFF, 2012].

In 2011 there was a big increase in the approved cases and the values of the agricultural loans nationwide (Figure 96). What is more, in Tohoku region there was much higher than the national rate of multiplication of the loan cases and the approved loans (78.1% and 97.3% accordingly). In the badly hit Miyagi prefectures the loans cases and volumes tripled comparing to the previous year. Similarly there was significant growth in the cases and volume in Fukushima and Yamagata prefectures, and of the loans value in Aomori prefecture.

Consequently, the Tohoku prefecture expended significantly its share in the country's loan cases (from 14.30% in 2010 to 20.12% in 2011) and values (from 10.48% to 16.94%) [MAFF, 2012].

[95] utilizing a variety of financing programs and schemes to meet social needs while complementing the activities of private financial organizations.

**Figure 96. Dynamics of cases and values of loans to agriculture business units approved by Japan Finance Corporation (percent)**




Source: Statistical yearbook of MAFF

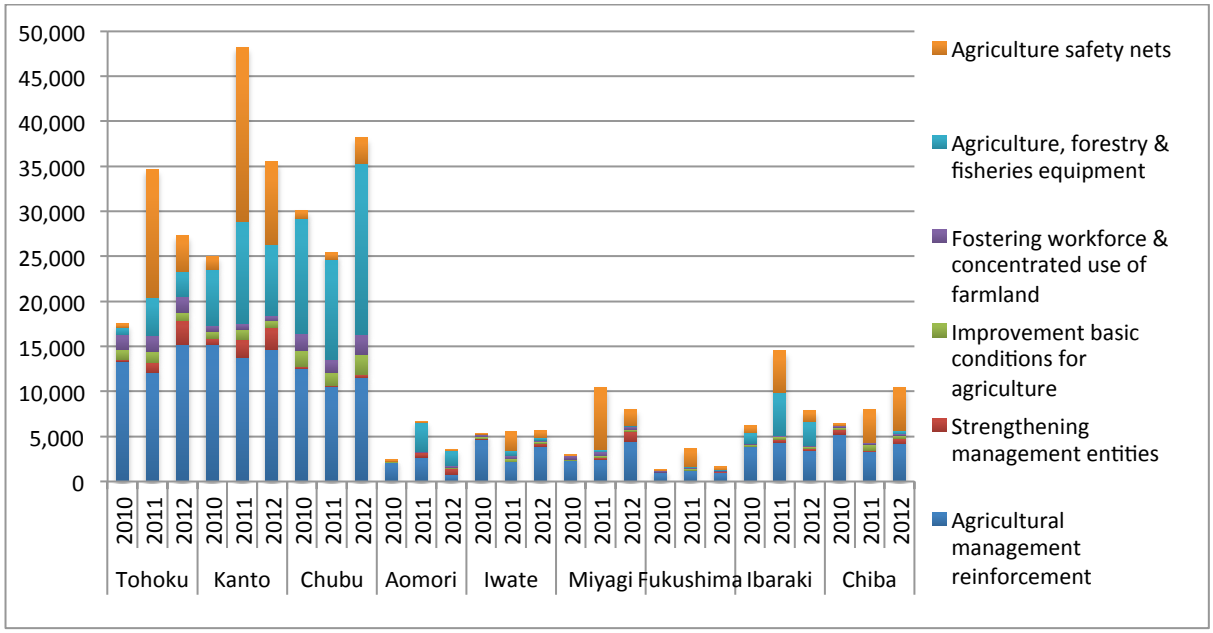
Likewise, there was a great augmentation of the loan cases and values in Kanto region (69.41% and 95.19% accordingly) and its most badly affected prefectures (Ibaraki, Tochigi, etc.). Subsequently, region's portion in the national loan cases and values considerably augmented - from 11.55% to 15.45%, and from 14.77% to 23.62% accordingly [MAFF, 2012].

On the other hand, in the less affected by the earthquake Chubu region a lower than the national dynamics of the loan cases and value was registered - 7.01% increase and 7.44% reduction accordingly. As a result, the region's fraction in the overall loan cases dropped from 16.46% to 13.91% and in the loan values from 17.64% to 13.38% [MAFF, 2012].

Furthermore, there was a substantial change in the structure of approved agricultural loans comparing to the pre-disater year. In 2011 the "Agricultural management reinforcement" loans retained, but diminished considerably, their major share in the overall amount nationwide – the portion of loans numbers declined from 54.94 % to 42.26 %, and that of the loans value from 61.70 % to 45.85% [MAFF, 2012]. At the same time, the "Agriculture safety nets" stake expended enormously – from 9.51% to 19.28% in terms of loan cases, and from 5.3% to 18.02% in terms of loans value. All other type of agricultural loans diminished their importance in terms of cases and values.

On the other hand, in Tohoku and Kanto regions, and in the most affected by the disasters prefectures, but Aomori, the "Agriculture safety nets" loans become dominant in terms of cases and value (Figure 97). Simultaneously, in Aomori prefecture a tiny share of the loan cases for Agriculture, Forestry and Fisheries Equipment (0.83%) become the major loans value users (45.18%). In Chubu region the later type of relatively small number of loans retained its bulk share in terms of value.

**Figure 97. Values of loans to agriculture business units approved by Japan Finance Corporation during 2010-2012 in most affected regions (million yen)**




Source: Statistical yearbook of MAFF

In 2012 there was a slight reduction in cases and a small augmentation of the values of the agricultural loans nationwide. Nevertheless, the numbers and amounts of the loans in Tohoku and Kanto regions considerably declined – accordingly by 24.66% and 18.45% in terms of cases, and by 21.54% and 23.76% in terms of value [MAFF, 2013]. Consequently, the relative share of the two regions in the national loan numbers diminished to 15.74% and 12.91% accordingly, and in loans values to 13.12% and 17.8%.

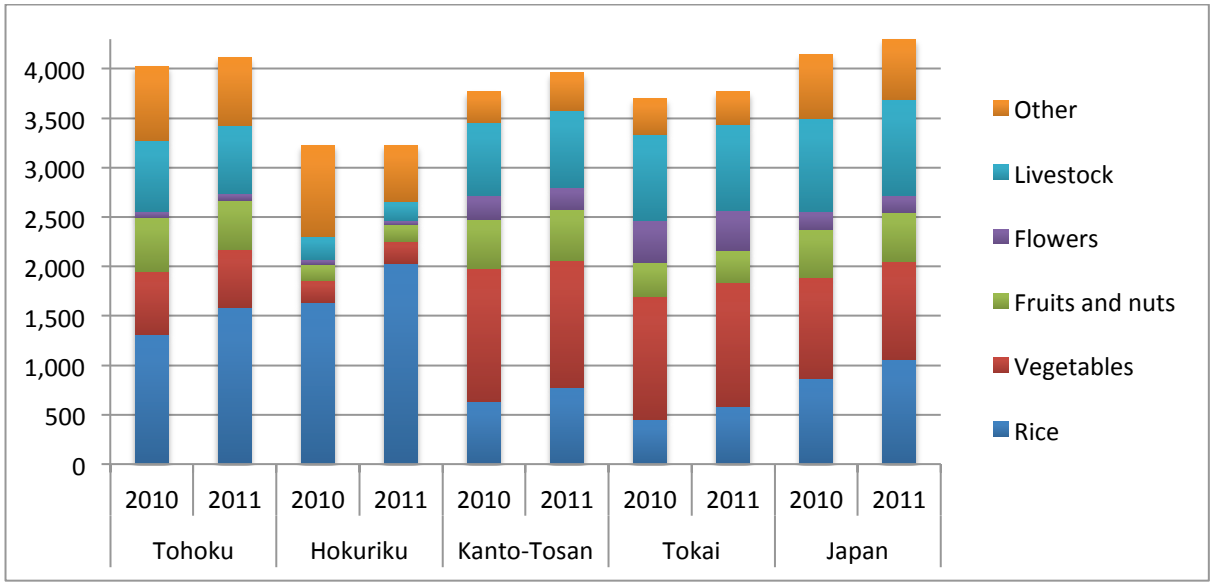
At the same time the loans cases and amounts increased a lot in Chubu region (by 7.2% and 44.76%) as the region enlarged its portion in the national one to 15.27% and 19.12% accordingly [MAFF, 2013].

In 2011 there was some annual growth in the Gross Agricultural Income of farm households in all affected regions but Hokuriku. What is more, in Tohoku and Tokai regions the expansion was slower than the country's average, and much higher in Kanto-Tosan region.

The Gross Agricultural Income of farm households from the "Crops" augmented more than the overall in Tohoku, Tokai, and nationwide, while in Kanto-Tusan the growth of the "Livestock" contribution was higher that the composite one (Figure 98). Consequently, the crop shares in the Gross Agricultural Income increased further everywhere. At the same time, there was slight rise in the fraction of the "Livestock and livestock products" in Kanto-Tosan region and countrywide at the expense of the "Others".

In all regions there was a huge increase in the "Rice" Gross Agricultural Income of farm households (20.87% in Tohoku, 22.68% in Kanto-Tosan, 23.9% in Hokuriko, and 30.22 in Tokai) being lower than the national (22.52%) in Tohoku region.

**Figure 98. Dynamics of farm households Agricultural Gross Income in affected regions (Thousands yen)**




Source: Statistical yearbook of MAFF

Simultaneously, there was a considerable (and higher than the national 3.33%) decline in the "Vegetables" in Tohoku (8.52%) and Kanto-Tusan (4.39%) regions with a good growth registered in Hokuriko (3.23%) region. Similarly, there was a great reduction in the "Fruits and nuts" in Tohoku (8.03%) and Tokai (6.09%) regions with positive growth nationwide (1.14%) and lesser one in the other regions. Furthermore, there was huge fall in the contribution of the "Livestock and its products" in Hokuriko (14.83%), Tohoku (6.12%) and lesser in Tokai (1.15%), on the background of the good growth in Kanto-Tosan (5.55%) and country's average (2.87%).

Tohoku region also registered a high growth in the "Flowers" (10.17%) at the time of the overall decline in their contribution in the other regions and country as a whole.

Meanwhile, farm households in all regions but Kanto-Tosan reported downsizing of "Others", including the "Mutual relief indemnity". Nevertheless, in 2011 the later still composed a good segment in the Gross Agricultural Income of all regions being higher than the (10.65%) national in Tohoku (12.69%) and Hokuiko (11.41%), and lower in Kanto-Tosan (7.69%) and Tokai (6.01%).

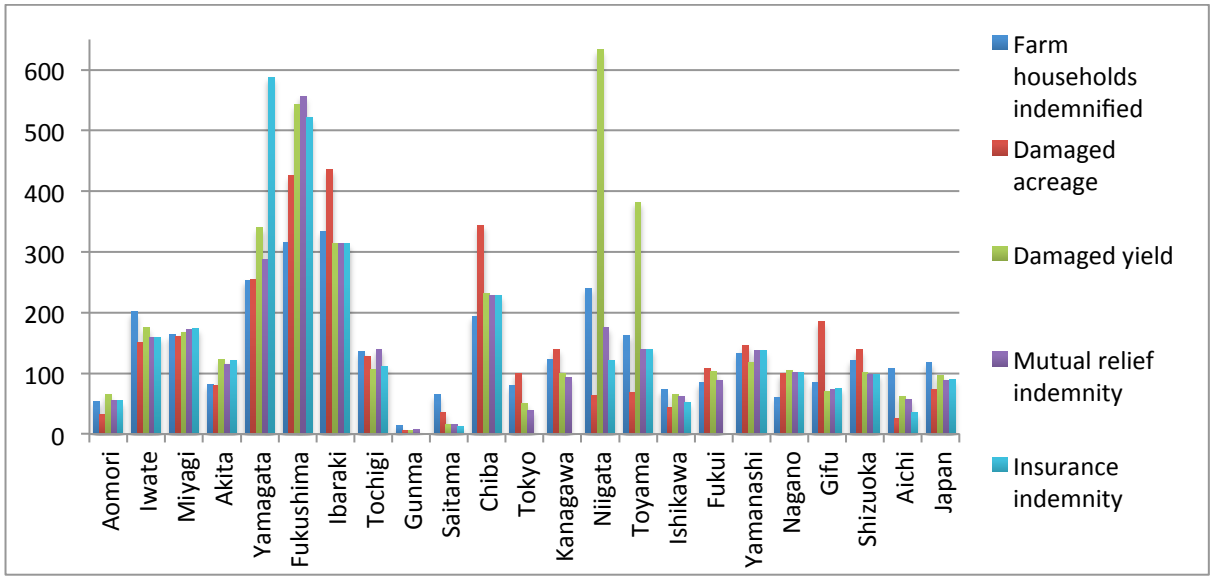
In the pre-disater period there was a decrease in the national figures for the farm households indemnified for paddy field rice, damaged acreages and yields, and the mutual relief, insurance and reinsurance indemnities paid [MAFF, 2012]. The later followed the tendencies for reduction of insured farm households[96], and the mutual relief, insurance and reinsurance premiums, and the "stable" amounts of covered acreages and yields.

In 2011 a good progression of the total number of farm households indemnified in the country was registered and they reached 63,750 or 3.86% of all insured farm households (Figure 99). At the same time, further reductions in damaged acreages and yields, and mutual relief, insurance and reinsurance indemnities were reported as they dropped to 25,637ha (or

[96] In Japan practically all market-oriented farms are insured for paddy filed rice.

1.74% of the insured paddy fields), 21,745t (0.4% of the insured crops), 4,045.85 million yen (16.72% of the mutual relief premiums), and 1,285.129 million yen (7.21% of the insurance premiums), and 93.112 million yen (0.62% of the reinsurance premiums) [MAFF, 2013].

**Figure 99. Dynamics of mutual relief and insurance of farm households for paddy field rice in affected regions in 2011 (2010=100)**




Source: Statistical yearbook of MAFF

At the same time, in Tohoku region there was a huge increase as the number of indemnified for rice farm households increase by 74.33%, the amount of damaged areas and yields by 58.41% and 93.86%, and the mutual relief and insurance indemnity by 99.28% and 154.29% (MAFF, 2013). The biggest rise in these figures was reported in the most affected Fukushima, Yamagata, Iwate and Miyagi prefectures.

Consequently, the Tohoku's share in the country's indemnified farms augmented from 6.02% to 8.94%, in damaged acreages from 11.3% to 24.38%, in damaged yields from 6.07% to 12.19%, in mutual relief indemnity from 6.85% to 15.39%, insurance indemnity from 4.91% to 14.01%, and reinsurance indemnity[97] from 0.24% to 40.79% [MAFF, 2013].

In Kanto region there was overall reductions of farms households indemnified (by 36.87%), damaged areas (by 67.42%) and yields (by 60.36%), and mutual relief indemnity (by 59.03%), and a small increase in the insurance indemnity (1.02%). However, in the most severely hit by the disasters Ibaraki, Tochigi and Chiba prefectures a considerable rise in all these figures was registered.

Consequently, the region's portion in the country's overall number shrinked enormously – from 15.81% to 8.63% for indemnified farms, from 18.17% to 8.06% for damaged rice paddies, from 16.94% to 6.95% for damaged rice yields, from 14.14% to 6.53% for mutual relief indemnity, from 3.99% to 4.53% for insurance indemnity, and 53.27% to 0.37% for reinsurance indemnity [MAFF, 2013].

[97] Reinsurance indemnities were applied only in Akita (2010) and Yamagata (2011) prefectures.

In Chubu region there was a good increase in the number of indemnified farms (38.24%), damaged yields (179.76%), and paid mutual relief (44.05%) and insurance (14.25%) indemnities. The biggest rise was registered in Nigata, Toyama, Yamashi, and Shizuoka prefectures.

Subsequently, the region's share in the country's indemnified farms further increased from 12.97% to 15.25%, in damaged yields from 10.62% to 30.76%, in mutual relief indemnity from 15.53% to 25.21%, and in insurance indemnity from 23.09% to 29.62%, while slightly decreased for damaged acreages (from 20% to 18.81%) and plummeted for reinsurance indemnity (from 43.54% to 0.01%) [MAFF, 2013].

The Japanese farms have been well supported by the government through various subsidy schemes. In FY 2011 there were 1,150,159 payments to Agricultural Management Units under "Individual Income Support Allowance System for Farmers" amounting to 5,366 million yen (MAFF, 2013).

The average amount of support per payment was 466,544 yen [MAFF, 2013]. The highest amount per payment was for "Income support allowance subsidy for upland field crops" averaging 2,114,998 yen, followed by the "Additional subsidy" (428,878 yen), the "Income support allowance subsidy for utilizing paddy fields" (410,938 yen), and the "Income support allowance subsidy for rice (fixed amount)" (152,081 yen).

The greatest majority of the recipients of public subsidies were Individuals (Table 25), and the rest Juridical Persons (0.66%) and Rural Communities (0.66%). A great portion of the commercial farms households was covered by this support system as the number of payments to Individuals accounts for 75.47% of the number of Farm households.

Tohoku, Kanto, and Chubu farms got accordingly 19.82%. 9.65% and 20.34% of the overall national payments under that scheme (MAFF, 2013). In 2011-2012 as many as 227,920 Tohoku farms, 110,951 Kanto farms, and 233,941 Chubu farms were supported by the scheme.

The majority of supported farms in the affected regions received "Subsidy for rice (fixed amount)" and a considerable portion of them "Subsidy for utilizing paddy fields" (Table 19). Furthermore, a small part of the farms also got "Subsidy for upland field crops" and "Additional subsidy".

The biggest part of the public payments in Tohoku and Kanto regions was for "Utilizing paddy fields" followed by the "Subsidy for rice" and "Upland field crops". The later took relatively a higher share in Ibaraki region at the expense of lower portion of rice subsidy.

On the other hand, in Chubu region the support for rice dominated, followed by the subsidies for utilizing paddy fields and for upland field crops. In all affected regions the "Additional subsidies" were a tiny fractions of the overall amount similar to countrywide trend.

The shares of the subsidies for utilizing paddy fields and for the rice in the total for all affected regions were higher than the national, while for upland field crops lower than the country's average.

**Table 19. Share in total numbers and amounts of payments under Individual Income Support Allowance System for Farmers, April 30, 2012 (percent)**

| Regions | In total number of payments | | | | | In total amount of subsidies | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Indivi-duals | Subsidy for rice (fixed amount) | Subsidy utilizing paddy fields | Subsidy upland field crops | Addi-tional subsidy | Rice fixed amount | Utilizing paddy fields | Upland field crops | Addi-tional |
| **Tohoku** | **98.57** | **89.29** | **50.86** | **8.15** | **0.79** | **41.77** | **47.04** | **10.44** | **0.65** |
| Aomori | 99.07 | 84.29 | 52.61 | 6.78 | 0.52 | 32.50 | 56.88 | 10.00 | 0.63 |
| Iwate | 98.60 | 85.51 | 55.17 | 3.21 | 0.59 | 36.67 | 52.22 | 10.00 | 1.11 |
| Miyagi | 97.90 | 94.06 | 27.52 | 2.73 | 0.72 | 38.16 | 46.05 | 14.91 | 0.44 |
| Akita | 98.27 | 92.41 | 63.36 | 9.95 | 1.02 | 46.02 | 45.13 | 8.41 | 0.44 |
| Yamagata | 98.44 | 87.03 | 65.01 | 17.32 | 1.26 | 46.11 | 43.33 | 10.00 | 0.56 |
| Fukushima | 99.40 | 91.15 | 43.03 | 11.41 | 0.63 | 55.56 | 36.11 | 7.41 | 0.93 |
| **Kanto** | **99.15** | **90.28** | **46.74** | **6.49** | **0.74** | **30.41** | **48.16** | **20.82** | **0.20** |
| Ibaraki | 99.27 | 88.71 | 45.28 | 5.70 | 0.34 | 31.39 | 43.80 | 24.82 | 0.00 |
| Tochigi | 99.24 | 92.59 | 52.13 | 9.00 | 1.18 | 32.50 | 53.00 | 14.00 | 0.50 |
| Gunma | 98.63 | 85.65 | 44.95 | 6.06 | 0.98 | 17.74 | 45.16 | 35.48 | 0.00 |
| Saitama | 98.95 | 91.25 | 42.57 | 6.52 | 0.49 | 25.00 | 46.15 | 28.85 | 0.00 |
| Chiba | 99.08 | 90.81 | 45.49 | 1.27 | 0.67 | 43.24 | 48.65 | 8.11 | 0.00 |
| Tokyo | 100.00 | 98.84 | 1.16 | 2.31 | 0.00 | 0 | 0 | 0 | 0 |
| Kanagawa | 99.48 | 96.77 | 17.87 | 3.14 | 0.05 | 50.00 | 0.00 | 0.00 | 0.00 |
| **Chubu** | **98.50** | **92.67** | **38.84** | **5.79** | **0.84** | **43.57** | **40.08** | **15.55** | **1.07** |
| Niigata | 98.49 | 97.99 | 45.16 | 5.35 | 1.03 | 55.27 | 36.71 | 7.17 | 0.84 |
| Toyama | 96.87 | 97.17 | 45.93 | 5.07 | 0.69 | 42.74 | 41.03 | 15.38 | 0.85 |
| Ishikawa | 98.25 | 98.32 | 19.58 | 3.61 | 0.84 | 57.63 | 30.51 | 11.86 | 1.69 |
| Fukui | 97.50 | 97.78 | 29.54 | 7.94 | 0.71 | 41.98 | 37.04 | 19.75 | 1.23 |
| Yamanashi | 99.47 | 88.83 | 24.55 | 6.95 | 0.10 | 50.00 | 50.00 | 25.00 | 0.00 |
| Nagano | 99.04 | 84.46 | 41.36 | 11.00 | 0.66 | 35.53 | 36.84 | 26.32 | 1.32 |
| Gifu | 99.05 | 86.70 | 41.70 | 1.08 | 0.50 | 31.43 | 50.00 | 17.14 | 1.43 |
| Shizuoka | 98.84 | 86.19 | 34.82 | 3.78 | 1.64 | 42.11 | 52.63 | 10.53 | 0.00 |
| Aichi | 99.38 | 90.49 | 33.67 | 6.13 | 1.69 | 20.48 | 49.40 | 27.71 | 1.20 |
| **Japan** | **98.68** | **87.64** | **46.93** | **6.49** | **0.73** | **28.57** | **41.33** | **29.41** | **0.67** |

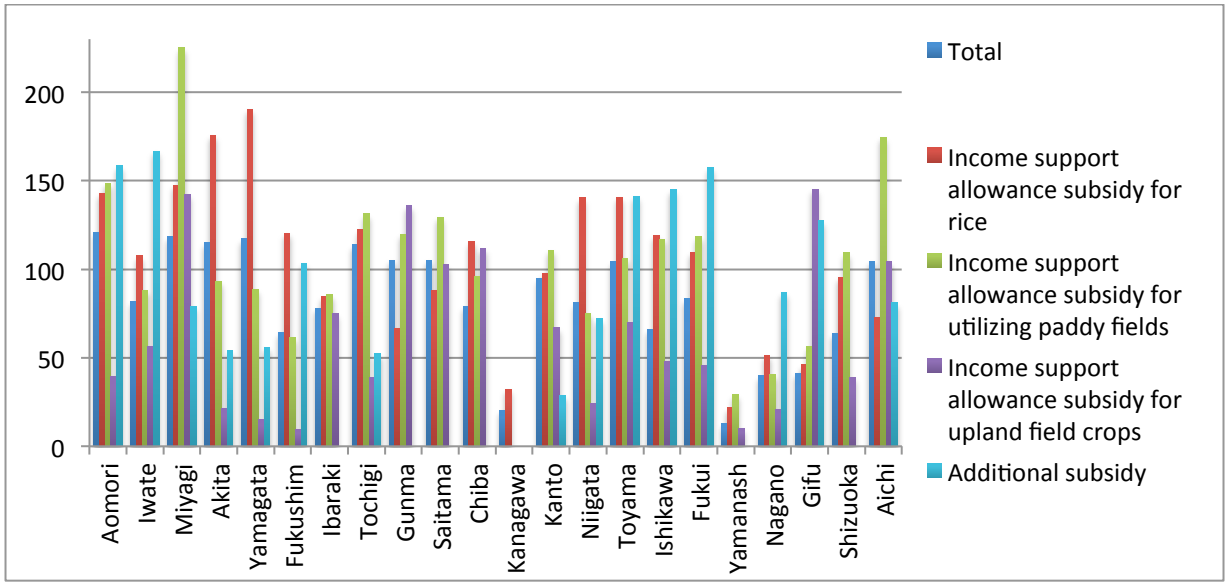
Source: Statistical yearbook of MAFF

Furthermore, for Tohoku farms the level of overall public support under that scheme was a little big higher (1.75%) than the national, being a considerable above the country average for all but Iwate and Fukushima farms (Figure 100). What is more, all farms in the region received significantly more Income support allowance subsidy for rice, and Miyagi farms more Income support allowance subsidy for utilizing paddy fields and for upland field crops, and Aomori farms more Income support allowance subsidy for utilizing paddy fields, and Aomori, Iwate and Fukushima farms more additional subsidies, than in the other parts of the country.

On the other hand the overall support to Kanto and Chubu farms was much lower than the country's average. Nevertheless, the level of certain support measures in some prefectures were much higher that the national.

In FY 2012 there was a decrease in the number of payments under Individual Income Support Allowance System for Farmers in the country (2.76%) and increase in the amount of support (4.42%) [MAFF, 2013].

**Figure 100. Amount of support per farm of different type of payments in FY2011 (Japan=100)**




Source: Statistical yearbook of MAFF

In Tohoku region there was less than the national reduction in number of payments (1.22%) and a slight augmentation in the badly affected Fukushima (3.58%) and Miyagi (1.09%) prefectures. At the same time, there was a less that the country's average increase in the total subsidies in the region as a whole (0.83%) and in most prefectures (Iwate and Yamagata – 2.22%, Miyagi 2.63%, Fukushima – 2.78%), with a decline in Aomori (4.37%) and Akita (0.78%) prefectures.

In Kanto and Chubu regions there was registered a reduction in number of payments (2.5% and 4.34% accordingly) and increase in the total amount of support (3.88% and 5.76% accordingly).

In 2012 the amount of subsidies per payments increased less that the country's average of 7.38% in Tohoku and Kanto regions (1.97% and 6.54% accordingly) and faster in Chubu (10.56) region (MAFF, 2013). Consequently, the amount per a payment in all affected regions was bellow that the country's average level – with 3.37% in Tohoku, 6.08% in Kanto, and 29.62% Chubu region [MAFF, 2013].

While the overall subsidies per payment was still higher that the national in Aomori (10.15%), Miyagi (12.01%), Akita (10.05%), and Yamagata (16.23%) prefectures, it was significantly lower in the badly hit Iwate (20.56%) and Fukushima (39.59%) prefectures. Nevertheless, the specific payments for Income support allowance subsidy for rice was considerably higher that the national average in all prefectures (with 45.1% in Tohoku region as a whole) as well as for Income support allowance subsidy for utilizing paddy fields in Aomori and Miyagi, and for Income support allowance subsidy for upland field crops in Miyagi, and for Additional subsidy in Aomori, Iwate and Akita prefectures.

Furthermore, there has been a huge budget of the Ministry of Agriculture, Forestry and Fisheries for direct and indirect support of diverse aspects of agrarian and rural development (Table 20). Particularly, there has been increasing amount of the public works expenditures

for “Improvement of agriculture and agricultural village”, constant spending on “Disater restoration”, and fluctuating “Subsidies for development of rural areas” (Figure 101).

**Table 20. MAFF accounts for agrarian and rural development (million yen)**

| Budget items | 2011 | 2012 | 2013 |
|---|---|---|---|
| Securing food safety and consumer trust | 12,272 | 10,882 | 9,961 |
| Strengthening cooperation between food and agriculture for domestic agricultural and livestock products | 134,510 | 82,880 | 61,645 |
| Strengthening cooperation between food and agriculture for domestic agricultural and livestock products, by customs duty on beef etc. | 65,966 | 64,247 | 60,035 |
| Strengthening agricultural and food industries | 3,127 | 2,093 | 24,422 |
| Establishment of food security | 8,349 | 12,922 | 11,922 |
| Farm management | 670,617 | 705,896 | 670,175 |
| Securing and efficient use of superior farmland | 17,863 | 22,377 | 20,326 |
| Promotion of maintenance of agricultural production infrastructure | 2,432 | 28,643 | 17,967 |
| Maintenance and development of agricultural production infrastructure | 62,479 | 63,754 | 60,710 |
| Support for environmentally-sound agricultural production | 4,024 | 3,403 | 3,119 |
| Collaboration of primary, secondary, and tertiary industrialization of rural areas | 13,236 | 10,962 | 10,193 |
| Securing against expansion of consumption for national agriculture, forestry, fisheries | na | na | 3,984 |
| Exchange between cities and rural areas | 1,749 | 1,449 | 2,546 |
| Conservation of rural area resources and others | 49,296 | 50,763 | 56,857 |
| Countermeasure against tidal damage | 2,936 | 2,866 | 2,917 |
| Preservation of farmland | 14,465 | 15,072 | 36,670 |
| Development of infrastructure for facilitating individual income support allowance | 17,870 | 18,290 | 2,092 |
| Maintenance of strengthening agricultural conflict | na | na | 36,507 |
| Revitalization of rural areas | 29,640 | 13,575 | 15,733 |
| Development of rural areas | 25,669 | 8,570 | 91,357 |
| Global environment of agriculture, forestry and fisheries industry | 95 | 114 | 129 |
| For storm damages | 90 | 63 | 57 |
| Contract construction costs such as implementation costs | 1,553 | 1,197 | 3,564 |
| Coastal project surveys | 4 | 4 | 4 |
| Surveys on maintenance and development of agricultural production infrastructure | 1,146 | 1,146 | 1,145 |
| Damaged agricultural facilities restoration works | 7,932 | 7,990 | 7,977 |
| Works associated with disaster against agricultural facilities | 228 | 170 | 183 |
| Transfers to special accounts | 253,051 | 219,928 | 210,051 |

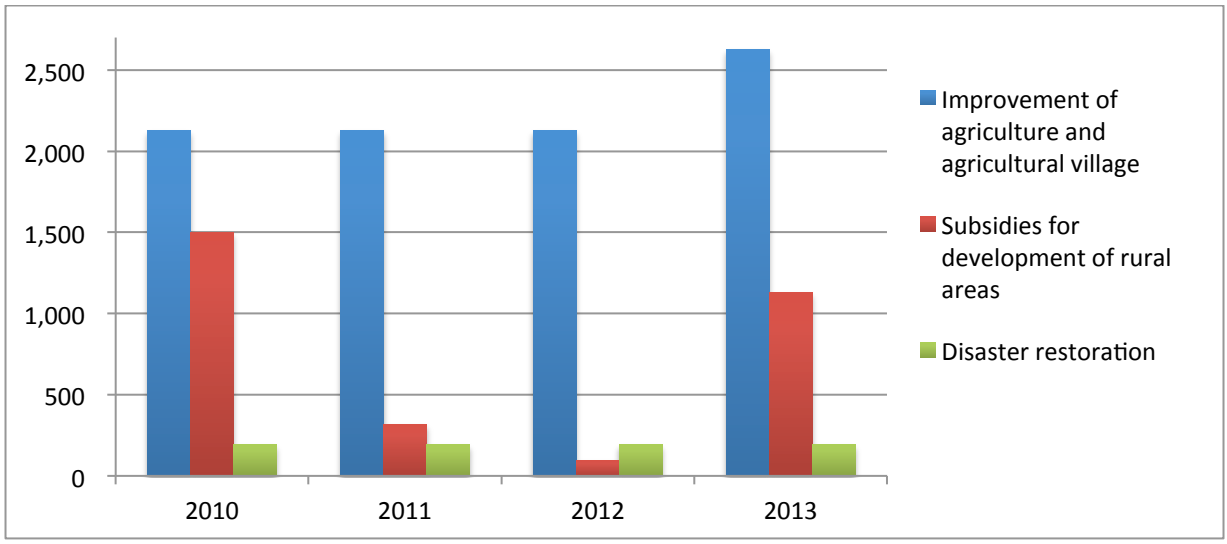
Source: Statistical yearbook of MAFF

As a result of all these development, there was higher than the national (2.15%) augmentation of the Cash Income from Agriculture per farms households in Kanto-Tosan region (3.3%), lesser rise in Tohoku (1.09%) and Tokai (0.63%) regions, and a (1.19%) reduction in Hokuriko region.

Comparing to the pre-disater period in 2011 there was certain growth in the Gross Agricultural Income of farm households in the most affected regions. However, that was accompanied by a higher rise in the farm households Agricultural Expenditures.

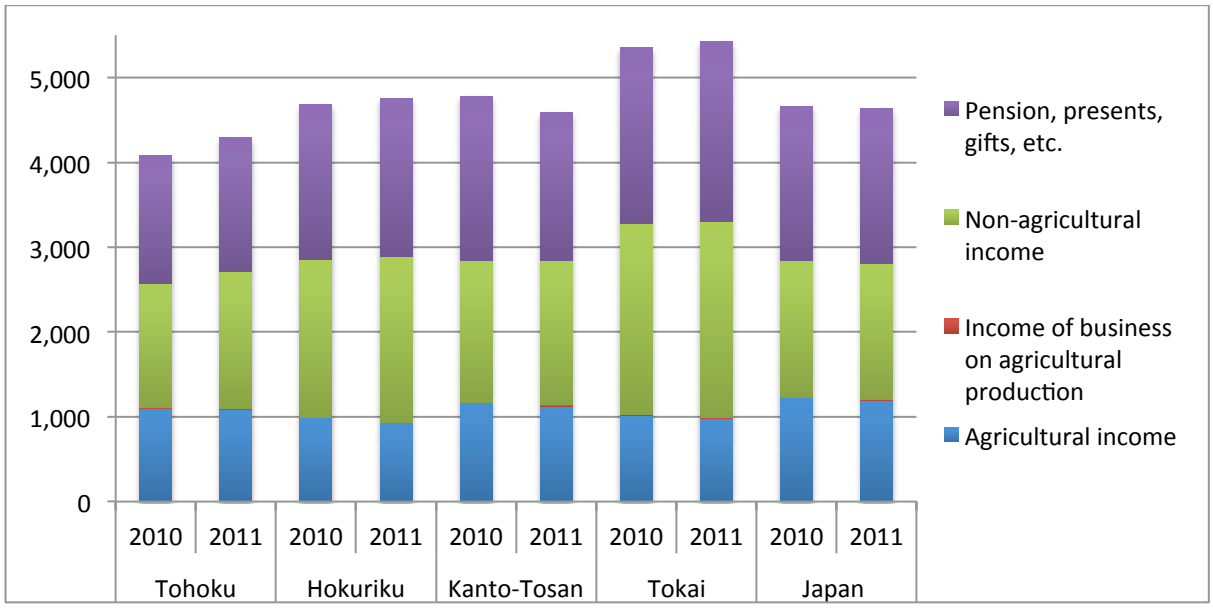
Consequently, the Net Agricultural Income per farm households contracted in all affected regions and nationwide (Figure 102).

**Figure 101. Evolution of public works expenditures related to agriculture (100 million yen)**




Source: Statistical yearbook of MAFF

**Figure 102. Dynamics of farm households income in affected regions (Thousands yen)**




Source: Statistical yearbook of MAFF

In Tohoku region the Agricultural Income of farm households contracted less (0.91%) then the national one (2.21%) while in the other affected regions the reduction was much greater (Hokuriko – 6.17%, Tokai – 3.72%, and Kanto-Tosan 3.45%).

Consequently, in 2011 the relative share of Agricultural Income in the Total Farm Households Income decreased in most regions (from 26.95% to 25.81% in Tohoku region, from 21.12% to 19.51% in Hokuriko, and from 19.08% to 18.11% in Tokai) and nationwide

(from 26.24% to 25.81%). On the other hand, in Kanto-Tosan there was a slight augmentation in the relative importance of that income source - from 24.37% to 24.54%.

The agricultural income has been the third biggest income source of the farm households in all affected regions and nationwide. In Tohoku and Kanto-Toscan regions this source of income comprised a bigger part of the overall households' income, and therefore its variation affected strongly the overall farm households income.

At the same, the Income of Business on Agriculture Production was not affected in Tohoku and Hokuriko regions, and largely increased in the other parts of the country (55.56% in Kanto-Tosan, 25% in Tokai, and 14.29% nationwide). Subsequently, the relative portion of that income source increased slightly in all but Tohoku regions. Nevertheless, this income source has been insignificant part of the overall income of farm households in the affected regions (0.07% in Tokai, 0.1% in Tohoku, 0.15% in Hokuriko, and 0, 19% in Kanto-Tosan) and nationwide (0.15%). Therefore, the variation of the later had no essential effect on the overall households' income.

MAFF survey on effects of nuclear plant accident found out that 3% of surveyed Japanese farmers indicate that "Income declined due to the abandonment of farm products and the relinquishment of manufacturing and production due to foreign countries' import controls and trading partners' refusal to import Japanese products". The later share for farmers in Fukushima prefecture is almost three times higher.

Furthermore, there was an increase in the Non-agricultural Income of farm households in all affected regions. That was a result in the increased Gross Non-agricultural Income in all regions but Tokai, and effective diminuation of Non-agricultural Expenditures everywhere.

The expansion of the Non-agricultural Income was particularly high in Tohoku region (10.06%) and good in other regions (4.94% in Hokuriko, 2.48% in Tokai, and 2.4% in Kanto-Tosan) on the background of the overall reduction in that income source at nationwide scale (0.37%). Subsequently, the comparative importance of this income source increased across the country – from 42.24% to 42.67% in Tokai region, from 39.8% to 41.12% in Hokuriko, from 36.06% to 37.75% in Tohoku, and from 34.87% to 37.21% in Kanto-Tosan, and 34.55% to 34.62% in the country as a whole [MAFF, 2013].

In Tohoku, Hokuriko and Tokai regions the Non-agricultural Income represents the biggest segment of the overall income of farm households while in Kanto-Toscan and nationwide it is the second most important one. Therefore, its variation affected quite significantly the overall income of farm households.

Finally, there was much higher than the national (0.27%) augmentation of the Pension, Presents, Gifts etc. in all affected regions (Tohoku – 4.71%, Tokai – 2.81%, Hokuriko – 2.36%) with exception of Kanto-Toscan, where there was a sizable reduction (10.26%) in that income source. Consequently, the relative segment of that income source slightly increased in Hokuriko (from 38.93% to 39.23%), Tokai (from 38.61% to 39.13%), and nationwide (from 39.06% to 39.39%), and decreased in the other two regions (from 36.89% to 36.75% in Tohoku, and from 40.58% to 37.95% in Kanto-Tosan).

In Kanto-Toscan region that source accounts for the biggest income source for the farm households while in all other regions it is the second biggest one.

As a result of all these developments, the Total Farm Household Income in Tohoku, Hokuriko and Tokai regions increased, which was particularly high (5.12%) for Tohoku

farmers, and modest for other two regions (1.58% in Hokuriko, and 1.44% in Tokai). At the same time, in Kanto-Tosan region there was a considerable (4.04%) and higher than the national (0.58%) reduction of the farm households income.

The Taxes, Imports and Other obligations (except agricultural management) effectively decreased in all affected regions, which was less than the national (3.98%) reduction in Tohoku region (3.27%) and higher in the other regions (Tokai – 7.58%, Kanto-Tosan, 6.13%, and Hokuriko 5.96%). Subsequently, the relative importance of these payments diminished everywhere – from 12% to 11.05% in Tohoku, from 12.17% to 11.27% in Hokuriko, from 16.38% to 16.02%, from 18.73% to 17.06% in Tokai, and from 14.55% to 14.05% nationwide [MAFF, 2013].

Ultimately, the Disponible Income of farm households in all but Kanto-Toscan region augmented being especially high in Tohoku region (6.26%), and modest in Tokai (3.52%) and Hokuriko (2.63%) regions. On the other hand, in Kanto-Toscan region farmers saw their Disponible Income reduced (3.73%) while at nationwide scale it was the same as in the pre-disater year.

What is more, there was augmentation of the share of the Disponible Income in the Total Income of Farm Households in all affected regions (from 88% to 88.95% in Tohoku, from 87.83% to 88.73% in Hokuriko, from 83.62% to 83.98% in Kanto-Tosan, and from 81.27% to 82.94% in Tokai) and nationwide (from 85.45% to 85.95%).

In the pre-disater period farm households in Tohoku region had lower than the national Agricultural, Total and Disposable Incomes (Table 21). On the other hand, farmers in other affected regions had lower than the national Agricultural Income but higher overall and disponible incomes.

**Table 21. Level and structure of farm households income in affected regions (Japan=100)**

| Regions | Agricul-ltural income | Income agricul-tural business* | Non agricul-tural income | Pension, presents, gifts, etc. | Total farm hosehold income | Taxes, imports, obli-gations | Dispo-sabe income |
|---|---|---|---|---|---|---|---|
| **2010** | | | | | | | |
| Tohoku | 89.94 | 57.14 | 88.94 | 82.75 | 87.60 | 72.27 | 90.21 |
| Hokuriku | 80.87 | 100.00 | 104.35 | 100.16 | 100.49 | 84.07 | 103.29 |
| Kanto-Tosan | 95.26 | 128.57 | 111.01 | 106.59 | 102.60 | 115.49 | 100.40 |
| Tokai | 83.48 | 57.14 | 153.11 | 113.52 | 114.83 | 147.79 | 109.22 |
| **2011** | | | | | | | |
| Tohoku | 91.14 | 50.00 | 96.72 | 86.41 | 92.62 | 72.81 | 95.86 |
| Hokuriku | 77.59 | 87.50 | 109.91 | 102.25 | 102.68 | 82.33 | 106.00 |
| Kanto-Tosan | 94.15 | 175.00 | 114.61 | 95.40 | 99.03 | 112.90 | 96.76 |
| Tokai | 82.19 | 62.50 | 148.71 | 116.38 | 117.16 | 142.24 | 113.06 |

* calculate labor cost and material cost
Source: Statistical yearbook of MAFF

After the 2011 disasters, the farm households in Tohoku region diminished the differences with the average nationwide level slightly for the Agricultural, and more visibly for the Total and the Disposable Incomes. At the same time, farm households in other two

regions saw their agricultural income decreased comparing to the average national level. However, while there was a further enlargement of the total households and disposable incomes in Hokuriko and Tokai regions, in Kanto region these levels deteriorated bellow the country's average.

## Conclusion

The unprecedented triple disaster in Northeast Japan in March 2011 was among the worst in the Japanese and world history. The earthquake, tsunami and Fukushima nuclear accident have had immense impacts on diverse aspects of people life in the most affected regions, the rest of the country, and beyond.

The excellent individual and community disaster preparedness, and well-established national system of disaster management, have been a major reason for the adverse impacts to be much lower that it would have been elsewhere in a similar disaster. Furthermore, a superior disaster recovery experience, good organization, and enormous public support from government, other organizations, volunteers, etc. have allowed a rapid recovery and a successful reconstruction of a great part of devastated regions and sectors. For home country of the paper author (Bulgaria) a recovery from such a disaster certainly would have taken decades.

Almost four years after the disaster there are still a number of challenges associated with the recovery and reconstruction in Tohoku region and elsewhere. They are mostly related with a big number of evacuees with destructed life and businesses (temporary accommodation, health problems, lost relations and employment, etc.), continuing outmigration from the badly affected areas, slow pace of rebuilding of devastated infrastructure, housings and businesses, prolong decontamination process in some places, on-going crises in Fukushima nuclear plant, consumer reluctance to visit and buy products of affected regions, etc.

Subsequently, the speed and extent of disaster recovery and post-disaster reconstruction differ quite substantially among individual agents, (sub)sectors, and (sub)regions. Besides, there are great uncertainties associated with the long-term social, health, economic, environmental, policy etc. consequences of the 2011 disasters.

Nevertheless, people in the disaster regions have proved their determination to overcome all challenges and rebuild their lives looking forward to future.

On the eve of the forth anniversary of the 2011 disaster a number of conclusions on the agricultural and food chain impacts could be made.

Agriculture, food industry and food consumption have been among the worst hit by the disasters areas. Agri-food sectors of Fukushima, Miyagi and Iwate prefectures have been particularly severely affected in the short and longer term. There are also significant adverse consequences on other (neighboring) regions and entire food chains at a larger (regional, national, international) scale.

There is a great variation of the specific and combined impacts of the earthquake, tsunami, and nuclear disaster on different type of farming and business enterprises (small-big scale, specialized, diversified, integrated), particular agents (producers, processors, distributors, consumers, community and public organizations), individual sub-sectors (rice, vegetables, beef), and specific locations (evacuation zone, seaside).

Moreover, there have been enormous damages and long-term consequences on farming and rural households, important properties (farmland, livestock, orchards), personal ties, established brands, informal organizations and traditional communities. Many of all these negative effects can hardly be adequately expressed in quantitative (e.g. monetary) terms.

In addition, the 2011 disasters have considerably aggravated some already existing problems of the agrarian and rural regions such as: aging and shrinking population, lack of labor and young entrepreneurs, low competitiveness and efficiency, income and services disparities, etc.

The specific responses to the 2011 disasters have highlighted the comparative advantages of traditional communities and non-governmental organizations, and certain less "efficient" but more resilient structures (such as small operators, partnerships) and sectors (one season crops, poultry, pig, processing). What is more, the disasters have had positive impacts on the development of certain (more resilient, adaptive) sectors in the most affected regions and some (traditional, prospective) sectors in other parts of the country.

The post disaster recovery and reconstruction have also given opportunities and induced considerable policies and institutional modernization in agrarian and other (e.g. energy, security) sectors, and improve disaster prevention and management, food safety information and inspection, technological and product innovation, jobs creation and investment (including in "new" areas such as research and innovation, ICT, renewable energy, robotization), farmlands consolidation and enhancement, infrastructural amelioration, organizational restructuring, etc.

Not least important, the failures of government bureaucrats to foresee, prevent, communicate, and deal with the March 2011 disaster and its consequences have thought individual agents to take decentralized actions – self-recovery and reconstruction, community and business initiatives, private and collective safety checks and decontamination measures, voluntary shipment restrictions, new production and marketing methods, movements for fundamental policies change, etc.

This study was just a first attempt to specify and assess the overall impact of the March 2011 disasters on Japanese agriculture and food chains, and present it to a wider world audience. Understandably the research is incomplete due to the "short" period of time after the disasters, insufficient and controversial data, difficulties to adequately assess longer term implications, etc. Therefore, more future studies are necessary to evaluate and update the "known" agricultural and food impacts of the 2011 disasters. Besides, further in depth "micro" studies are needed to fully understand and estimate the impacts of the disasters in each location and community, type of farms and productions, and component of agri-food chain.

There are a number of major lessons that can be learned from the study of the March 2011 disasters' impact on and post disaster reconstruction of agri-food sector in Japan.

First, the triple March 2011 disaster was a rare but a high impact event, which came as a "surprise" even for a country with frequent natural disasters and well-developed disaster risk management system like Japan. Therefore, it is necessary to "prepare for unexpected", and design, build and test a multi-hazard disaster risk management for the specific conditions of each country, region, sector, etc. Accordingly appropriate measures and sufficient resources (funding, personnel, stock piles, shelter cites, transportation means) have to be planed for the effective prevention, early warning, mitigation, response, and post disaster relief and recovery from big disasters and accidents. Besides state resources it is important to mobilize huge private, community, NGOs, and international capabilities, expertise and means. For instance, a public-private partnership is necessary to properly identify and designate available public

and private resources (accommodations for a longer stay, relief supply, etc.) in case a big disaster occurs and evacuation needs arise.

Second, the risk assessment is to include diverse (health, dislocation, economic, behavioral, ecological, etc.) hazards and complementary, (food, supply, natural, biological) chain, spin offs, and multilateral effects of a likely (natural, man made, combined) disaster. Modern methods and technologies are to be widely employed (mass and social networks, computer simulation, satellite imaging, etc.) for effective communication, preparation of disaster maps, assessment of likely impacts, planning of evacuation routs, relief needs, and recovery measures, secure debris and waste management, etc. It is crucial to involve multidisciplinary and multi-stakeholders teams in all stages of risk management to guarantee a holistic approach, "full" information and transparency, adequate assessment of risks, preferences and capabilities, and maximum efficiency.

Third, the risk management system is to be discussed with all stakeholders, and measures taken to educate and train individuals, organizations and communities for complex disasters and all contingencies. The individual responsibilities are to be well-specified and effective mechanisms for coordination of actions of authorities, organizations, and groups at different levels put in place and tested to ensure efficiency (speed, lack of duplication and gaps) during emergency. Individual and small-scale operators dominate in the agri-food sector of most countries around the world, and their proper information, training, and involvement is critical. The later is to embrace diverse agri-food and rural organizations, consumers, and population of each age group, which all commonly have no disaster management "culture", knowledge, training, and plans (particularly for large disasters like earthquakes, tsunamis, nuclear and industrial accidents).

Forth, it is necessary to modernize the specific and overall formal institutional environment (property rights, regulations, safety standards, norms) according to the needs of contemporary disaster risk management. A particular attention is to be put on updating agri-food safety, labor, health, and animal welfare standards, and ensure adequate mechanisms, qualified agents, and technical instruments for effective implementation and enforcement. Establishment of an accessible cooperative, quasi public or public agricultural (crop, livestock, machineries, building, life and health) insurance system, including assurance against big natural, nuclear etc. disasters is very important for many countries for rapid recovery of affected agents and sectors. Modernization of the out of dated (often informal) lands, material, biological and intellectual property registration and valorization system is also important for effective post disaster compensation, recovery and reconstruction. That is particularly true for the great number of subsistent and "semi-market" holdings dominating the agro-food sector around the globe, which usually suffer significantly from disasters (often losing all possessions) but get no market valuation, insurance and/or public support.

Sixth, it is important to set up mechanisms to improve efficiency of public resource allocation, avoid mismanagement and misuse of resources as well as reduce individual agents' costs for complying with regulations and using public relief, support and dispute resolution (e.g. court) system. That would let efficient allocation of limited social resources according to agents needs and preferences, intensify and speed up transactions, improve enforcement (of rights, laws, standards) and conflict resolution, decrease corruption, and eventually accelerate recovery and reconstruction. In this respect it is obligatory to involve all stakeholders in

decision-making and control, increase transparency etc. at all levels and stages of disaster planning, management, and reconstruction. In the case of a post-disaster evacuation it is essential to secure proper (police, voluntary group) protection of private and public properties from thefts and wild animal invasion in disaster and evacuation zones.

Seventh, different agents and elements of agri-food chain are affected unlikely from a disaster and have dissimilar capability to recover. Most farming assets (multiannual crops, irrigation facilities, building, brands, biodiversity, landscape) are interlinked with the land, and if the later is damaged a rapid recovery (rebuilding, relocation, alternative supply) is very costly or impossible. Similarly, smaller-scale and highly specialized enterprises, small-member communities and organizations, and visitors and tourists to the disaster regions, are all more vulnerable and have less ability to protect, bear consequences and recover. All that require differential public support (intervention, compensation, funding, assistance) to various types of agents it order to provide emergency relief, accelerate recovery and diminish negative long-term consequences.

Eight, there is also a strong "regional" specificity (interdependency) of agrarian, food and other rural assets. Subsequently, if a part of these assets/products is damaged or affected (e.g. destruction of critical transportation, communication, distribution, electricity and water supply etc. infrastructure; a nuclear, chemical, pathogen etc. contamination) the negative externalities impact all agents in the respective region (including undamaged lands, livestock, produce and services). In order to minimize damages it is important to properly identify (locate) risk and take prevention measures, recover rapidly critical infrastructure, strictly enforce quality (safety, authenticity, origin) of products and adequately communicate them to all interested parties (producers, processors, distributors, consumers, international community).

Ninth, good management of information and communication is extremely important in emergency, recovery, and post disaster reconstruction operations. The March 2011 disasters have proven that any delay, a partial release or controversies of official information have hampered the effective (re)actions of agents, and adversely affected public trust and behavior (e.g. buying products from disaster regions). Before, during and after a disaster all available (risk, monitoring, measured, projected) information from all reliable sources is to be immediately publicized in an understandable by everyone form through all possible means (official and community channels, mobile phones, social media, etc.). It is essential always to publish alternative (independent, private, scientific, international) information as well, including in foreign languages, which would build public trust and increase confidence. In Japan it has not been easy to find all available information related to the Match 2011 disasters in a timely and systematized way (updates, diverse aspects, unified measurement, time series, alternative sources), which make many foreigners and local alike skeptical about accuracy.

Tenth, a big disaster like the Match 2011 in Japan often provides an extraordinary opportunity to discuss, introduce and implement fundamental changes in (agricultural, economic, regional, energy, disaster management) policies, improve disaster management and food security, modernize regulation and standards, relocate farms and houses, consolidate lands and operations, upgrade infrastructure, restructure production and farming organizations, introduce technological and business innovation, improve natural environment, etc. All such opportunities are to be effectively used by central and local authorities through

policies, programs, measures, and adequate public support given for all innovative private and collective initiatives in the area.

Eleventh, it is important to learn from the past experiences and make sure that "lessons learned" are not forgotten. The impacts and factors of a disaster, disaster management, and post disaster reconstruction are to be continuously studied, knowledge communicated to public, and "transferred" to next generation. It is critical to share "good" and "bad" experiences with disaster prevention, management and recovery with other regions and countries, in order to prevent that happening again. It is particularly important to share the advance Japanese experience at international scale through media, visits, studies, conferences, etc. and turn Tohoku in a disaster risk management hub for other regions and countries. It is essential not to copy but adapt the positive Japanese experiences to the specific (institutional, cultural, natural) environment and risks structure of each community, subsector, region, and country.

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