【論　文】

The Influence and Damage caused by the Nuclear Disaster on Fukushima's Agriculture

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Abstract

This paper firstly focuses on the critical issue of radioactive contamination. Secondly, we evaluate the effects of the nuclear disaster on the regional economy, agriculture and community in Fukushima Prefecture. Finally, the locality and industrial structure there is deeply considered. To do so, the way how the inspections and distribution of agricultural goods and products should be enacted in radioactive-polluted areas, is examined for the agricultural industry in future.

Keywords : Nuclear Disaster, Fukushima Agriculture, Radioactive Contamination, Damage Compensation

1. Introduction

So far, the overall influence of the nuclear disaster on the local society, economy, and industry of Fukushima Prefecture remains unclear. Unlike the nuclear disaster at Chernobyl, the Fukushima nuclear disaster resulted in an unprecedented international incident because the population density there was larger compared to the contaminated areas in the USSR. In addition, residents there must continue to live and farm as the restoration and recovery are making progress. Therefore, it is difficult to directly apply past issues to this case straightly. Though two years has passed since the nuclear disaster, there are still no prospects for a resolution to the issue of radioactive contamination. Japan has implemented some decontamination projects. however, the accurate radioactive contamination of all agricultural land has not been investigated yet. Without making a contamination map, systematic decontamination cannot be proceeded and a restoration plan cannot be drawn up. Therefore, it is necessary for policy makers there to make a systemized investigation.

This paper examines the influence of the nuclear disaster on the local society, economy, and industry of Fukushima Prefecture and clarifies the correct scope of the damage, particularly for agriculture. In addition, some countermeasures are considered against economic damage caused by rumors, which is an issue with emergency recovery, as well as a framework for clarifying the structure of damages :

Flow : regional products

Stock : regional property

Social capital : infrastructure

As long as such a systematic analysis of the current situation is not performed, it will remain impossible to determine a practical recovery plan. This is precisely the greatest reason for confusion within the contaminated regions.

2. Characteristics of agriculture in Fukushima Prefecture and the issue of radioactive contamination

As illustrated in Figure 1, Fukushima Prefecture is divided largely into three districts : Hamadori, Nakadori, and Aizu. The current nuclear disaster occurred in Futaba-gun, situated in the Hamadori district. The radioactive contamination spreads from the center of Hamadori through the northern area of Nakadori which is called the Kempoku region, and the center of Nakadori called the Kenchu region. According to the map, areas with systematic evacuations and restricted entries have been labeled as A : restricted planting districts. This is the area where efforts have been made to create a horticultural production area recently (the Soma and Futaba greenbelt plan), decided by the Fukushima Prefecture Agricultural Promotion Plan. Therefore long-term employment-type horticultural production companies had been established. Furthermore, the prefecture embarked upon an agricultural land improvement project, the introduction of collective crop conversion, formation of open-air vegetables cultivation areas (e.g. broccoli, tomatoes, and so on), and implementation of community farming area. This last is rare in Fukushima Prefecture paddy field agriculture, which strongly emphasizes individual administration. In other words, because the region received strategic agricultural investments, the influence of the evacuation of citizens and planting restrictions was not limited to loss of the annual harvest. Moreover in Abukumakouchi, high-land where stock breeding has been developed, the dairy farms faced issues of raw milk contamination. In addition, the region has invested money and effort over an

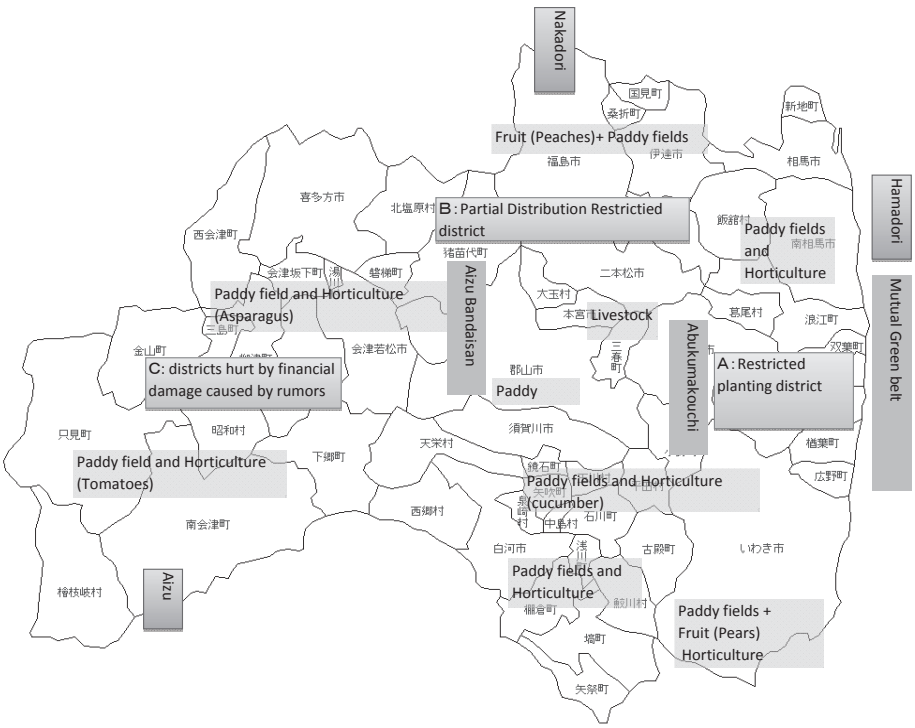

Figure 1 Characteristics of agriculture in Fukushima prefcture and response to radioactive contamination material : prepared by the author

extended period of time in implementing livestock branding such as Date free-range chickens, Kawamata gamefowl, and Iitate beef. As demonstrated by the systematic evacuation of Iitate Village, radioactive contamination does not spread in consecutive circles but rather it depends on the geological features and climatic conditions. These semi-mountainous livestock and agricultural areas have become highly contaminated with radioactivity.

We can confirm the serious fact that radioactive contamination also spread to the northern (Fukushima City, Population of 290,000) and central area (Koriyama City, Population of 340,000) of Nakadori[1]. In these areas, constant measurements indicate an air radiation level of 1.5 μSv/h as of May 2011 (the normal level for Japan being 0.05-0.08). However, hotspots have also been observed ; contamination was scattered in a mosaic pattern. Areas with soil pollution of 1,000-5,000 becquerels/kg are widespread ; some areas have been observed to comprise agricultural land containing 5,000-10,000 Bq/kg, which exceeds planting restriction standards. Many administrative bodies such as prefectural offices, educational institutions, and regional corporate headquarters are intensively located in the Nakadori district. Furthermore, Nakadori holds both an area providing traffic infrastructure such as the Tohoku Shinkansen and National Highway No. 4 and a distribution hub for various regions of Tohoku. Nakadori's agriculture is based on rice cultivation, while being an integral agricultural community endowed with horticulture/fruit tree cultivation as the definitive product of the prefecture. The significance of Nakadori agriculture is great. At present, a portion of agricultural products have been restricted from distribution.distribution. The Aizu district is situated more than 100 km away from the Fukushima Daiichi Nuclear Power Plant ; radioactive contamination is light in this district. Air radiation levels were measured at 0.16 μSv/h in Aizuwakamatsu, and 0.07 μSv/h in Minamiaizu (as of January 2012). Radioactive material in the soil did not exceed 1,000 Bq/kg. However, the original distribution regulations framework mandated a complete restriction on distribution within a prefecture if any agricultural production was found to exceed temporary regulatory values ; as such, Aizu also faced distribution restrictions. Subsequently, regulations were revised to apply to respective cities, towns, and villages ; however, the area was exposed to economic damage caused by harmful rumors and misinformation.

Three months later the nuclear accident, the issue of agricultural product distribution restrictions in Fukushima Prefecture has been announced, focusing on livestock and horticulture. In the months following the season for exporting fruit, the chief commodities of the prefecture (apples, peaches and pears from July) and rice (Aizu Koshihikari from October) arrived and restrictions on the export of both resulted in rumors. Henceforth, the issue will be whether we can (1) create a system for inspecting radioactive contamination, (2) construct an easy approach to understand the distribution system, and (3) work out an accurate method for information transfer to overcome rumors.

3. Problems with the food inspection system and contradictions evident in Fukushima

A) Food inspection system in Fukushima Prefecture

In Fukushima Prefecture, after rice crops were declared safe, some rices that were detected with over 500 Bq/kg, i.e., above the temporary regulatory value, had been found one after another. If we consider safety and peace of mind, then this is the worst phenomenon that could have occurred. As a

[1] See "Results of Airborne Monitoring by the Ministry of Education, Culture, Sports, Science and Technology and the U.S. Department of Energy" (announced April 5, 2011). http://radioactivity.mext.go.jp/old/en/1280/2011/05/1304797_0506.pdf

result, all shipments of rice were delayed, regardless of whether contracts had been finalized before rice above the regulatory value was detected. Though levels far below those of regulatory values were found in rice from the Aizu district and the level of radiation contamination was virtually undetectable, the sales of rice proved to be difficult nevertheless proved difficult. According to an emergency survey of radioactive contamination of rice conducted by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and Fukushima Prefecture, product with levels exceeding 500 Bq/kg accounted for 0.3% of the total rice produced and crop that exceeded the new standard level of 100 Bq/kg commanded only 2.3% of the total. Regardless of this fact, circulation of all rice produced in Fukushima Prefecture was stopped.

It can only be said that this problem was a result of the inspection system. According to inspection methods during the first year after the nuclear accident, farms could generally freely choose what to plant as long as cesium on agricultural land was below 5,000 Bq/kg. At the stage when product was ready for harvest, samples were examined and the crop was approved for distribution as long as the sample was found to be below regulatory values. In case where the sample was found to exceed regulatory values resulted in the restriction of all distribution within the area (first, municipalities ; now revised to former town/village level). In other words, the inspection system comprised of the following points. 1) Crops could be produced without restriction of shipment, 2) Measuring product for radiation and then deciding whether to allow distribution, 3) Conducting a survey of one sample from the selected produce from the former municipality. This system has a great flaw.

Radioactive material and contamination has been proven to disperse widely. This effect was already understood from surveys of the nuclear incident at Chernobyl and should have been assumed from the beginning when drafting Fukushima countermeasures. Radioactive material indicators differ with each area of cultivated field and each agricultural area. Specimens were selected as survey samples through the process of random sampling. For the sampling survey results to hold significance within the entire agricultural area, it must be assumed that radioactive material follows a normal distribution. However, contaminants are not expelled from the source evenly but rather scatter irregularly. Maps of the actual contamination conditions show that the contaminants scattered in a mosaic pattern. Observing the state of contamination dispersion, an organizational flaw of the present survey system allowed agricultural produce that was overlooked by the survey to be distributed. While survey organizations remain limited, inspectors have no choice but to conduct sample surveys before distribution. Henceforth, efforts must be made to raise sample accuracy. In addition, sample survey accuracy must be raised by creating a detailed contamination map, dividing districts according to the division of agricultural land into areas of high concentration, medium concentration, and low concentration, and performing sample selection according to pollution indicators. Even with the latter approach, it is important to realize the current state of contamination.

B) Realities of the nuclear disaster

On February 2012, the Reconstruction Agency office was finally established, 11 months after the disaster and nuclear accident. Branch Office were established in Iwaki and Soma. It has been noted that these institutions were responsible for taking measures to mitigate the effects of both the earthquake and nuclear disaster. However, problems surrounding the nuclear disaster were deeply rooted ; the scope of this endeavor spanned both Miyagi and Iwate prefectures and involved 30 different systems. No one predicted a nuclear disaster, there was no agency tasked with addressing such a long-term problem, and it was considered within the framework of the Great East Japan Earthquake.

Furthermore, the cabinet decided in February to establish the “Act on Special Measures Concerning

Fukushima Recovery," addressing recovery from the Tokyo Electric Power Co., Ltd. Fukushima Daiichi Accident. This act did have a "sweetener ;" it included business incentives and preferential tax treatment aimed at Fukushima Prefecture, an area contaminated by radioactive materials. However, an issue with this act is that development of plans was entrusted entirely to local municipal governments. Such a situation is the same for developing nuclear disaster recovery and decontamination plans.

The method implemented for recovery and restoration from the tsunami and earthquake was a plan for advancing community development involving outside consultants working together with each municipal government to designate special economic zone ideas[2]—in other words, a top–down political decision process. On the other hand, no government guidelines were issued in reference to the nuclear disaster (or if there were limited guidelines, local understanding was lacking) ; circumstances continued to evolve in which all decisions were left to local governments, which groped in the dark for a plan without valid materials or data.

There were no government guidelines or timeline for responding to a nuclear disaster because writers of government guidelines did not anticipate the situation and did not direct accurate analysis of the extent of contamination. This process, wherein Japan did not initially contend with the issue, further magnifying damage, was also noted in the results of research into the Minamata disease[3].

Is it possible for effective decontamination to proceed without a detailed contamination map that measures the spread of nuclear contamination ? Is it possible to construct a food safety survey system without understanding the circumstances of a radioactive contamination event ? Is it possible to plan for life without a systemized health survey or to decide upon and implement a recovery plan without taking into account the inhabitants' need for peace of mind ?

The reality of the nuclear disaster is that the first responsibility for mitigating the disaster goes to the power company business employees and organizations supervising their actions. These did not take actions that should have been taken, resulting in the scattering of radioactive material across the country. The government, which did not take valid countermeasures, did not survey present damages, and did not confirm the state of radioactive contamination, is largely responsible for the disaster. A large portion of the rumor-caused economic damage could have been overcome by measures after the accident. At the very least, the government should have been able to prevent the exacerbation of the issue. It would have been possible to prevent in advance the rice straw, beef, rice, and concrete problems by conducting detailed surveys of the damage due to radioactive contamination. This issue was pointed out locally prior to the incident.

C) Composition contradictions held by the Fukushima Prefecture

Many research institutions and corporations established presences in Fukushima Prefecture to conduct research and technological development. The chief of these was decontamination technology which, if selected by Japan or municipal governments, would result in a great amount of decontamination-related business. The national budget concerned with decontamination comprised approximately 453.6 billion yen (requested in one sum by the Ministry of the Environment) and for the period of 2012-2013 amounted to 1.1482 trillion yen, with appropriations from the Cabinet Office.

There are some issues with decontamination technology ; however, the greatest issue is that each organization or region was conducting disconnected technological development or investigation and the

[2] See Hamano (2012).

[3] See Harada (2004).

creation of plans for decontamination were entrusted to each municipal government body. The spread of radioactive material transcends municipal governments and has no concern for administrative districts. For this reason, there was no reason to emphasize the boundaries of Fukushima Prefecture. "Hot areas" also exist in Tochigi, Ibaraki, and Miyagi prefectures.

What we shoud do is the establishment of a functioning center of comprehensive information and research comprising a database of various combined research results. Construction of a research system for disaster recovery has been required, which does not represent "business model" by which universities, institutions, and corporations compete each other in research and development. The needs of areas contaminated by radiation are expressed by this single fact. Already over one year has passed since the nuclear accident occurred ; however, no location for listening to local concerns over the centralization of information and establishment of a base of research has been established as of yet. This is perhaps the most necessary function among the roles necessitated for the recovery government and the Fukushima recovery department.

Why, is there not more protest from the inhabitants of the Fukushima Prefecture ? The truth is that the region face a composition of contradictions. Enthusiastic efforts to turn toward recovery and reconstruction are being conducted in Fukushima. They are attracting tourism and promoting sales of agricultural produce from the region. Fukushima aid events persistently advance recovery efforts. This reflects that the nuclear disaster was not so extensive. On the other hand, the number of independent evacuees is increasing and a large amount of damage has been caused by the stagnation of regional industry, economy, and so on. How can a solution for this be demanded from the government and Tokyo Electric Power Co., Ltd ? As a nation, this thought is connected to the following two logical questions. 1) Why is decontamination needed if the government has declared it safe ? and 2) Should a fee for the inconvenience caused to people be charged to Tokyo Electric Power Co., Ltd. ?

We cannot condemn those present at the affected locations. The desire for returning to normal life and early recovery would occur in the same fashion even if the nuclear disaster had hit another region. The issue lies in the social landscape in which voices wishing for an early recovery are confronted with the underestimation of damages and coincides with the interests of the perpetrators of this underestimation. Perpetrators work in safety without grasping the reality of the situation and the present analysis, and they do not understand the true damages incurred in the current disaster. For this reason, true recovery and restoration can be neither established nor put into practice. Essentially, whether it is safe cannot be determined without discussing the present analysis and accurate information on which it is based.

There is some public access to information regarding cesium (e.g., the 2-km graphed contamination map). However, only a portion of the publicly available information depicts visualizations of the diffusion patterns in regard to plutonium and strontium ; there is no established organized inspection/monitoring system. National political policy omitted the fact-gathering stage and instead suddenly declared that less than 100 mSv/year, or up to 20 mSv/year, is permissible. Before discussing its scientific foundation, the issue should be whether this is a standard that can be accepted by society. The desire to declare it safe and anxiety of not understanding the current contamination conditions are the greatest contradictions faced by those affected.

4. Damages and Compensation

A) Three types of damage caused to agriculture.

Damage caused by radioactive contamination can be perceived in three frameworks.

(1) Flow damage is the real economic harm due to the portion of products that could not be sold, such as agricultural products that could not be planted because of restrictions or those held up because of distribution restrictions, and the portion of the loss of value caused by rumors. This accounts for the current retroactive increase in claims for damages.

According to Table 1, damages to agricultural production produced in areas, where planting restrictions/partial distribution restrictions were implemented, were calculated to be 41.9% of the prefectural total or 107.7 billion yen. In other words, if farmers receive 100 billion yen in compensation, they can for the time being voluntarily restrict distribution of their agricultural produce, secure funds necessary for current living and farming needs, and utilize the money for future countermeasures. For Tokyo Electric Co., Ltd., considering that the cost of the nuclear accident, which was calculated in this year's deficit, was 1.3 trillion yen, the area can cope with this limited compensation.

(2) Stock Damage includes material funds, damage to the production infrastructure, radioactive contamination of agricultural land, facilities for evacuation, and usage restrictions on machinery. At present, damage surveys have yet to cover this. In order to measure damage incurred to agricultural land, an accurate radioactive contamination map must be drafted and soil analysis of individual portions of cultivated land must be conducted.

(3) What is important is the loss of society-related capital. Till date, a great variety of tangible and intangible damages have paid to cover such things as investments into creating production areas within the region, regional brands, human resources, a foundation necessary for establishing a region, network structure, community, and cultural capital. Furthermore, evacuated areas have lost the ability to utilize resources and funds for ten-odd years. Answering the questions of how can this loss be measured and how can gaps in countermeasures be filled is exceedingly important. At present, the need for a review board for compensating damages has been entirely ignored.

Table 1 State of Agricultural Product Damages in areas effected by the Nuclear Disaster

item \ product	Vegetables	Livestock	Fruit	Rice	Regional Total	Fukushima Prefecture Total
evacuated/restricted area share (%)	42.4	68.0	48.9	35.9	—	—
evacuated/restricted area ratio (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	100.0

Source : The Tohoku Department of Agricultural Administration "MAFF Statistics"
Note 1) Evacuated/restricted areas are calculated from portions of the north and central areas of the prefecture that have records of distribution restrictions and evacuation/entering restrictions.
Note 2) Evacuated/restricted areas share is a ratio of the appropriate region's production comprising the total for Fukushima Prefecture for each agricultural produce type.

B)　State of damage compensation for agricultural produce

The Fukushima JA group established the "JA Group Tokyo Electric Co., Ltd. Nuclear Accident Agriculture and Livestock Damage Compensation Countermeasures Convention of Fukushima Prefecture" on April 26. This comprises all JA within Fukushima Prefecture as well as 35 other organizations, including the All-island Prefectural Headquarters, Prefectural Dairy Association, Livestock Recovery Association, Prefectural farm managers organization Liaison Assembly, and Prefectural Mushroom Promotion Assembly. The executive office has taken the burden of the Central JA Union for Fukushima Prefecture. Every month since its establishment, the prefectural association general meeting has been held to decide upon the amount demanded for compensation of damages and bring these demands to Tokyo Electric Power Co., Ltd. So far, the amount of compensation demanded (as of May 2012) amounts to 62.5 billion yen. The amount of money received accounts for 73% of the amount claimed.

Claims for compensation according to Table 2 can be broken down into 1.1 billion yen for rice, 13 billion yen for horticulture, 6.2 billion yen for fruit, 1.8 billion yen for milk, 9.9 billion yen for livestock, 8.5 billion yen for other livestock related damages, 2.7 billion for pasture, 16.3 billion yen for untilled land (compensation for suspension of work), and 3 billion yen for damage to business.

Many problems have been pointed out in regard to claims for damages submitted to Tokyo Electric Power Co., Ltd, but those issues related to Fukushima Prefecture agriculture and agriculture cooperative include ; (1) delays in payment (payment on a three month basis), (2) not paying the full amount claimed, (3) denying claims when people restrain themselves from production and distribution voluntarily, (4) claims related to property damage, (5) compensation for discontinuation of business, (6) the closing date issue (compensation period), (7) business damages of organizations such as the JA, and (8) support for damages not clearly specified in the Dispute Reconciliation Committee for Nuclear Damage Compensation guidelines.

The Central JA Union for Fukushima Prefecture is undertaking countermeasures to support funds for farmers who sustained damages. The union is organizing zero interest funds in coordination with

Table 2　Breakdown of Fukushima Prefecture Union Compensation Claims（Present May 1, 2012）

Claims Details	Monetary value (100 million yen)	Percentage (%)
Rice	11	1.8
Horticulture	130	20.8
Fruit	62	9.9
Milk	18	2.9
Livestock disposal	99	15.8
Other livestock damages	85	13.6
Pasture	27	4.3
Untilled land (compensation for suspension of work)	163	26.1
Business damages	30	4.8
Total	625	100.0

Source : Central JA Union for Fukushima Prefecture

Fukushima Prefecture and aid from the Central Federation of Societies of Commerce and Industry for the immediate needs of those union member farmers who fell victim to the disaster (Farmers management stability funds). Funds for compensating national and prefectural level deal with beef distribution restrictions help projects support emergency management of national companies raising cattle for consumption, measures for support of emergency rice straw provisions, and in Fukushima Prefecture projects for measures to allow undisturbed distribution of cattle and programs sponsoring free rice straw.

How to proceed with the issue of compensation for those things, which is not noted within this framework is still unclear. In areas where restrictions were placed on planting, standard compensation per 10 are is guranteed ; however, in reality, issues with uniform compensation exist, including differences in the amount of produts per 10 are, discrepancies in farming method (e.g., organic farming,), and the rise and fall of the added value of produce. At present, compensation claims negotiations are being conducted separately ; however, realistically it is quite difficult for an individual farmer to independently negotiate claims. For example, compensation for areas with new planting restrictions as of 2012 was measured at 59,000 yen per 10 are ; however, in reality, cases existed whereby people who purchased rice for their own consumption and managed maintenance themselves fell into a deficit. This amount cannot be considered compensation. Similar issues have been identified in connection with the question of compensation, which takes into account living property in evacuation areas.

5. Conclusion

In order to resolve the problems being currently faced by Fukushima Prefectural agriculture, we have no choice but to drastically reexamine the way in which the inspection of radioactive materials is conducted. Thus far, the inspections and regulations concerned with food and agriculture were conducted within Japan's vertically segmented administration through : (1) soil surveys and inspection of agricultural produce by the Ministry of Agriculture, Forestry and Fisheries, (2) monitoring of air radiation levels by the Ministry of Education, Culture, Sports, and Science and Technology, (3) regulation value determination of food products conducted by the Ministry of Health, Labor, and Welfare, and (4) training regarding food safety conducted by the Consumer Affairs Agency. The government did not indicate fundamental national policies, and each agency was left to independently improvise its actions in pieces. This disallowed exhaustive utilization of investigation results in the realization of production and distribution countermeasures, clearly resulting in at least one of either the "rice distribution restriction/planting restriction problem." Systemizing investigations of radioactive materials would allow for unified control over production, distribution or consumption, and experimental work/agricultural leadership.

A map of agricultural land pollution is a source document for policy making, and can be practically applied to a cross section of fields related to evacuation instructions and rescinding, decontamination, and agricultural countermeasures. A map depicting the visualization of radiation levels in the sphere of daily existence could also be used by local residents as a resource for choosing methods for decreasing external exposures in their daily lives. At present, the contamination map drafted by the Ministry of Education, Culture, Sports, Science and Technology is a 2-km gridded map. A detailed survey needs to be conducted. In order to conduct a factual investigation, it is important that : (1) the Recovery Office manages the investigation comprehensively, (2) the investigation be made according to the level of damage incurred in an area, (3) central government reacts more quickly to respond to the level of damage, (4) the government maintains the budget by adopting simple techniques for restraining expenses,

and (5) the Recovery Office utilizes the maximum amount of power held by the government, research institutions, local people, and private businesses in surveys.

Regardless of whether the data from germanium solid-state detectors are scientifically accurate, this data has been positioned merely as the data utilized for judging "distribution permissions." If we link data from : (1) the radioactive material content of agricultural produce, (2) cultivated land position data, and (3) soil composition data, it is possible to complete a database of the rate of transfer of radioactive material to agricultural produce and a contamination map according to different commodities. If we assemble this type of source material, it will be possible to encourage use of produced vegetables unaffected by the transfer of radioactive materials.

Japan's central and local government should introduce an approval system for voluntary food product inspections, the need for which began to increase gradually in the summer of 2011. Japan should : (1) consider results reports for the government as a prescreening for obligatory monitoring inspections, (2) prevent misinterpretation of inspection results related to the spread of financially damaged rumors, and (3) instruct retailers and distributers regarding indications related to radioactive materials that are connected to food safety and peace of mind. In 2012, when simple food product measurement inspection units were established for each area, education regarding inspection manuals, technology instruction for those responsible for taking measurements, and interpretation of inspection results holds greater significance.

One further issue of importance is the construction of a system that allows results of experimental work done by universities or research institutions to rapidly be fed back into regional agriculture and connected to "the recovery of food and agriculture." If we do not take measures now, reviving and resettling agricultural regions cannot be done after a great majority of farmers abandon their profession. This will increase the amount of abandoned agricultural land, regardless of whether research results are published years from now. What is needed now for Fukushima Prefecture is to become the nexus for research promoting factual investigation and technological development in connection with municipalities and local citizens, for research to be promptly made public, and for effective countermeasures to be spread rapidly and systematically implemented.

[note]

A portion of this manuscript is being revised according to cited literature [2][3]

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