Radioactive contamination of Japanese agricultural soil and plant caused by the Fukushima nuclear accident

National Institute for Agro-Environmental Sciences

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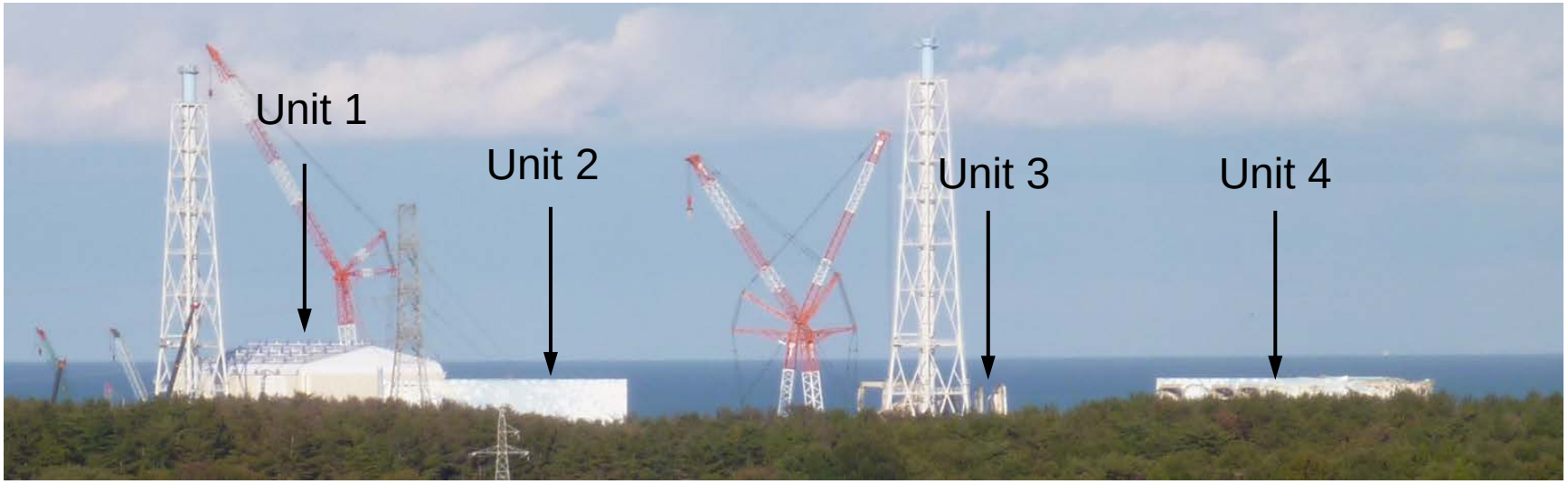


Fukushima Daiichi NPP（Nov.15, 2011）

Today’s topics

1. Outline of the accident and emission of radioactive substances to environment.

2. Direct radioactive contamination of vegetable just after the accident.

3. Spatial distribution of radioactive Cs in agricultural soil.

4. Radioactive Cs contamination of rice in Fukushima Prefecture.

5. Decontamination methods.

1. Outline of the accident and release of radioactive substances.

Fukushima Daiichi NPP（Nov.15, 2011）

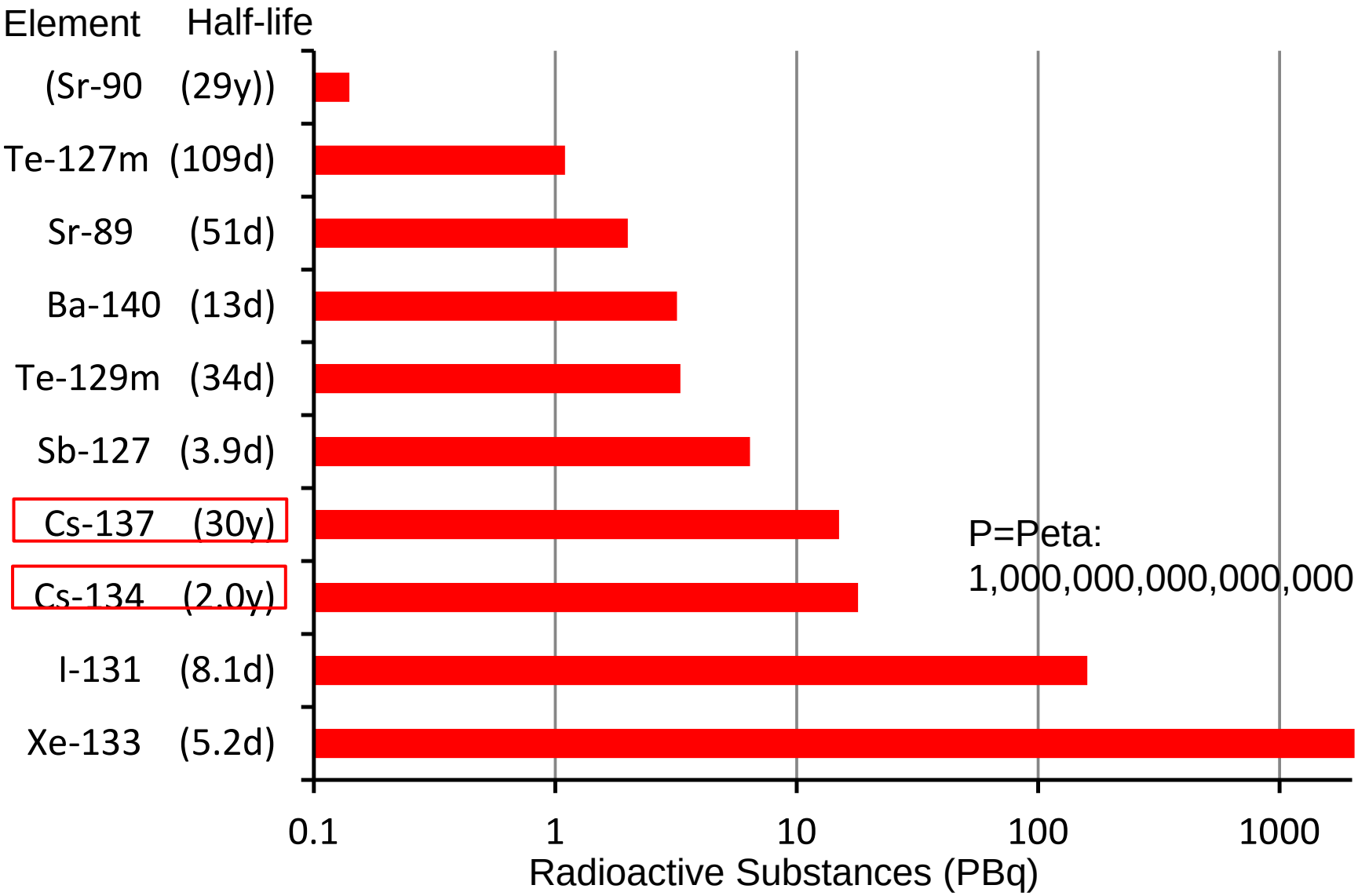


Fig.1 Amount of estimated major radioactive substances (above 1PBq) released from the Fukushima Daiichi NPP into the atmosphere (Nuclear Emergency Response Headquarters, 2011)

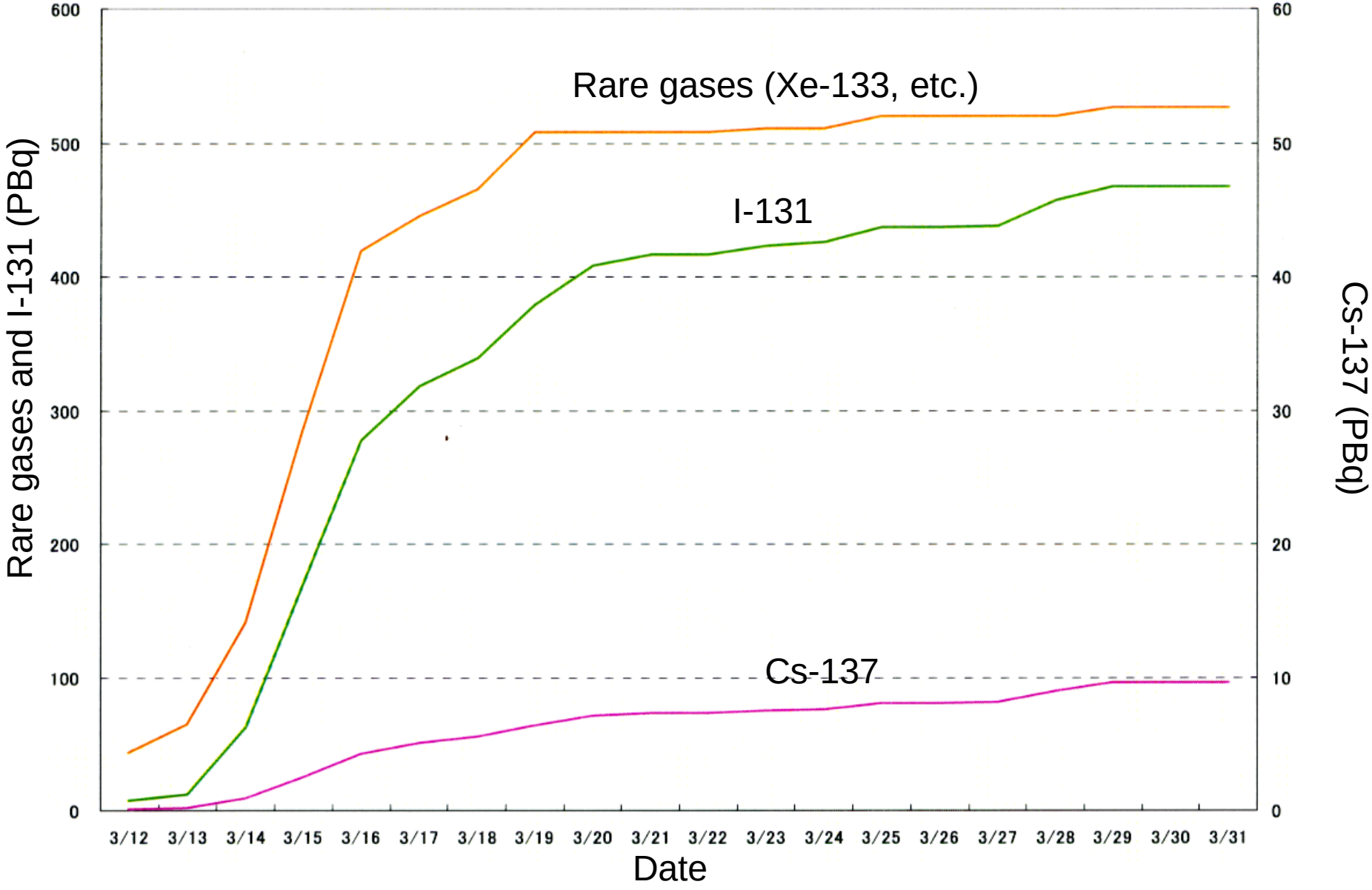
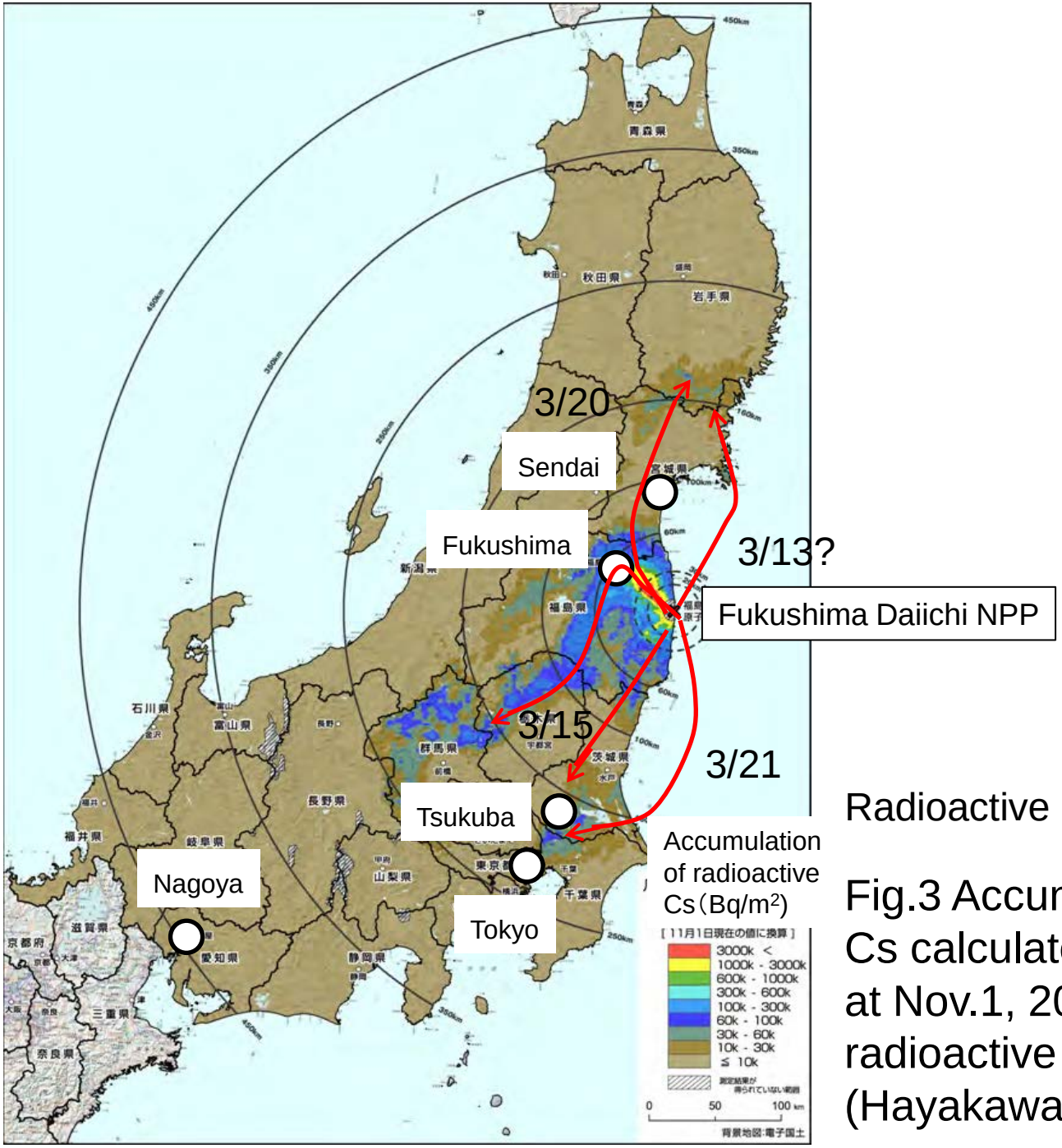


Fig.2 Changes in cumulative values of main radioactive substances released from the Fukushima Daiichi NPP into the atmosphere (TEPCO, 2012)

Outline of Accident

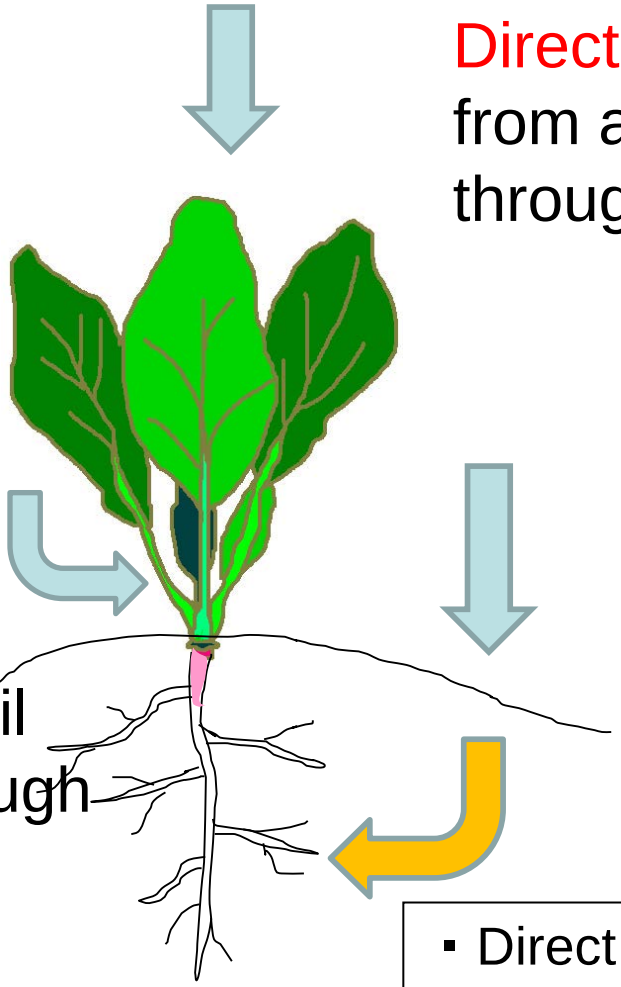


Radioactive Cs: Cs-134+Cs-137

Fig.3 Accumulation of radioactive Cs calculated by air survey at Nov.1, 2011 (MEXT, 2011）and radioactive contamination routs (Hayakawa, 2011)

2. Direct radioactive contamination of vegetable just after the accident.

Preliminary check for radioactive contamination of vegetables by using GM survey meter (Mar 18, 2011)



Direct contamination: deposit from atmosphere and uptake through leaf and body

Indirect contamination: uptake through plant roots from soil after accumulating to soil

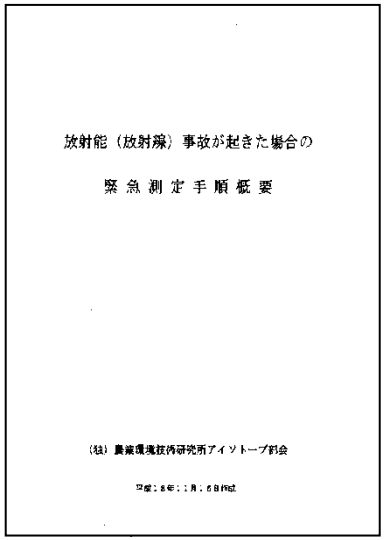
Mixed contamination: uptake from soil and water through stem or body

- Direct contamination is important just after accident.
- Indirect contamination continues long time after stopping fall out.

Fig.4 Uptake rout of radioactive substances to plant

Direct Contamination

Radioactive monitoring upland field in NIAES



放射能（放射線）事故が起きた場合の

緊急測定手順概要

（社）農業環境技術研究所アイソトープ部会

Emergency manual of sample determination at nuclear accident

Isotope research building in NIAES

Ge detecting system of NIAES

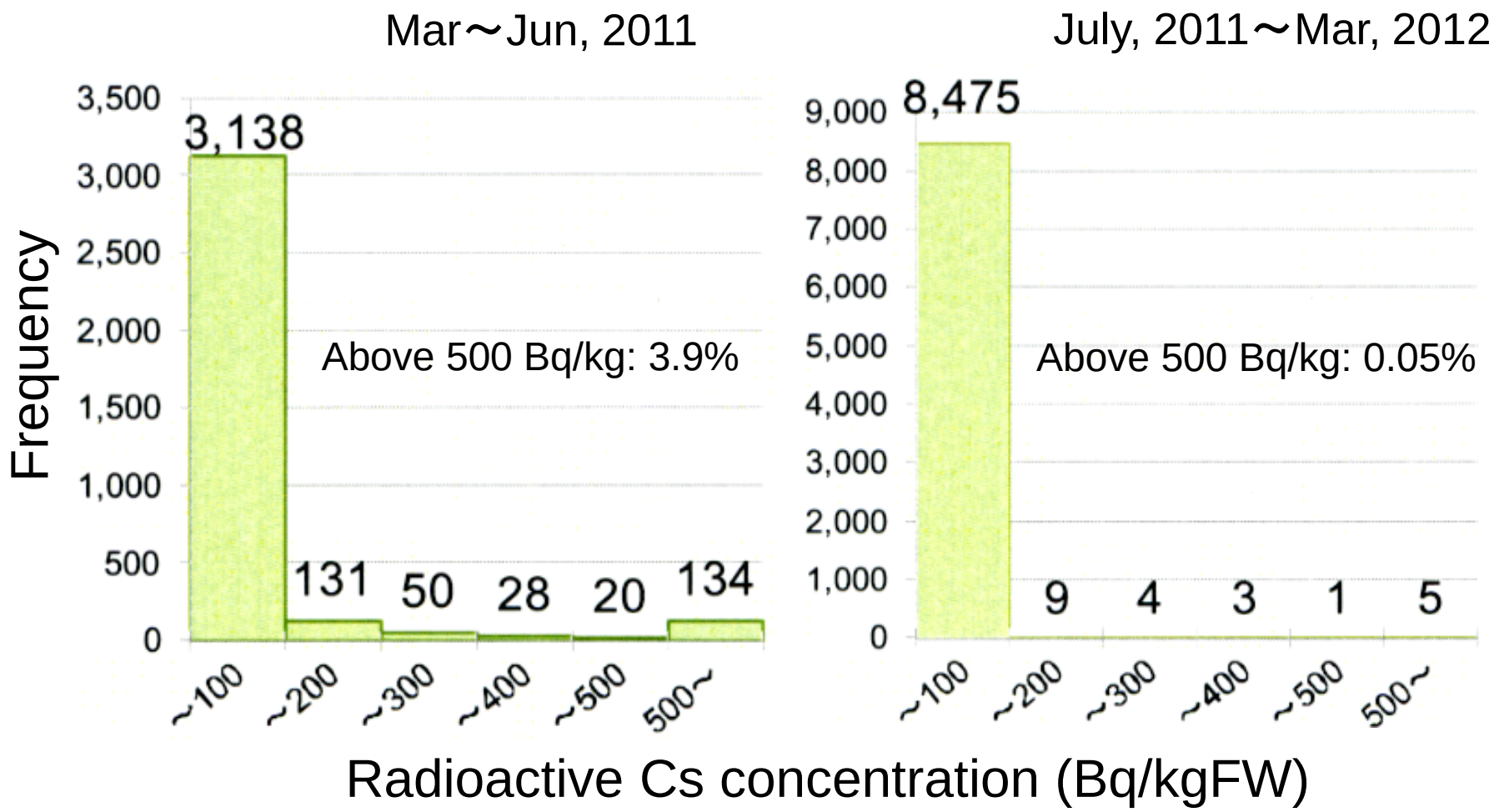


Fig.7 Radioactive Cs concentration in vegetables (MAFF, 2012)

3. Spatial distribution of radioactive Cs in agricultural soil.

Soil sampling at paddy field near Fukushima Daiichi NPP
（Nov.15,2011）

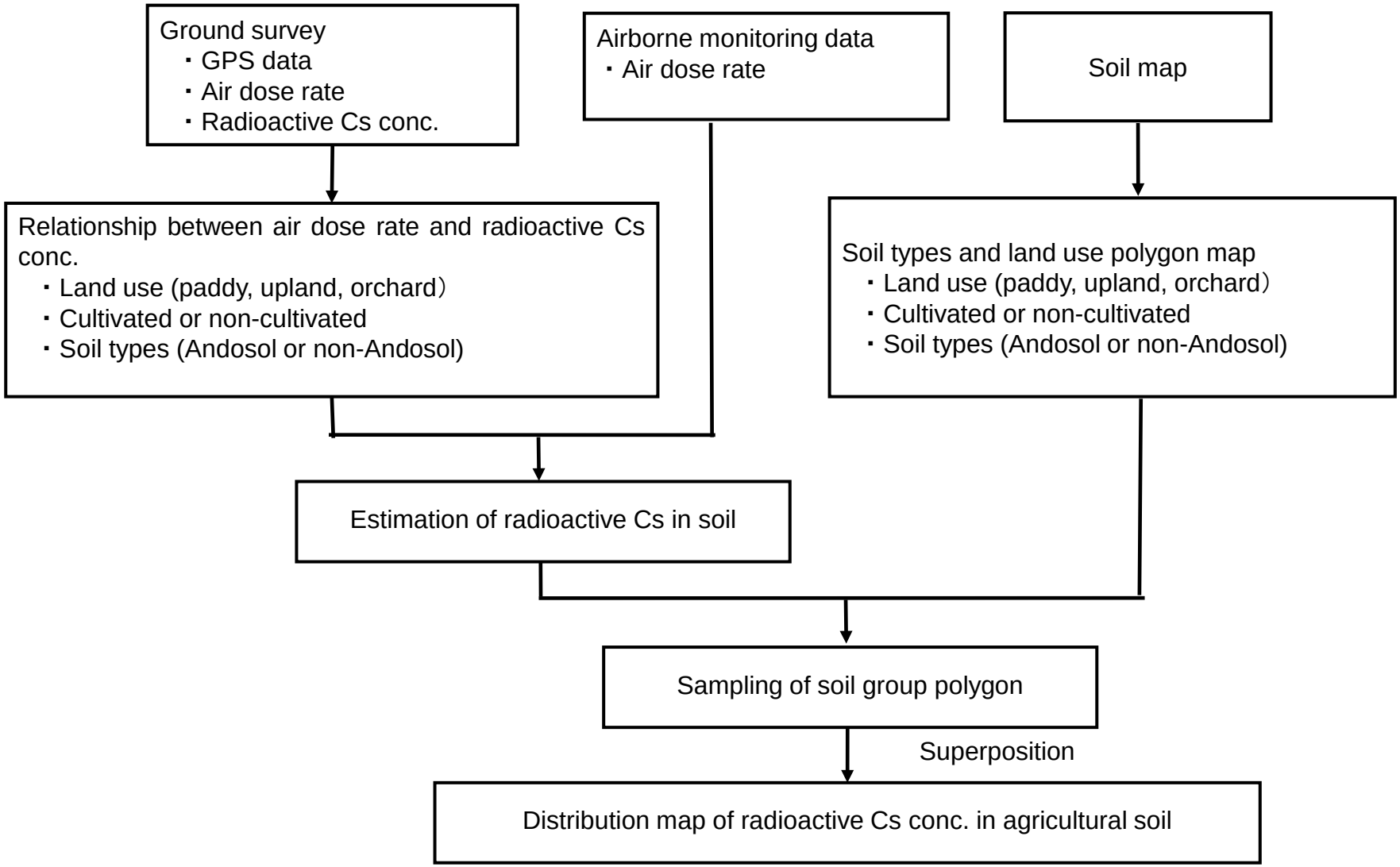


Fig.8 Procedure of creating distribution map of radioactive Cs concentration in agricultural soil

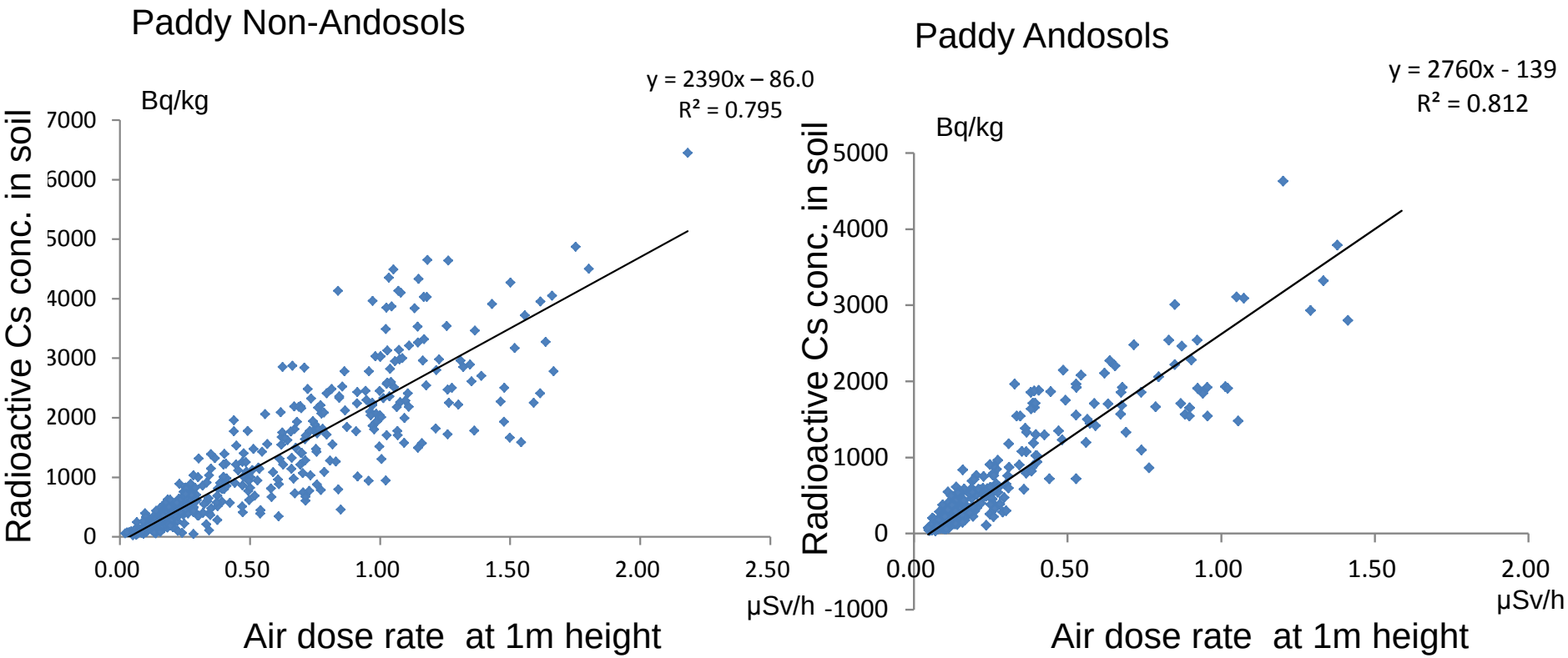


Fig.9 The correlations between radioactive Cs concentration and air dose rate at different soil and land use units

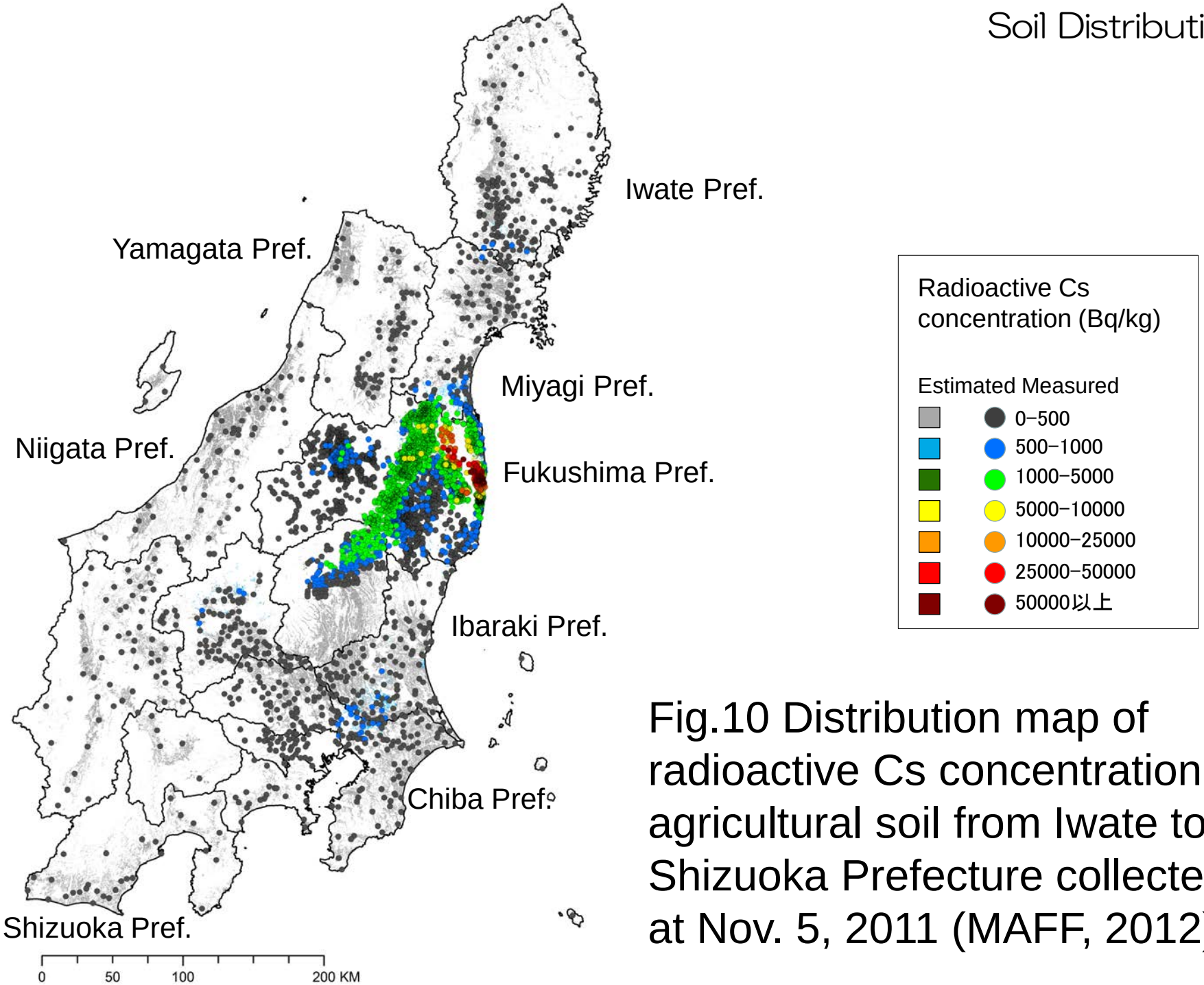


Fig.10 Distribution map of radioactive Cs concentration in agricultural soil from Iwate to Shizuoka Prefecture collected at Nov. 5, 2011 (MAFF, 2012)

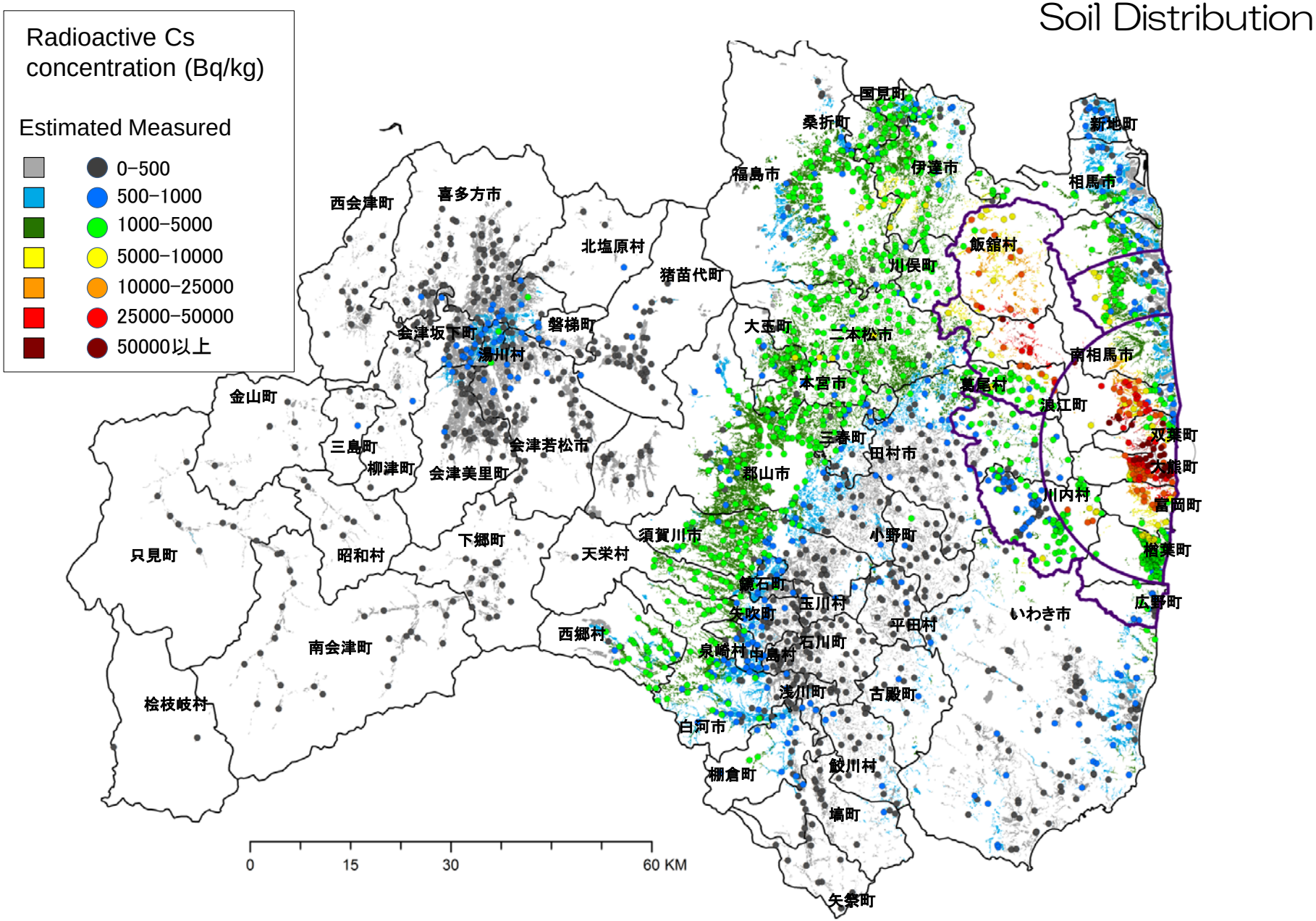


Fig.11 Distribution map of radioactive Cs conc. in agricultural soil at Fukushima Prefecture collected at Nov. 5, 2011 (MAFF, 2012)

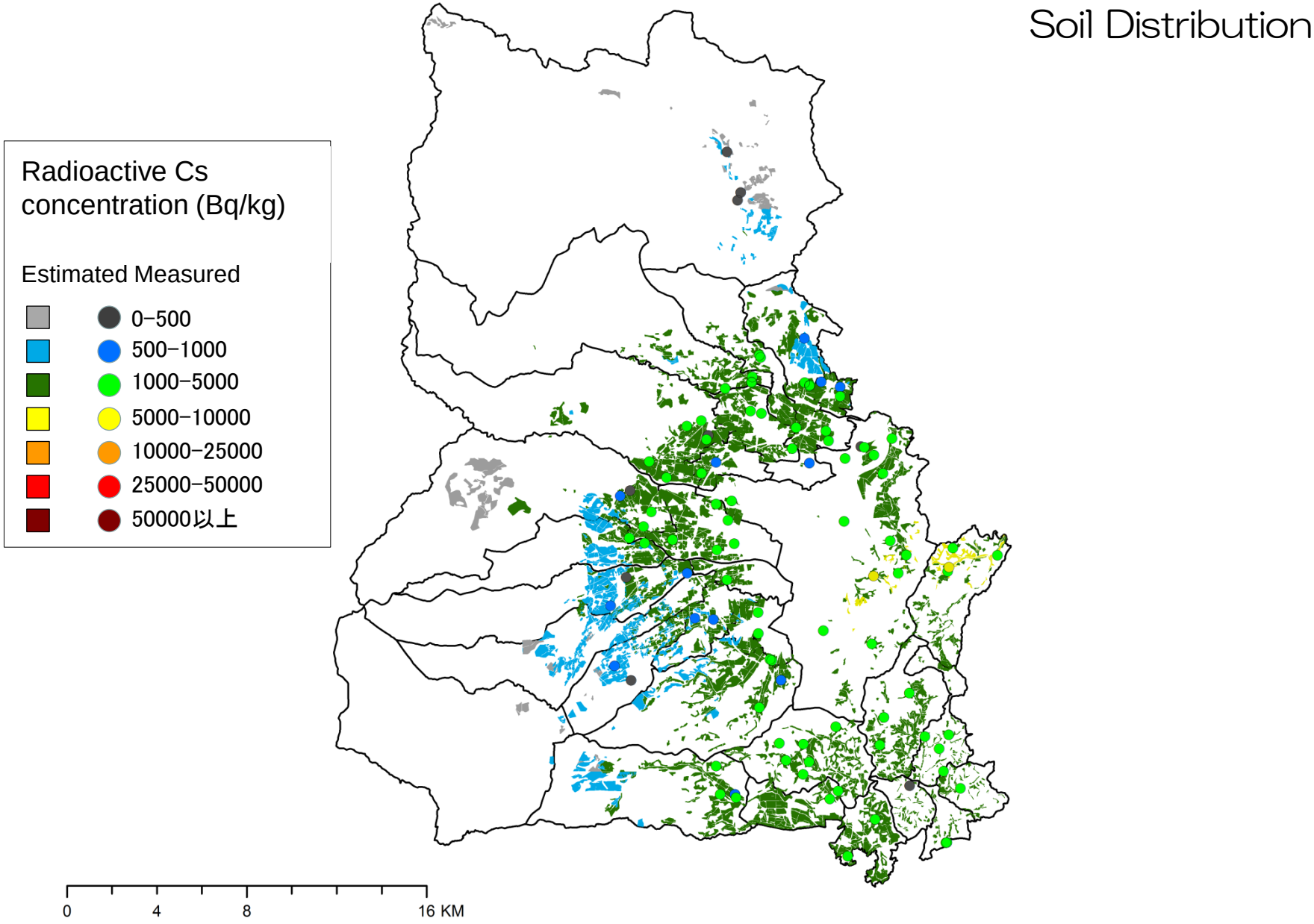


Fig.12 Distribution map of radioactive Cs conc. in agricultural soil at Fukushima City collected at Nov. 5, 2011 (MAFF, 2012)

4. Radioactive Cs contamination of rice in Fukushima Prefecture.

A rainfall meter and basin for collecting precipitation Cs at paddy field of Fukushima Prefecture

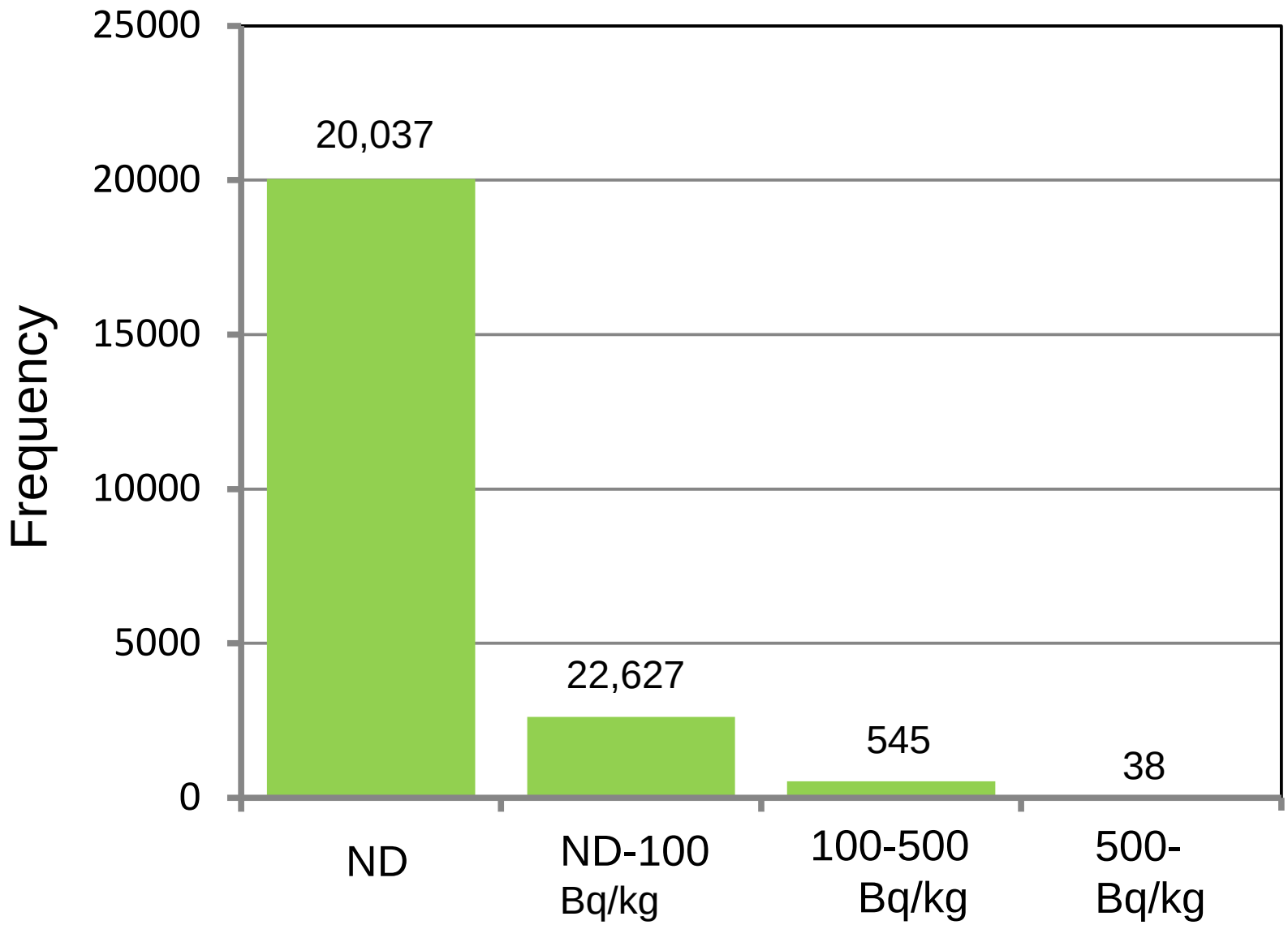


Fig.13 Radioactive Cs concentration in brown rice at Fukushima Prefecture, 2011 (MAFF, 2012)

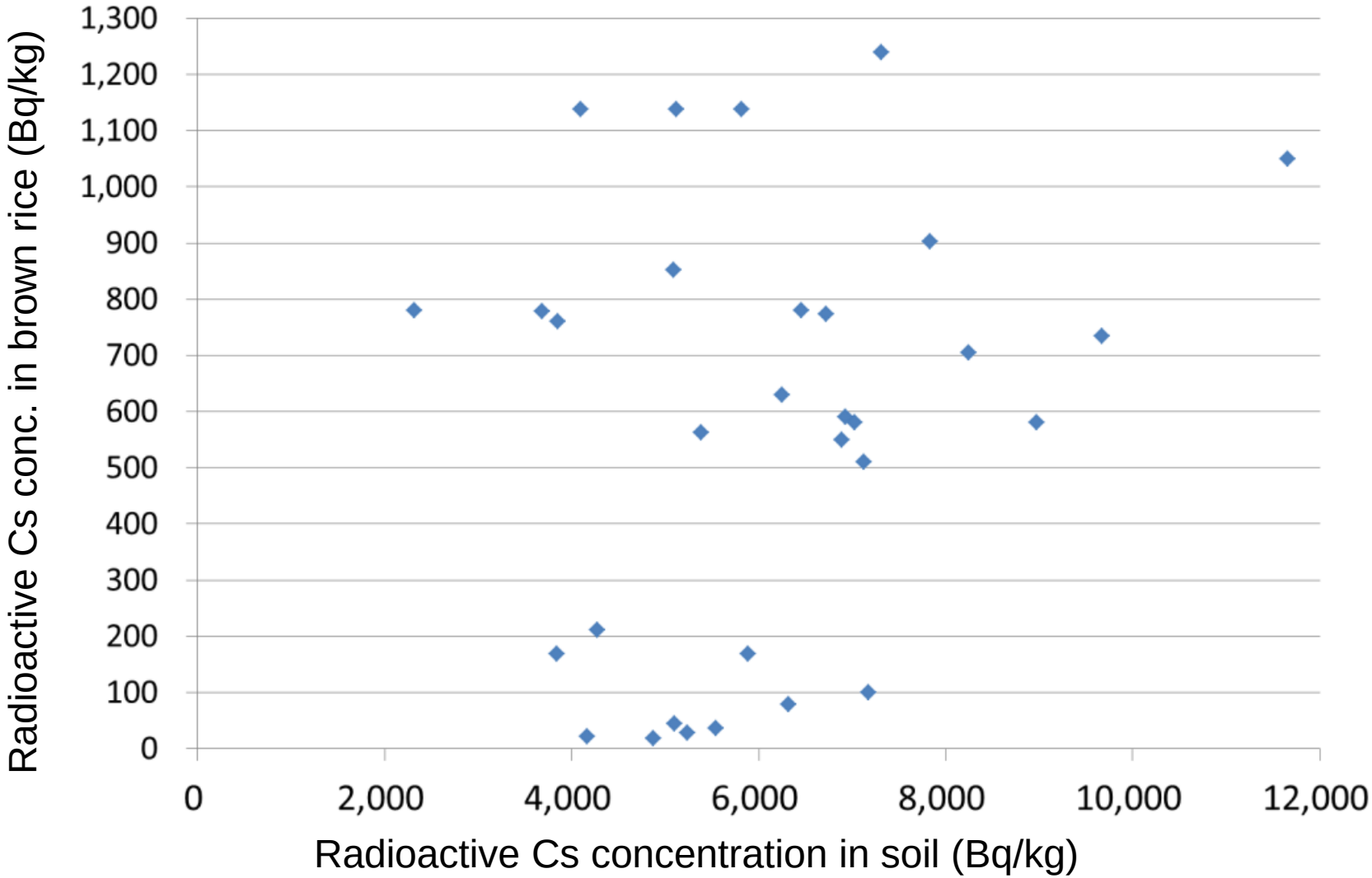


Fig.15 Relationship between radioactive Cs concentration in soil and brown rice (Fukushima Prefectural Government, 2011）

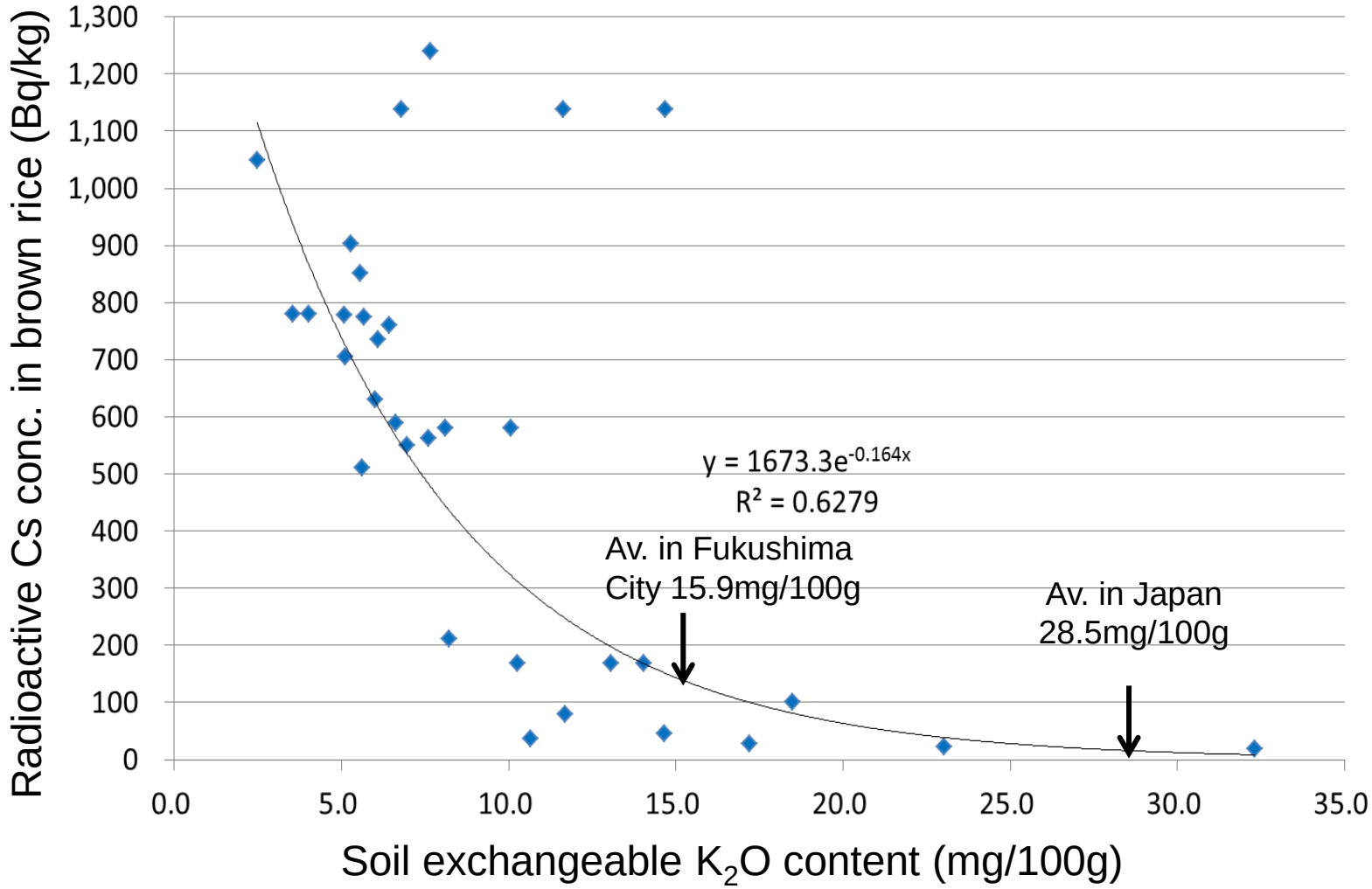
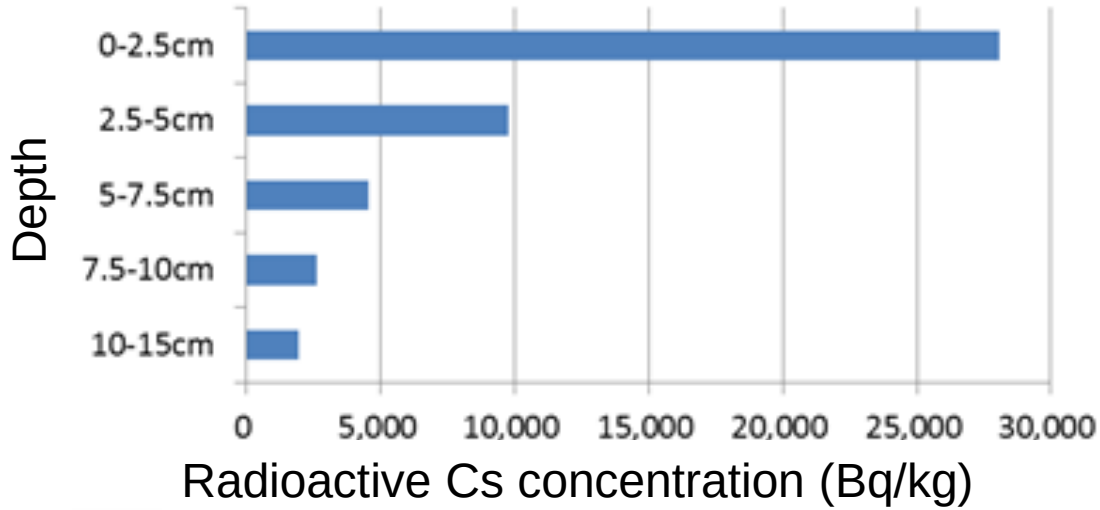


Fig.16 Relationship between soil exchangeable potassium content and radioactive Cs concentration in brawn rice (Fukushima Prefectural Government, 2011）



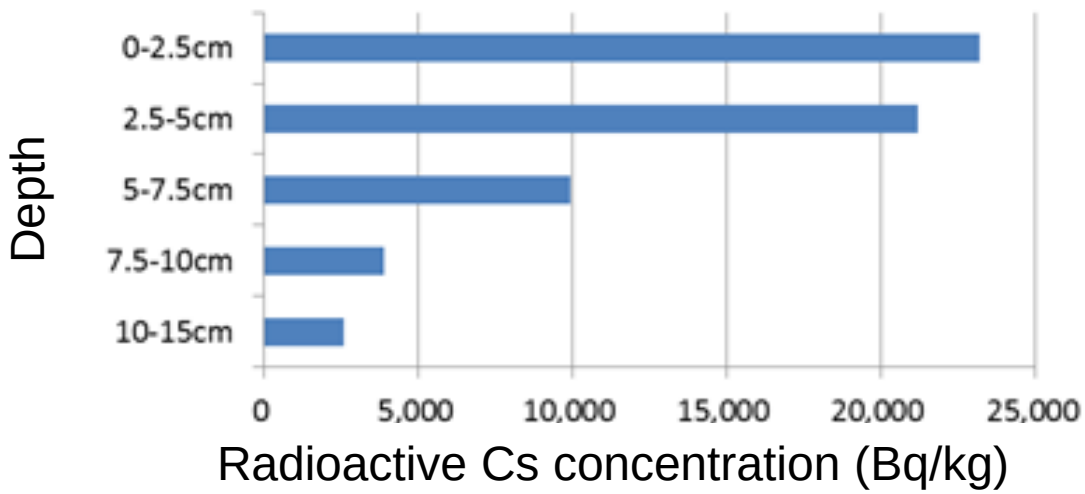


Fig.17 Vertical distribution of radioactive Cs concentration in paddy soil (Fukushima Prefectural Government, 2011)

5. Decontamination methods.

Model experimental paddy field for method of mixing soil and removed contaminated soil using water in Fukushima Prefecture.

Table 2 Radioactive Cs concentration in 15cm soil depth
（Nagasaka et al., 2012）

	Before removing (Bq/kg)	After removing (Bq/kg)	Reduction rate (%)
Paddy	15,180	2,801	82

Surface soil crushing

Scraping surface soil

Accumulating soil and carrying out

Fig.18 Removing field top soil (MAFF, 2011)

Paddling

Settling pond and pumps

Reduction rate of radioactive Cs in 15 cm soil depth after treatment：29～71%

Fig.19 Mixing soil and removed using water（MAFF, 2011)

Deep plowing (30cm depth)

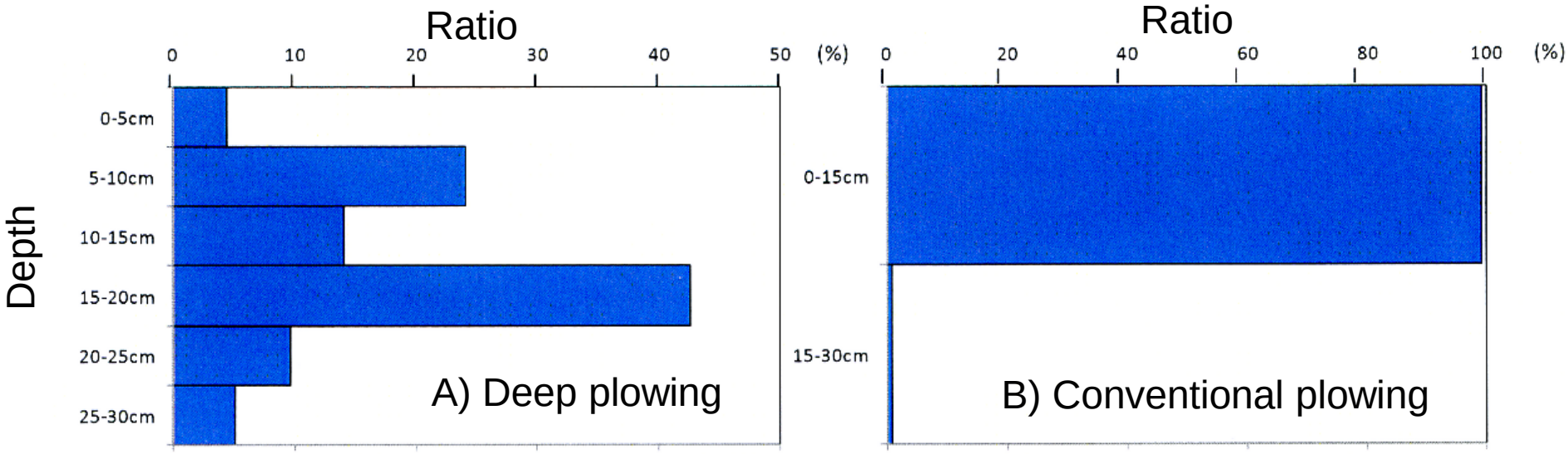


Fig.20 Vertical distribution of radioactive Cs in soil after A) deep plowing and B) conventional plowing (MAFF, 2011)

Table 3 Radioactive Cs concentration and transfer factor of Sunflower（Fukushima Agricultural Technology Center, 2011）

Sample / Treatment	Acceleration*	Suppression**
Seed（Bq/kg FW）	3.2	5.0
Stem & Leaf（Bq/kg FW）	32.4	31.3
Soil（Bq/kg DW）	1,045	1,134
TF from Soil to Seed	0.0031	0.0044
TF from Soil to S&L	0.031	0.028

* ：Acceleration: $(NH_4)_2SO_4$ + no K
** ：Suppression：NH_4NO_3 + KCl

Conclusions

- The main nuclide of radioactive contamination in agriculture is radioactive Cs.
- Radioactive Cs released from Fukushima Daiichi NPP is distributed in agricultural soil from Tohoku to Kanto district.
- Area of radioactive cesium concentration above 5,000Bq/kg was estimated 8,900ha in farm land at Nov 5, 2011.
- There are many factors of rice contamination.
- Physical methods are only effect for decontamination.