Efficient Food Standards for Radioactive Caesium Based on Cost-Benefit Analysis of the Regulation

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World Congress on Risk, Singapore, July 21-23, 2015

1 Background

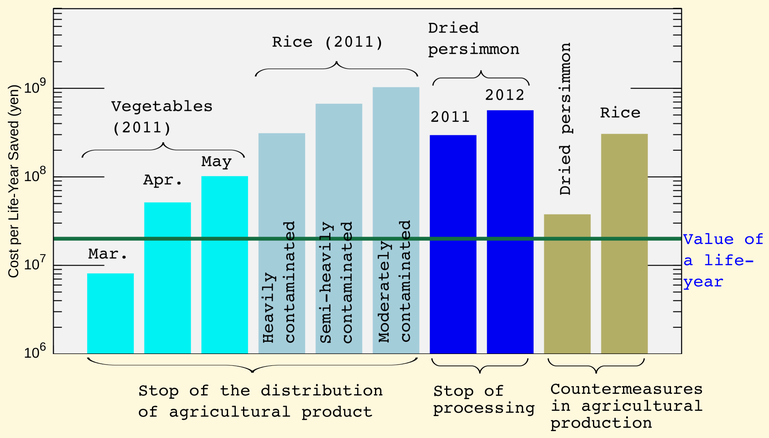
Supply of foods contaminated with radiocaesiums released from Fukushima Daiichi nuclear powerstation has been regulated; distribution of foods with concentrations of radiocaesiums exceeding the limit value (100Bq/kg for general foods) is not allowed. The regulation has incurred costs to the society.

2 Questions

- Does the present regulation of food contamination deserve its costs?
- What are the appropriate values for standard with regard to radioactive caesium in foods?

3 Results

- Cost per life-year saved (CPLYS)



- Efficient values for standard

(Bq/kg)

	To stop production or distribution	Taking countermeasures into account		
		2012	2015	2018
Vegetables	1000	100		
Rice	730	680		
Dried persimmon	3600	380	180	100

(Present standard: 100 Bq/kg)

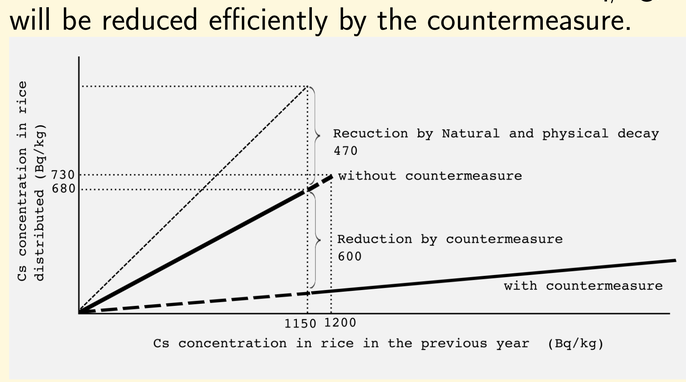
4 Method

4.1 Cost per Life-Year Saved

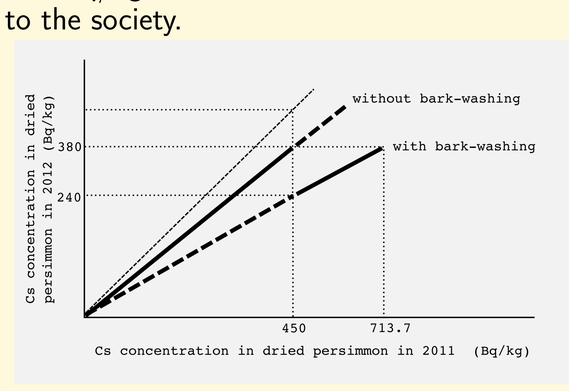
1. Stop of distribution or processing of products
   - $\text{CPLYS} = \dfrac{\text{Sales reduction} - \text{Saved cost [yen/kg]}}{\text{Avoided loss of life-expectancy(LLE) [y/kg]}}$
     LLE = (Unit LLE from intake of radiocaesium [y/Bq]) $\times$ (Concentration [Bq/kg])
     – Unit LLE: 2.0×10^{-8} y/Bq for Cs-134, 1.4×10^{-8} y/Bq for Cs-137
2. Countermeasures in agricultural production
   - Rice
     – Fertilization with potassium and zeolite; deep cultivation
     – Effect: reduction in caesium concentration in rice by 100 Bq/kg at the maximun
     – Cost: 870,000 yen/ha or 200 yen/kg-rice
   - Dried persimmon
     – Bark washing in winter 2011
     – Effect: increase in decay constant by 0.344, or 17 person-years of LLE reduced over 19 years
     – Cost: 620 million yen for 1700 t of dried persimmon

4.2 Efficient Values for Food Standard

1. Stop of distribution or processing of products
   - Efficient regulation should meet:
     (Value of a life-year (VLY)) $\times$ (LLE reduction) $\geqq$ (Cost of regulation)
     (LLE reduction) $\geqq$ (Limit value) $\times$ (unit LLE)
     $\Rightarrow$ (Limit value) $\geqq \dfrac{\text{(Cost of regulation)[yen/kg]}}{\text{(VLY)[yen/y]} \times \text{(Unit LLE)[y/Bq]}}$
2. Countermeasures in agriculture
   - Efficient countermeasure should meet:
     (Value of a life-year (VLY)) $\times$ (LLE reduction) $\geqq$ (Cost of countermeasure)
   - Vegetables
     No countermeasure is needed for meeting the present standard limit; 100Bq/kg is efficient.
   - Rice
     – Cost: 195yen/kg, VLY: 2×10^7yen, Unit LLE: 1.6×10^{-8}y/Bq $\Longrightarrow$ When reduction in concentration is greater than 600Bq/kg, countermeasure is efficient.
     – If the initial concentration is greater than 1150Bq/kg, the reduction due to the countermeasure could be greater than 600Bq/kg, and the concentration in the next year without countermeasure would be 680Bq/kg.
     – So 680Bq/kg will be an efficient value for standard; if the initial concentration is below 1150Bq/kg, no countermeasure is needed for the product to be distributed, and if the initial concentration is above 1150Bq/kg, it will be reduced efficiently by the countermeasure.



   - Dried persimmon
     – When the initial concentration is greater than 450Bq/kg, the countermeasure will be efficient taking the effect over the next 19 years into account. The concentration in the next year will be 240Bq/kg.
     – As long as the initial concentration does not exceed 3600Bq/kg, to stop the production of dried persimmon will not be efficient, but the countermeasure would have reduced the concentration efficiently, if the initial concentration is not below 450Bq/kg.
     – The maximum value of concentration in 2011 was 713.7Bq/kg. The value in the next year would have become 380Bq/kg if bark-washing was carried out. Hence to set the standard value at 380Bq/kg and to encourage bark-washing for the trees that have produced fruits which would have concentration greater than 450Bq/kg when dried in 2011 will not cause net loss to the society.



References

1. OKA, T. (2014), 'Cost-benefit analysis of the regulation of food contamination with radioactive caesium within a year after the Fukushima accident: the case of vegetables and rice', *Japanese Journal of Risk Analysis*, 24(2), 101-110 (in Japanese).
2. Sato, M., Abe, K., Kikunaga, H., Takata, D., Tanoi, K. Ohtsuki, T. and Muramatsu, Y. (2015), 'Decontamination Effects of Bark Washing with a High-Pressure Washer on Peach [*Prunus persica* (L.) Batsch] and Japanese Persimmon [*Diospyros kaki* Thumb.] Contaminated with Radiocaesium durign Dormancy', *The Horticultural Journal*, doi: 10.2503/hortj.MI-054.