International Symposium on Food Irradiation
"Role of Irradiation in Food Safety & Security"
May 16-19, 2011, Seoul, Korea

Food Security and Irradiation

Prof. Cherl-Ho Lee
Chairman, Korea Food Security Research Foundation
Emeritus Professor of Korea University, Seoul

World Health Organization

Food security (식량안보 의 정의)

- The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life".

- 모든 사람들이 건강하고 활동적인 삶을 영위하기 위한 안전하며 영양가 있는 식품을 항상 충분히 얻을 수 있는 상태

고려대학교 KOREA UNIVERSITY

Three pillars in food security

World Health Organization

Food availability (식품의 가용성)

– production, supply

Food access (식품의 접근성)

– price, purchasing power

Food use (식품의 이용성)

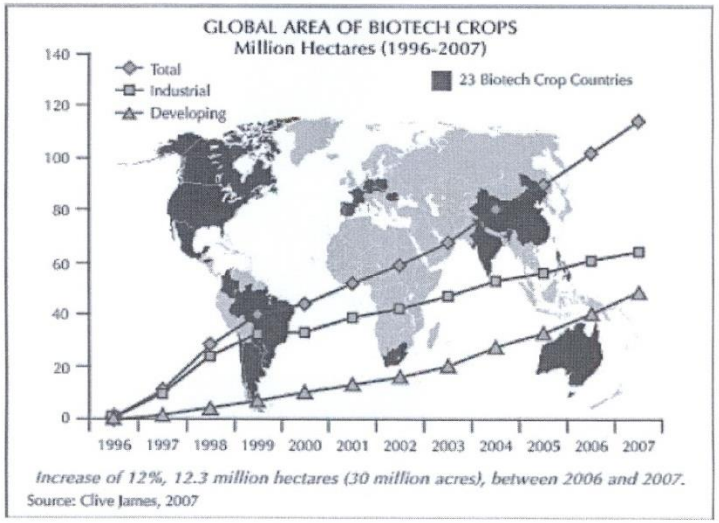
– safety, water hygiene, nutrition knowledge

Factors determining Food Availability

- Positive factors:

  Production will be increased by Biotechnology development.

  Food loss will be reduced by irradiation technology



Factors determining Food Availability

- Negative factors:

Production will be decreased by global warming and climate change. (draught, flooding, tsunami)

Supply will be reduced by non-food use of food materials. (Animal fodder, biofuel production)

Massive infectious animal diseases. (AI, Foot & mouth disease)

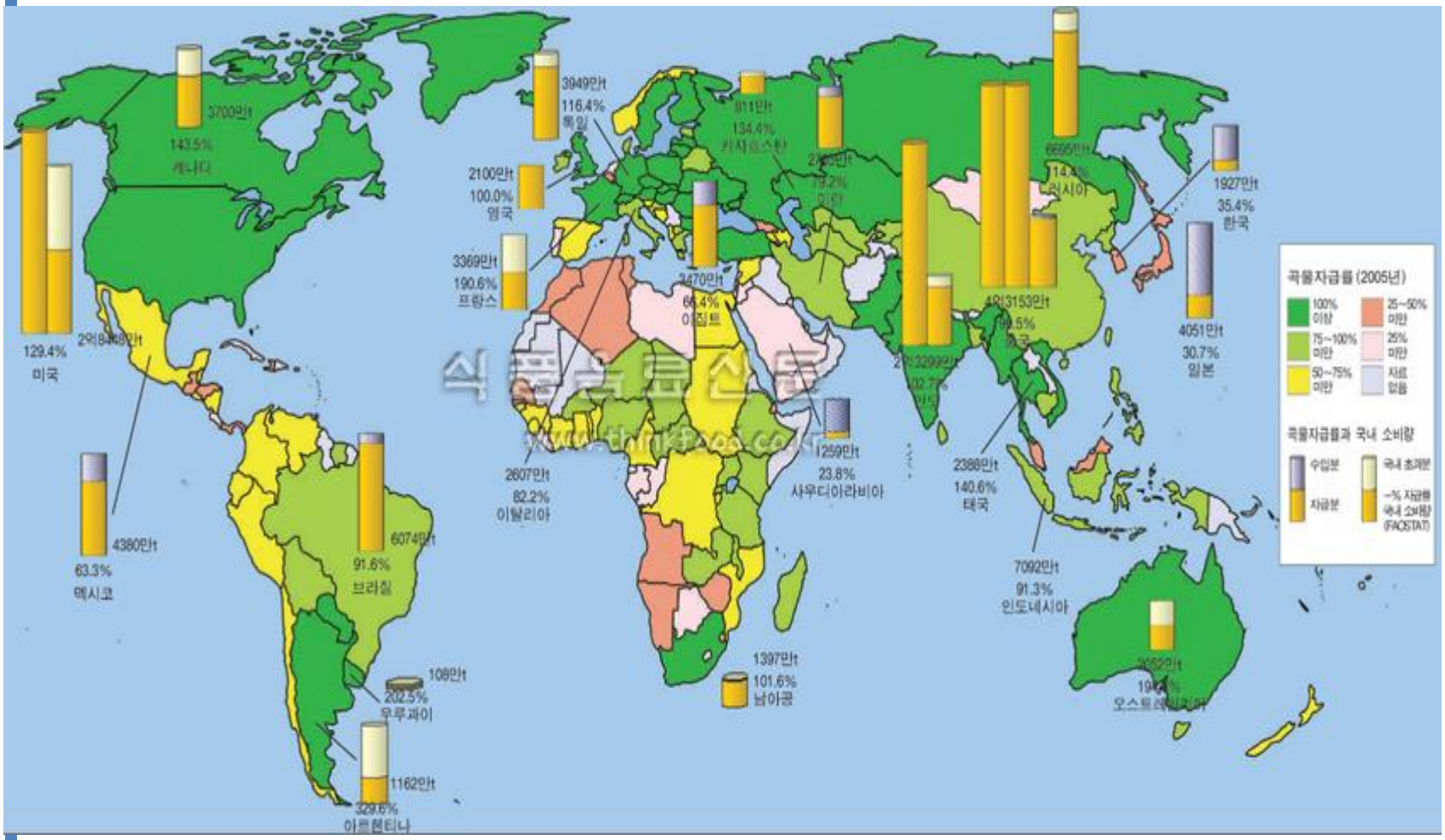
Factors influencing Food Access

- World trade liberalization skews even distribution of food.
  The richer gets more and the poorer gets less

- Food prices rise rapidly.
  FAO Monthly Food Price Index recorded to 231 in Feb. 2011.

- Food export restriction of major grain producing countries.
  (Russia, China, etc.)

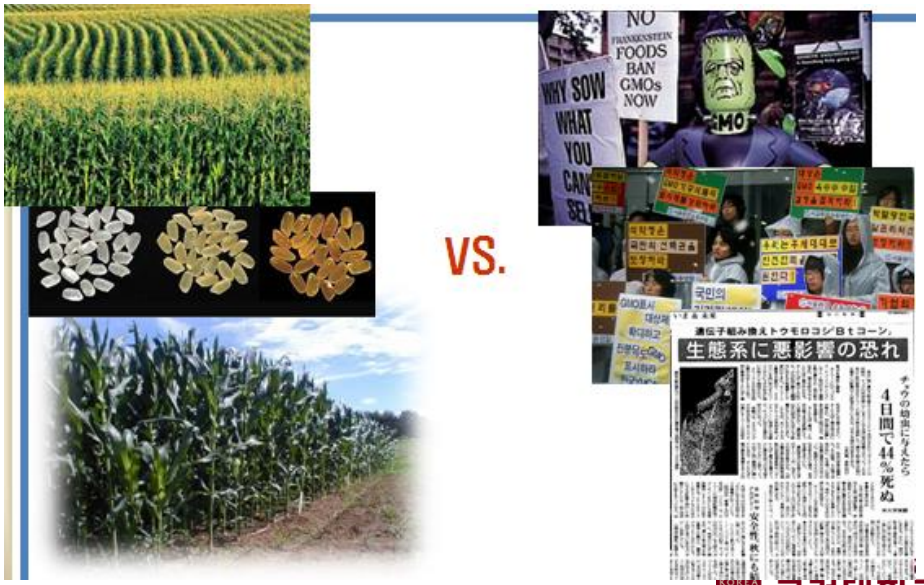
Grain self-sufficiencies



세계 국가별 곡물 자급율

Factors influencing Food Use

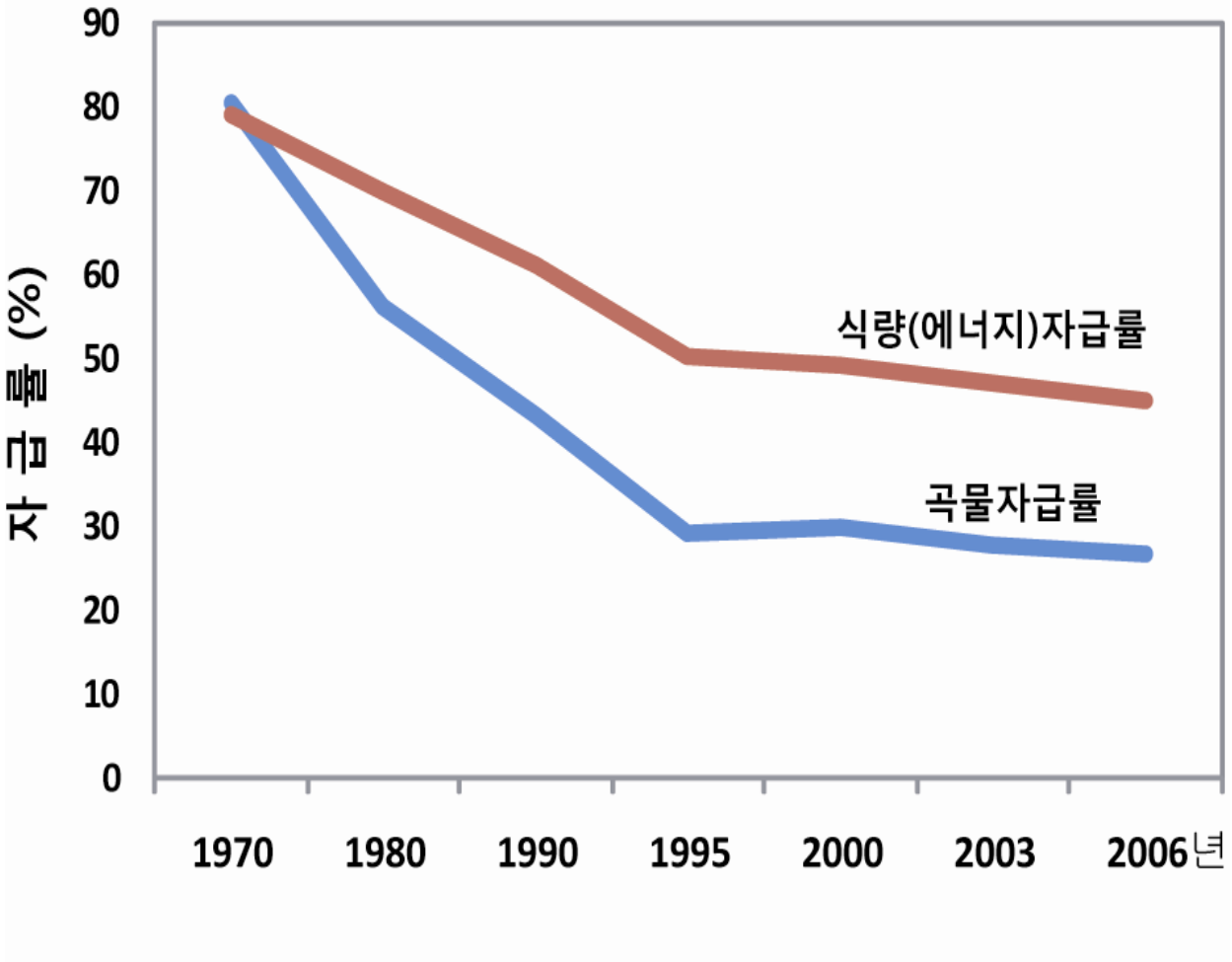
Postharvest loss and food waste
Poor utilization of food and imbalanced nutrition
Incidences of food hygiene and adulteration
Consumer's concern on novel food and new technology



Special situation in Korea

- **Food Security – very weak**
  - 70% of grains are imported.
  - Food energy self-sufficiecy – < 50%
- **Food safety demand – very high**
  - Frequent food safety incidences
  - Mistrust on government action
  - NGO's boycott campaign
  - Silence of scientists

Changes in food self- sufficiency in Korea



Food safety and Food security

- **Two sides of a coin**

- **Mutual colliding and supporting**

  In case of shortage – No room for Safety

  In case of unsafe – No use with pile of food

Food safety ⇧ - Food Availability ⇩, Food price ⇧

A social consensus is needed to harmonize food safety and food security

2009 IUFoST-Japan
Food Safety and Security Symposium

INTERNATIONAL UNION OF FOOD SCIENCE & TECHNOLOGY

IUFoST

E-Newsline #5

In This Issue

What's New This Week

-Kellogg's to stamp out imitation cereals as Corn Flake sales soar
-Actimel advert banned over 'misleading' claims
-Analyst ups Coca-Cola estimate
-Supermarkets reducing organic ranges
-Kraft to wait for Cadbury's Q3 results
-UK consumers want food labelled with country of origin
-Kraft makes multi-million dollar

IUFoST -JAPAN Food Safety and Security Symposium

September 2009 saw the opportunity for the IUFoST leadership to reaffirm and renew our long relationship with IUFoST founding member, Japan with the IUFoST-Japan Food Safety and Security Symposium, meetings with Japan industry and research institutes, with our colleagues in IUFoST Japan and with hands-on training in Cup-of-Noodle making.

From left: IUFoST Japan President, Tomohiko Mori, Academy Fellow Katsuyoshi Nishinari and Academy Founding Fellow and former IUFoST Governing Council member, Kyoden Yasumoto

The first paper of the symposium was given by Prof Seiichi Homma, the immediate past Commissioner of the Food Safety Commission, in the Cabinet Office of the Japanese government. He reminded us of Japan's high dependency on imported food, some 60% of its needs. Pressure was therefore on government both on food security, and on food safety, as improved methods of analysis lowered detection levels of pesticide residues and contaminants. Then Prof Takanori Mine, Director of Food Safety Research for ILSI Japan

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2009 IUFoST-Japan 식품안전 및 식량안보 심포지엄

2009년 9월 12일 일본 나고야대학

- Food Safety and Security in Japan
  Seiichi Homma (passed Commissioner of Food Safety Commission)
- Food Safety and Food Security – IUFoST Global Role
  Geoffrey Campbell-Platt (IUFoST President, Univ. of Reading, UK)
- Food Safety and Security in China
  Piingfan Rao (Fuzhou Univ., China)
- Food Safety and Security in Korea
  Cherl-Ho Lee (Korea Univ,. Korea)
- Food Safety and Security in Canada
  Rickey Yada (Guelph Univ., Canada)

Korean Dilemma

1. Grain self-sufficiency below 30% - Does Korean government take this situation seriously as crisis and is willing to improve?

2. Rice market will be opened in 2015 – Is Korean rice competitive to the imported rice?

3. Non-GM crops are disappearing from the world market – Are Koreans ready to consume GM food?

4. Ever-increasing constrains on food industries – is Korean food chain sound and responsible for national food supply?

FOOD SECURITY

REVIEW

Food Security: The Challenge of Feeding 9 Billion People

H. Charles J. Godfray,[1]* John R. Beddington,[2] Ian R. Crute,[3] Lawrence Haddad,[4] David Lawrence,[5] James F. Muir,[6] Jules Pretty,[7] Sherman Robinson,[8] Sandy M. Thomas,[9] Camilla Toulmin[10]

Continuing population and consumption growth will mean that the global demand for food will increase for at least another 40 years. Growing competition for land, water, and energy, in addition to the overexploitation of fisheries, will affect our ability to produce food, as will the urgent requirement to reduce the impact of the food system on the environment. The effects of climate change are a further threat. But the world can produce more food and can ensure that it is used more efficiently and equitably. A multifaceted and linked global strategy is needed to ensure sustainable and equitable food security, different components of which are explored here.

12 FEBRUARY 2010 VOL 327 SCIENCE www.sciencemag.org

Role of irradiation technology for food security

- Prevent food loss
- Improve food quality and shelf-life
- Reduce food poisoning
- Enhance food trade and quarantine control

Value analysis of IR in Korea

- 1. Fresh food storage
- 2. Processed food quality enhancement
- 3. Processed food shelf-life extension
- 4. Reduction of food-born diseases
- 5. Cost for IR detection for food labeling

Food items permitted for irradiation in Korea

허가품목	허가선량 (kGy)	목적	허가날짜
감자,양파,마늘 밤 생버섯 및 건조버섯	0.15 0.25 1	발아억제 발아억제 숙도지연	1987. 10. 16
건조향신료	10	살균. 살충	1988. 9. 13
가공식품 제조원료용 건조식육 및 어패류 분말 된장, 고추장, 간장 분말 조미식품 제조원료용 전분	7 7 5	살균. 살충 살균. 살충 살균. 살충	1991. 12. 13
가공식품 제조원료용 건조채소류 건조향신료 및 이들 조제품 효모, 효소식품 알로에 분말 인삼(홍삼포함)제품류 2차 살균이 필요한 환자식	7 10 7 7 7 10	살균. 살충 살균. 살충 살균. 살충 살균. 살충 살균. 살충 살균	1995. 5. 19
난문 가공식품 제조원료용 곡류, 두류 및 그 분말 조류식품 복합조미식품 소스류 분말차 침출차	5 5 7 10 10 10 10	살균 살균. 살충 살균. 살충 살균 살균. 살충 살균. 살충 살균. 살충	2004. 5. 24

자료 : 복지부

Average production amounts (1996-2004) and estimated post-harvest loss of fresh foods in Korea (Unit: MT)

연도	조미채소 전체		마늘		양파		고추	
	재배면적	생산량	재배면적	생산량	재배면적	생산량	재배면적	생산량
1970	63,013	288,600	15,351	78,009	4,006	83,387	36,983	53,484
1980	195,982	1,124,229	37,080	252,768	7,741	274,918	132,703	125,056
1990	136,375	1,458,365	43,643	416,774	7,602	407,353	62,759	132,748
1996	166,477	1,810,757	41,973	455,955	9,661	578,574	90,762	218,462
1997	149,605	1,860,507	36,292	393,384	12,539	740,187	77,549	200,705
1998	142,959	1,971,957	37,337	393,903	14,806	872,095	65,344	146,640
1999	162,170	2,297,122	42,416	483,778	16,131	935,828	75,574	215,382
2000	162,656	2,232,743	44,941	474,388	16,773	877,514	74,471	193,786
2001	152,712	2,316,476	37,118	406,385	18,995	1,073,708	70,736	180,120
2002	144,866	2,117,019	33,153	394,482	15,314	933,095	72,104	192,753
2003	124,743	1,810,150	33,140	378,846	12.352	745,203	57,502	132,010
2004	135,099	2,178,628	30,237	357,824	15,563	947,797	61,894	154,962
2005	132,403	2,101,662	31,766	374,980	16,737	1,023,331	61,299	161,380
평년	137,456	2,132,436	32,686	382,769	15.871	968,074	64,643	165,487

-자료: 농림부, 채소류 생산실적, 2005

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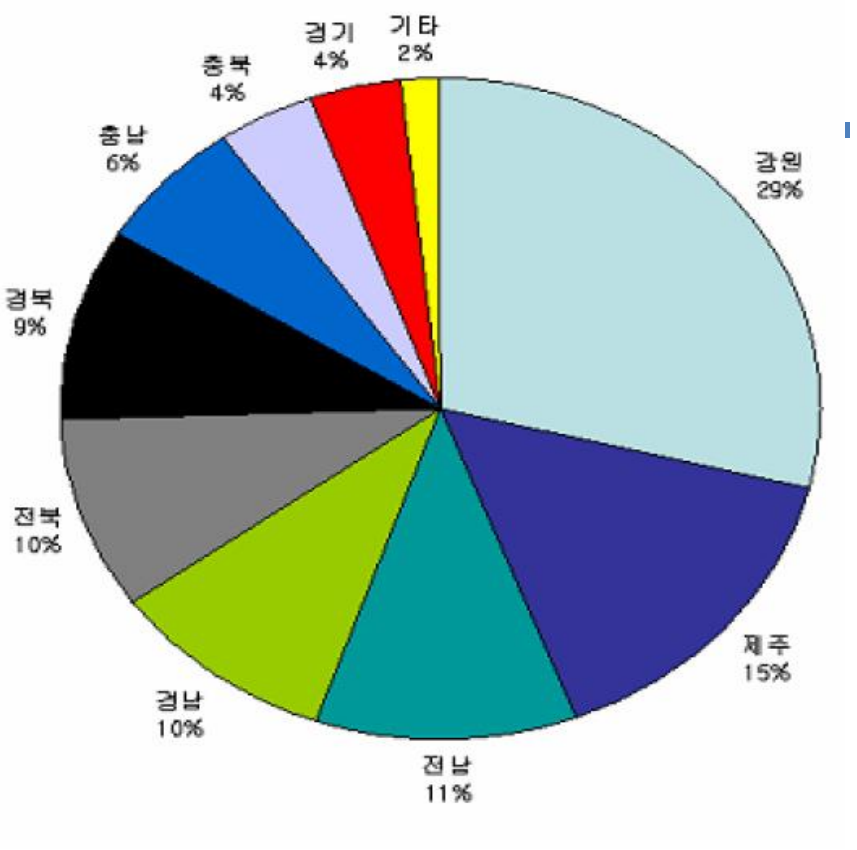
	2000	2001	2002
재배면적 (ha)	29,415	24,691	24,673
생산량 (ton)	704,623	603,627	573,415

자료: 감자 수확 후 관리기술 매뉴얼, 임학태(2005)



<시도별 생산량 비교>

감자큐어링 기술체계확립 및 저장기술, 정천순

표 5. 원예산물의 품목별 손실률

손상 용이도	평균보존 가능기간(주)	품목		손실률(%)
		과일	채소	
매우 높은 것	<1	딸기, 살구, 벚찌, 무화과	상추, 시금치, 파, 완숙토마토, 양송이 버섯	25~50
높은 것	1~2	포도, 비파, 밀감, 목숭아, 자두, 구아바, 망고, 파파야, 바나나	가지, 고추, 애호박, 양배추	20~40
중간 것	2~4	사과, 배, 오렌지, 레몬, 자몽	무, 당근, 미숙감자	15~30
낮은 것	>4	야자, 핵과류, 건과류	완숙감자, 양파, 마늘, 늙은호박, 고구마	10~20

감자의 저장 형태별 손실율

저장고 형태	손실률(%)
가 저장고(매장)	30 이상
반지하저장고	20~30
반지하저장 개량저장고	3~5
개량형 저온저장고	3

주요 채소류 수확 후 유통 중 감모율 (단위: ha. 톤)

작물	유통 단계					
	저장	선별, 포장	상, 하차	도매	소매	계
무	-	6.0	12.0	10.1	5.9	34.0
배추	-	6.5	13.0	11.5	7.1	38.1
고추	7.0	2.3	2.8	3.5	4.8	20.4
마늘	9.1	3.1	1.8	6.3	6.4	26.7
양파	5.4	6.5	3.4	5.4	3.4	24.1

자료: 마늘 수확 후 관리기술 매뉴얼, 이승구(2006)

Value of post-harvest loss of fresh foods in Korea (US$)

				
평균 생산량 (ton/year)	627,221[a]	382,769[b]	165,487[b]	968,074[b]
감모율 (%)	25[c]	26.7[d]	20.4[d]	24.1[d]
연간 감모량 (ton/year)	156,805	102,199	33,759	233,305
도매가격(원/kg)[e]	770	4470	13666	370
손실비용(원)	약 1,207억	약 4,568억	약 4,613억	약 863억

a ; 감자 수확 후 관리기술 매뉴얼, 임학태(2005)
b ; 농림부 채소류 생산 실적(2005)
c ; 반 지하 저장고 기준, 수확 후 관리기술 매뉴얼, 감자, 농림부, 농협중앙회(2005)
d ; 마늘 수확 후 관리기술 매뉴얼, 이승구(2006)
e ; 농산물 도매가격, 농수산물 유통공사, 2011. 5, 2 현재, 중품 기준

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Value of processed foods (IR Permitted) wasted by exceeding sell-by date (US$)

품목명	2008 년			2009 년		
	출하액(천원)	반품율(%)	손실액(천원)	출하액(천원)	반품율(%)	손실액(천원)
다류	450,199,836	6.30	28,362,590	512,966,958	6.30	32,316,918
장류	890,002,687	2.01	17,889,054	919,233,505	2.01	18,476,593
조미식품	1,705,198,787	1.85	31,546,178	2,045,684,520	1.85	37,845,164
드레싱	152,362,232	0.73	1,112,244	183,329,765	0.73	1,338,307
조사허가 합계			78,910,066			89,976,982

→ 조사허가 품목 중 유통기한 초과로 인한 가공식품 폐기 손실액은 연간 약 900억

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Value of processed foods (IR non-permitted) wasted by exceeding sell-by date (US$)

품목명	2008 년			2009 년		
	출하액(천원)	반품율(%)	손실액(천원)	출하액(천원)	반품율(%)	손실액(천원)
식육, 알가공품	256,990,730	1.85	4,754,329	329,459,431	1.85	6,094,999
어육가공품	423,143,845	4.73	20,014,704	468,441,578	4,73	22,157,287
건포류	199,997,946	1.85	3,699,962	235,986,045	1.85	4,365,742
축산물가공품	7,237,400,000	1.85	133,891,900	8,669,900,000	1.85	160,393,150
조사비허가 합계			162,360,895			193,011,178

→ 조사비허가 품목 중 유통기한 초과로 인한 가공식품 폐기 손실액은 연간 약 1900억

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조사허가 품목 중
유통기한 초과로 폐기되는
가공식품 손실액은 연간 약 900억

조사비허가 품목 중
유통기한 초과로 폐기되는
가공식품 손실액은 연간 약 1900억

방사선 조사기술이용

방사선 조사 품목 확대

유통기한 연장으로 가공식품 폐기율 감소

손실액 감소

경제적 이득 창출

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Food Irradiation

Which foodborne diseases could be prevented with irradiation?

Treating raw meat and poultry with irradiation at the slaughter plant could eliminate bacteria commonly found raw meat and raw poultry, such as *E. coli* O157:H7, *Salmonella*, and *Campylobacter*. These organisms currently cause millions of infections and thousands of hospitalizations in the United States every year. Raw meat irradiation could also eliminate Toxoplasma organisms, which can be responsible for severe eye and congenital infections. Irradiating prepared ready-to-eat meats like hot dogs and deli meats, could eliminate the risk of *Listeria* from such foods. Irradiation could also eliminate bacteria like *Shigella* and *Salmonella* from fresh produce. The potential benefit is also great for those dry foods that might be stored for long times and transported over great distances, such as spices and grains. Animal feeds are often contaminated with bacteria like *Salmonella*. Irradiation of animal feeds could prevent the spread of *Salmonella* and other pathogens to livestock through feeds.

미국 내 발생되는 주요 식중독 증상, 발생건수 및 주요감염원

Candidates for Food Irradiation

pathogens	cases	major complications	identified source of infection
E. coli O157 and other Shiga toxin-producing *E. coli*	More than 100,000 cases of illness per year	hemolytic uremic syndrome, chronic renal failure and death	Ground beef
Campylobacter jejuni	2,000,000 cases of illness	GBS(Guillain-Barre' syndrome), an acute neurologic disorder)	Poultry
Salmonella	1,400,000 cases of illness		Meat, poultry, eggs and raw milk
Listeria monocytogenes	2600 cases per year of severe invasive illness	Infection affects those who have compromised or the undeveloped immune system	Ready to eat processed meats and soft cheese
Toxoplasma gondii	400-4,000 cases of congenital disease/ 200,000 cases of noncongenital illness	hydrocephalus, mental retardation, blindness and death	Consumption of or undercooked meat, especially pork

Food Safety and Irradiation : Protecting the Public from Foodborne Infections, Robert V. Tauxe, CDC(2001)

Potential Health Benefits of Irradiating Meat and Poultry

1. Assume that 50% of poultry, ground beef, pork, and processed meats are irradiated.
2. Also assume that these foods are the source of 50% of foodborne E. coli O157, Campylobacter, Salmonella, Listeria and Toxoplasma infection

Potential number of health problems prevented annually if 50% of meat and poultry are irradiated

Pathogen	Cases	Hospitalizations	Major complications	Deaths
E. coli O157:H7 and other STEC	23,000	700	At least 250 cases of hemolytic uremic syndrome	20
Campylobacter	500,000	2,600	250 cases of GBS	25
Salmonella	330,000	4,000	6,000 cases of reactive arthropathy	140
Listeria	625	575	60 miscarriages	125
Toxoplasma	28,000	625	100-1,000 cases of congenital toxoplasmosis	94
Total	881,625	8,500	6,660 catastrophic illnesses	352

Food Safety and Irradiation : Protecting the Public from Foodborne Infections, Robert V. Tauxe, CDC(2001)

Estimated economic loss caused by food-born diseases in Korea

비용	식중독환자수 (명)	Bivariate logit을 이용한 WTP	Bayesian을 이용한 WTP	Bivariate logit을 이용한 총비용 (원)	Bayesian을 이용한 총비용 (원)
총 식중독 환자수	11,224,766	3,863	3,328	**1조 2천억원** (1,227,991,196,363)	**1조 5백억원** (1,057,922,521,743)
경증(미보고 환자)	9,046,696	3,767	3,152	**9천6백억원** (965,144,556,522)	**8천억원** (807,550,061,629)
중등도(외래환자)	1,548,612	3,966	3,388	**1천7백억원** **(173,935,639,837)**	**1천5백억원** (148,586,471,954)
중증(입원환자)	629,458	3,853	3,205	**6백9십억원** (68,684,543,408)	**5백7십억원** (57,133,133,045)

자료 : 기후변화에 따른 식품안전 분야의 사회 경제적 손실비용 평가. 2009

식중독 발생 감소에 따른 잠재적 가치(식중독 발생으로 인한 사회,경제적 손실비용)는 연간 1조 576억원 – 1조 2,279억원으로 추정

KFSRF 한국식품안전연구재단

Estimation of food poisoning prevention rate by IR in Korea

	연간 식중독 발생건수	방사선 조사 시 예방 가능한 발생건수	연간식중독 감소비율(%)
E.coli O157 and other Shiga toxin-producin *E.coli*	100,000	23,000	23
Campylobacter jejuni	2,000,000	500,000	25
Salmonella spp.	1,400,000	330,000	23.57

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전체 식중독 발생으로 인한 사회적 손실 비용
-1조2천억원
(- 1,227,991,196,363 원)

세균성 식중독 발생으로 인한
사회적 손실 비용

- 7490억
(- 749,074,629,781 원)

Salmonella, Campylobactor , E.coli
식중독으로 인한 사회적 손실 비용

- 3680억
(- 368,397,358,908 원)

방사선조사기술 이용 시
- 23.9% 감소

Salmonella, Campylobactor , E.coli
식중독감소로 인한 이득 비용

+ 880억
(+ 88,046,968,779 원)

KFSRF
한국식품안전연구재단

식중독 발생으로 인한 사회,경제적 손실비용 → 연간 1조 576억원 – 1조 2,279억원으로 추정

- 방사선 조사 시 살균효과가 높은 *Salmonella, Campylobactor jejuni, E.coli*에 의한 식중독은 전체 식중독의 30% 차지
- 세균성 식중독은 전체 식중독의 61% 차지

방사선 조사는

- 세균성 식중독으로 인한 7490억원 중 일부 비용 감소 효과
- 특히, *Salmonella, Campylobactor , E.coli* 식중독감소로 인한 3680억원중 880억원 비용감소

KFSRF 한국식품안전연구재단

Conclusion

- Food security is the most important issue for the future of human society.
- Technological developments including biotechnology and food irradiation can solve the global food crisis.
- In-depth risk and benefit analyses are needed for the new technologies
- Irradiation is estimated to save $ post-harvest loss and $ food poisoning cost in Korea
- More studies are needed to evaluate the socio-economic benefit of food irradiation
- Education of the people to distinguish radio-active contaminated food and irradiated food is urgently needed.

감사합니다

Thank you