Research on food and nutrition security and agriculture in Asia

- Opportunities and challenges -

A Report from the **Association of Academies and Societies of Sciences in Asia (AASSA)**
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I N D E X

PART 1. AASSA

PART 2. Food security for Korea

PART 1. AASSA

I. Introduction

1.1 The global challenge

- One of the **greatest challenges** is the provision **nutritious healthy foods** for a **rapidly growing** world population.

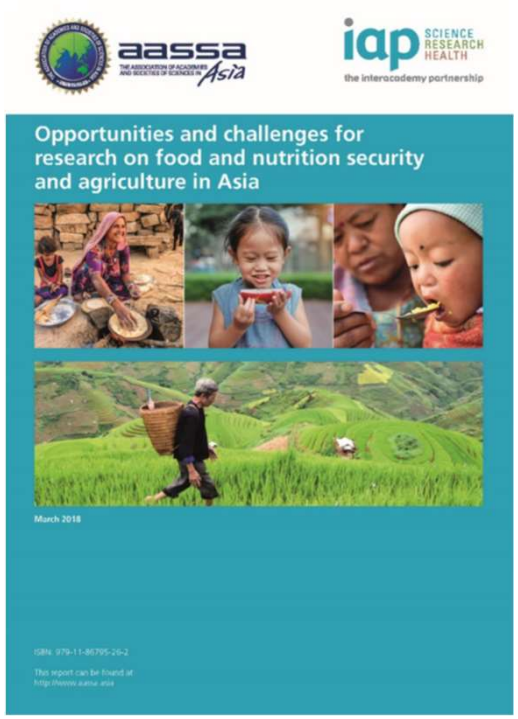
- **Much more food (e.g. cereals, vegetables, nuts, dairy products, eggs, meat and fish)** needs to be **produced** and **distributed** equitably to ensure a balanced diet for around **10 billion** persons by the year **2050**

2050 (+ 2.4 billion)

2019 world population (7.7 billion)

1.1 The global challenge

- The global science academies are committed to engaging widely to strengthen the evidence base for enhanced **food and nutrition security (FNS)** at global, regional and national levels.



- In this AASSA report, **messages** on how S&T can help the to resolve critical issues are aimed at
  1) key Asian and Pacific government organization and
  2) regional/national policy makers as well as
  3) the wider science and
  4) education community and
  5) other stakeholders.

1.2 The central importance of eradicating poverty

- Most of the projected **world population growth** to 2050(2.4 billion) will occur in **low-income countries**

- and almost **half of the population growth** will occur in **Asia.**

*FNS: food and nutrition security

1.3 What is different about the AASSA approach?

- The geographical area includes **Asia and the Pacific** (Australia, New Zealand and the Pacific Islands).

- Asia is the **world's largest & most populous continent** and compromises 48 UN countries and 6 other states.

- **Several countries** were selected for a detailed study to provide an overview of the region. **(Australia, China, India, Indonesia, Israel, Japan, South Korea, Thailand)**

1.3 What is different about the AASSA approach?

- This region includes numerous countries that differ in
  - gross domestic product (GDP) per capita,
  - economic growth rate,
  - population growth rate,
  - natural resources,
  - nutritional deficiencies and excesses,
  - and political, cultural and social drivers.

1.3 What is different about the AASSA approach?

- The analysis was guided by a template of common themes for the project developed at the IAP level

< IAP template[1] for common themes in the project and how these map over to the sections of the AASSA report>

IAP template theme	AASSA report section
1. Key elements for describing national/regional characteristics for FNSA.	1
2. Major challenges/opportunities for FNSA and future projections for region.	2
3. Strengths and weaknesses of science and technology at national/regional level.	3
4. Prospects for innovation to improve agriculture (next 25 years).	4
5. Prospects for increasing efficiency of food systems.	5
6. Public health and nutrition issues, impact of diet change on food demand and health.	6
7. Competition for arable land use.	7
8. Major environmental issues associated with FNSA at the landscape scale.	8
9. Impact of national/regional regulatory frameworks and impact of other sectoral/inter-sectoral public policies on FNSA.	
10. Implications at inter-regional/global levels.	

Ⅱ. Defining the challenge

2.1 Key elements for FNS at national and regional levels

- Key elements for **FNS** such that

  1. no **macro- or micronutrients** (including trace elements and vitamins) are deficient and

  2. such that other **plant and animal compounds** (e.g. marine omega-3 and other key fatty acids, phytochemicals, plant non-starch polysaccharides (fibers) and specific amino acids)

  are present in the diet in adequate amounts.

- The need for a balanced diet is exemplified by several data sets.

2.2 Projected changes in population size

Much of this growth is in Asia:

	2015	2050(projected)
	4.4 bill	5.3bill

But variable:

	2015	2050(projected)
India	1311 mill	1705 mill ⬆
Indonesia	258 mill	322 mill ⬆
Japan	127 mill	107 mill ⬇
China	1377 mill	1348 mill ⬇
South Korea	50 mill	50 mill ▬

- It is projected that there will be around **1 billion** (about half the projected world growth) more people **in Asia in 2050** compared with today.

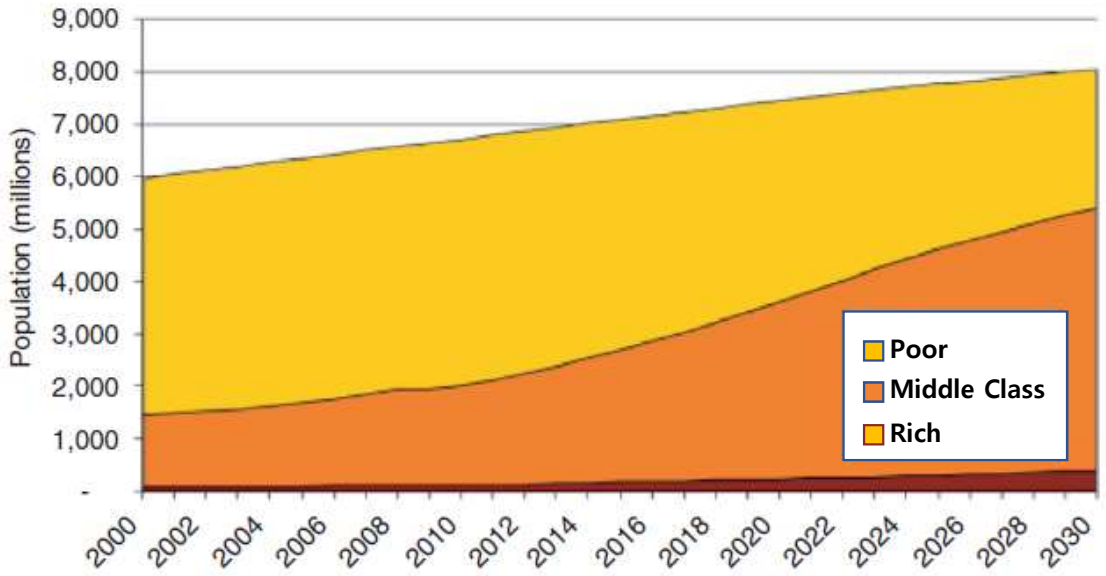
- Almost **half** of the projected **population growth** for Asia is **in India.**

2.3 Projected changes in the middle-class

- The world is moving **from being mostly poor** to being mostly **middle-class.**
- This projection has **positive implications for FNS.**
- On the based of these trends, it is predicted that **global meat and milk production** will need to increase considerably to the year 2050.

< A rising middle-class in the Asia/Pacific region (millions of people) >

	2009	2020 (projected)	2030 (projected)
Asia/Pacific	525	1740	3228



2.4 Current levels of under- and over nutrition

- Currently, in the world, **around 850 million people suffer** from **hunger**(calorie/protein insufficiency) and

- About 2 billion people suffer from **hidden huger** (Under-nutrition where **calorific and protein** needs seem to be **met**, **but** where **micronutrients, minerals and vitamins are undersupplied)**

2.4 Current levels of under- and over nutrition

[Example – Hidden hunger]

India

This example of a child's meal in India includes wheat, eggplant and potato

What is missing?

Vitamin A : 62% of children under 5 years are deficient in vitamin A.

Iodine : Only 71% of households consume adequately iodised salt

Iron : 70% children under 5 years are anaemic.

2.4 Current levels of under- and over nutrition

Major issue in Asia/Pacific

IFPRI Global Hunger Index (GHI)	
India	29
Indonesia	22
Pakistan	34
Tajikistan	30
Yemen	34
North Korea	34

Score > 10, moderate under-nutrition
Score > 20, serious under-nutrition
Score > 35, alarming under-nutrition

2.4 Current levels of under- and over nutrition

- In many countries, the development of **non-communicable diseases** (e.g. cardiovascular disease, type 2 diabetes and certain forms of cancers), all associated with **obesity.**

- These conditions, are **leading** to escalating **medical costs** worldwide.

Overweight among children aged 5-17 years in 2010

	% of age group
Australia	23
China	20
India	20
Indonesia	10
Israel	22
Japan	20
South Korea	23
Thailand	20(2015)

2.9 Socially sustainable diets and environmentally sustainable food production systems

There is **no doubt** that the **global net food supply** will be **required** to increase dramatically **towards the year 2050.**

< Solution >

1) **Reducing** food **wastage**
2) **Changing** food consumption **patterns**
3) **producing** more **food** from existing agricultural land

In future farm production**, 'Sustainable intensification'** will be required, and this will require a **step-change in S&T**

Ⅲ. Science and policy context

3.1 Importance of Science and policy context

- Politicians and policy-makers should involve in **planning for future FNS**(Food and Nutrition Security) issues, but scientists must provide the data-driven advice.

3.2 National and regional policies for FNS should include ..

1. Policies that affect technological or other innovation in food systems

- **Biotechnology** in agriculture **and** other **'new food' technologies.**
  A common terminology for describing the use of biotechnology in crop/strain improvement should be developed. The terms 'GMO', 'GM', 'biotech', 'genetic engineering', etc. are used interchangeably in different countries and by different agencies. ->a precise vocabulary is called
- Animal welfare
- **Labelling of food** with regard to nutrient content and nutritional value.

3.2 National and regional policies for FNS should include ..

2. Policies that build human resources, including those relating to the following

- Education and training.
- Attracting young people to work in food systems and agri-food research.

3.2 National and regional policies for FNS should include ..

3. Policies that help to redesign the agricultural economy.

(particularly in regard to land use, the environment and other rural development.)

- Social policies, including access to food.
- Policies to promote the consumption of sustainable, healthy food.
- Policies on climate and energy use, water availability and quality, habitats and biodiversity.
- Policies that mediate the relationship between countries within the region, and indeed with the rest of the world (e.g. trade agreements and development aid).

IV. Strengths and weakness of S&T at national/regional levels

4.1 S&T as the engine of long-term change in FNS

- **'Basic research'** is *experimental or theoretical work undertaken to acquire new knowledge of phenomena and observable fact without application or use in view*

- **'Applied research'** is *original investigation to acquire new knowledge directed toward a specific practical aim or objective*

- The benefits of investments in S&T are realized after years
- This lag return is detrimental to political desires for fast improvements that fit a voting cycle.

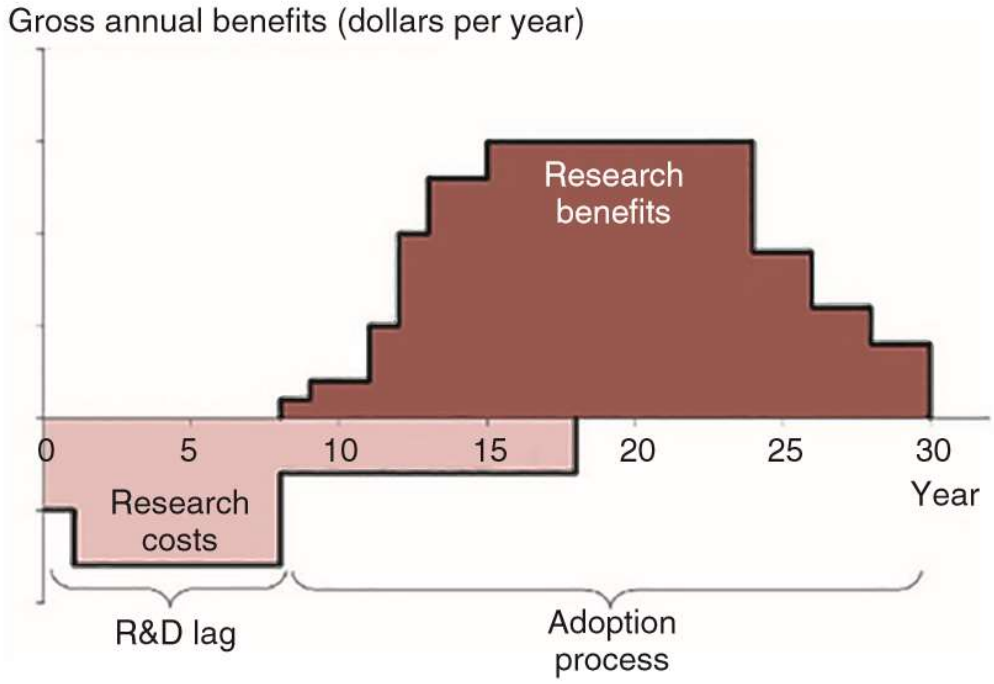


Figure 5 Research lag between investments and benefits. From Alston et al. (2008).

4.1 S&T as the engine of long-term change in FNS

- It took over **25 years** for hybrid maize to become the dominant technology in the corn industry
- Herbicide and advanced fertilizers took **30 years** to permeate the market
- In the adoption of GM tech for some crops like a GM maize, the R&D lag has shrunk/reduced to **15 years**
- Adoption of GM tech for most crops is endless due to regulatory issues

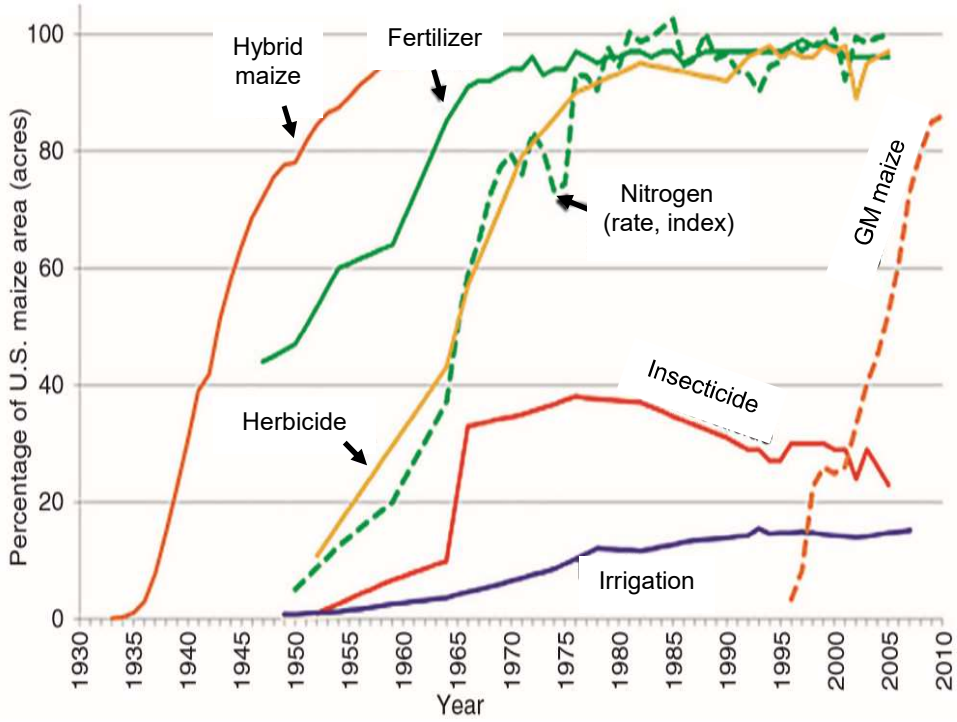


Figure 6. Rate of adoption of new technologies underpinning maize production on the USA (1935-2010)

4.2 S&T within the Asia/Oceania region at the national level

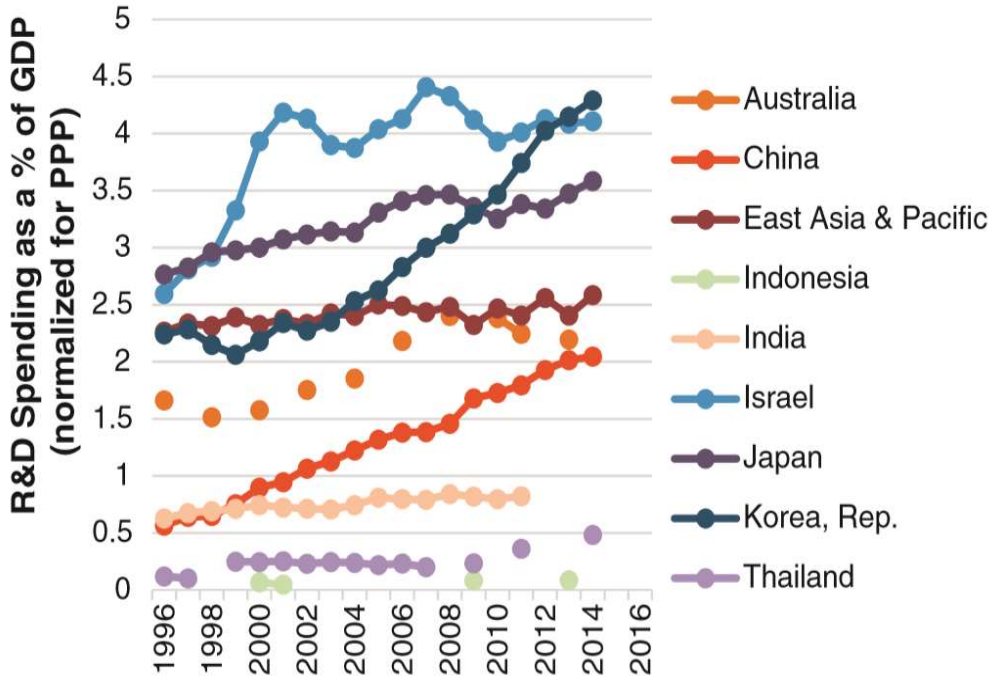


Figure 7 Trends in R&D expenditures (% of normalised GDP). Data taken from the World Bank (2017) and data within.

- Investment in the S&T across the region varies widely, but can be divided roughly into <u>four classes</u>

1) Mature S&T countries
   Australia, Israel, Japan, S. Korea
2) The advanced developing S&T countries
   China, India
3) Developing S&T countries
   Thailand
4) Countries with limited S&T capacity
   South-Eastern, Central and Western Asia

V. Opportunities for innovation in food, nutrition and health

5.1 Nutrients, foods and diets

- **A food, not a nutrient,** should be viewed **as the fundamental unit** of nutrition.
  - Because…
    - Foods have

      influencing the **physicochemical environment** in the gut lumen and

      influencing both the **extent and the rate of nutrient digestion**.

    - Foods contain many compounds that are **not classically viewed as nutrients** but may have **important effects** upon human health**.**

      (e.g. phytochemicals, bioactive proteins and peptides, and fibre)

5.2 Functional foods and food fortification

- **Functional foods** : Some foods have, naturally or because of fortification, particularly **high levels of certain bioactive compounds**, such that the food has particular importance, not only in relation to **the provision of nutrients** but also because of **the physiological effects** consequent upon its ingestion.

- Examples
  - Oily fish supplying the marine omega-3 fatty acids
  - Oat bran containing soluble fibre that may attenuate fatty acid and cholesterol uptake
  - Lycopene and lutein in tomatoes influencing oxidative reactions in the body

5.3 Defining a healthy diet

- Changing views on healthy and unhealthy dietary components, over the years, disclose that the **definition of a 'healthy diet'** is **a** moving target.
  - Dietary cholesterol and, in particular, eggs were seen as unhealthy, but this view has changed.

- As **knowledge** concerning the nutritional and other effects of specific foods and food types accumulates, it will be easier to define **'healthy diets',** and refined versions of diet, such as the 'Mediterranean-type' diet.

5.4 Food safety and food wastage - the role of food technology

- There is **considerable wastage of foods** along all steps of the food supply chain

- **Minimization of such wastage** provides a considerable opportunity to increase food availability.

- Food processing technologies have the potential
  - Decrease the loss of food material
  - Enhance the shelf life of food products
  - Increase the food nutrient bioavailability
  - Enhance food safety

5.5 Sustainable diets

- The **FAO** (2012) has given a consensus definition for **'sustainable diets':**

'Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources '

VI. Opportunities for innovation in agriculture, aquaculture and marine resources

6.1.1 Advances in plant-based agriculture

- **Long-term gains in FNS** will come from the development of better **seeds,**
  and yield gains will come through the **adoption of superior genotypes** in agriculture

- **The gaps in yield** between those of ASEAN countries and the world's highest yields
  - Rice 69%
  - Sugar cane 15%
  - Cassava 66%
  - Maize 150%

6.1.2 Advances in plant-based agriculture

- **Molecular breeding and CRISPR**(Clusters Of Regularly Interspaced Short Palindromic Repeats) **technology**

  - **NBTs** (New breeding techniques), **including molecular breeding and CRISPR/Cas9**(CRISPR as associated protein 9),

  give scientists the ability to modify DNA more precisely by turning genes on or off, or to exact edit DNA for a desired new modification.

  - On the basis of using GM seeds,
    crop yields have increased 22% and that
    pesticide use has been reduced by 39%.

6.2 Advances in animal-based agriculture

- The efficiency of **conversion** of animal feed protein to meat protein is low, and scientific investigation at a mechanistic level is needed to allow increases in the efficiency of the utilization of protein

- Research into **pasture-based systems** for ruminant production and **the reduction of** GHGs(Greenhouse gas) should be a priority

- **NBTs** (New breeding techniques) and **new reproductive technologies** need to be properly assessed on the basis of scientific evidence.

6.3 Precision agriculture/robotics

- **Precision agriculture**

is an emerging farming concept that utilizes geographical information to determine field variability, to ensure optimal use of inputs and **to maximize the output** from a farm

6.3 Precision agriculture/robotics

- Particularly **in the developing world**,

the use of precision agriculture and new age robotics has the potential for greatly assisting small scale farmers

- If the data are collected and analyzed remotely,

the resulting instructions (e.g. time to harvest)

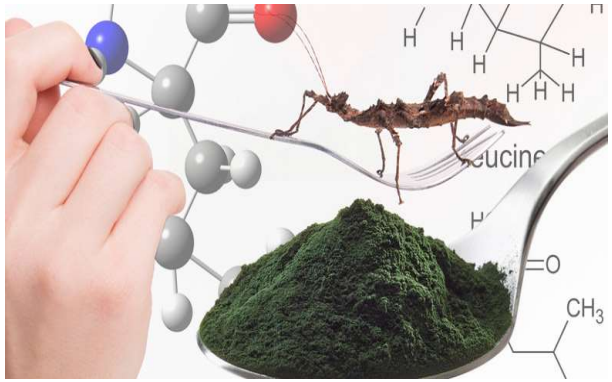
can be delivered through pervasive smart phone technology

in a graphical manner

6.4 Alternative food sources

- **Alternative food sources** are needed to provide protein for farm animals, in place of proteins that can be consumed by humans directly

- **Insects and algae** provide several advantages **over classic plant-based sources of protein** (e.g. grains and legumes), especially in terms of yield per unit area and environmental footprint when considering GHG(Greenhouse gas) emissions



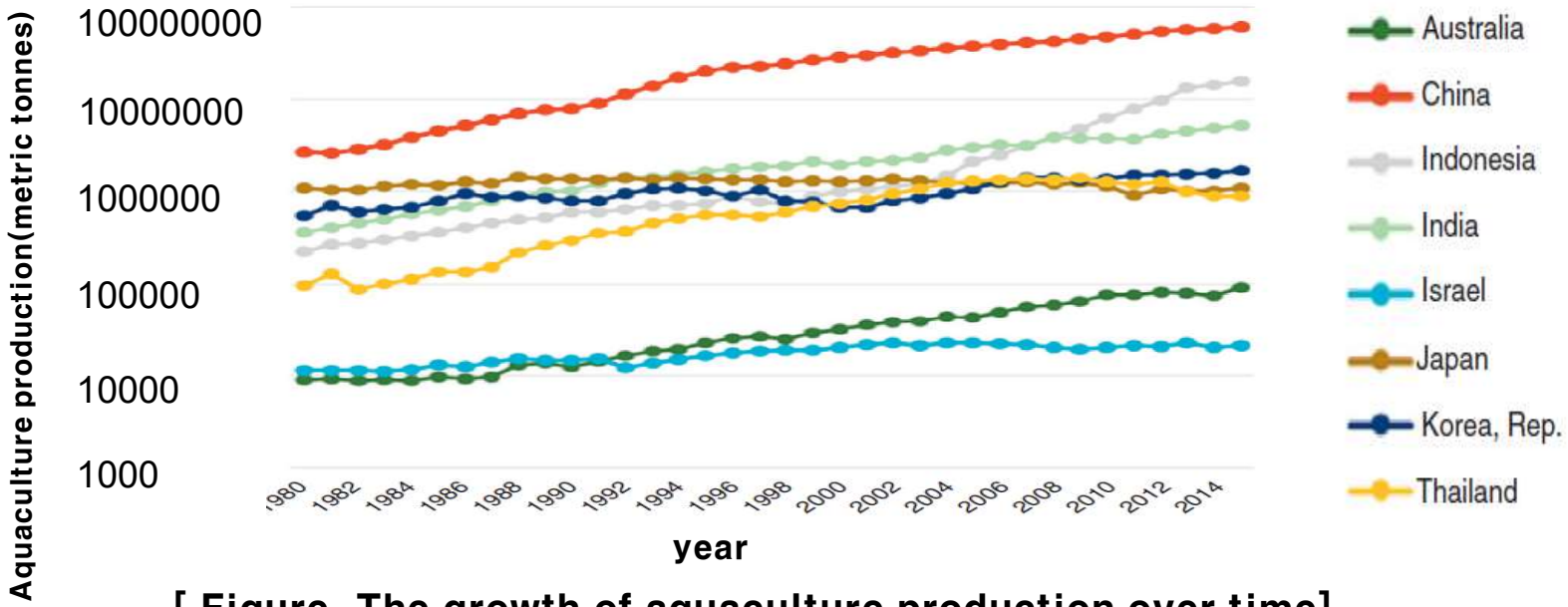
6.5 Aquaculture and marine resources

- **Aquaculture** is regarded worldwide as one of the fastest growing food-producing sub-sectors, particularly in several developing countries

- **Constituting a supply of food and a commodity for trade**,

aquaculture has the potential to contribute to the food and nutritional status of numerous people and is an especially valuable source of protein

6.5 Aquaculture and marine resources



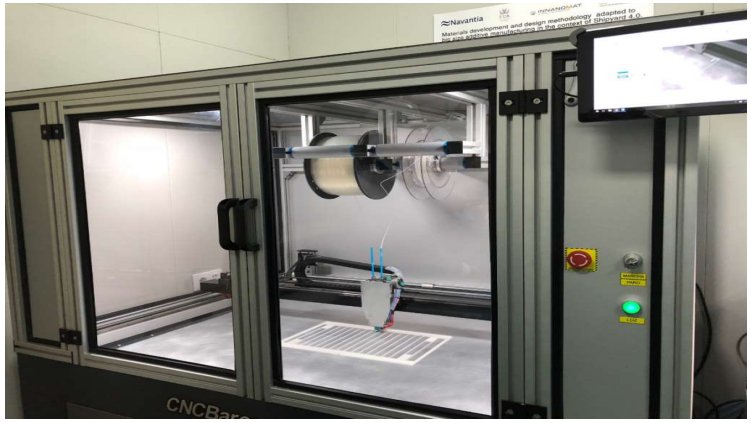
[Figure. The growth of aquaculture production over time]

- **China** is clearly the world leader in aquaculture production, with **Indonesia and India** having rapidly developing aquaculture industries

6.6 Potentially disruptive technologies

- Discoveries, often arising from fundamental science,
  have the capacity to lead to step-changes in agricultural productivity

- Examples of emerging disruptive technologies are **3D printing** from the ICT sector, **driver-less vehicles** and bio-based manufacturing to produce fuels, chemicals and materials through advanced, efficient and environmentally friendly approaches

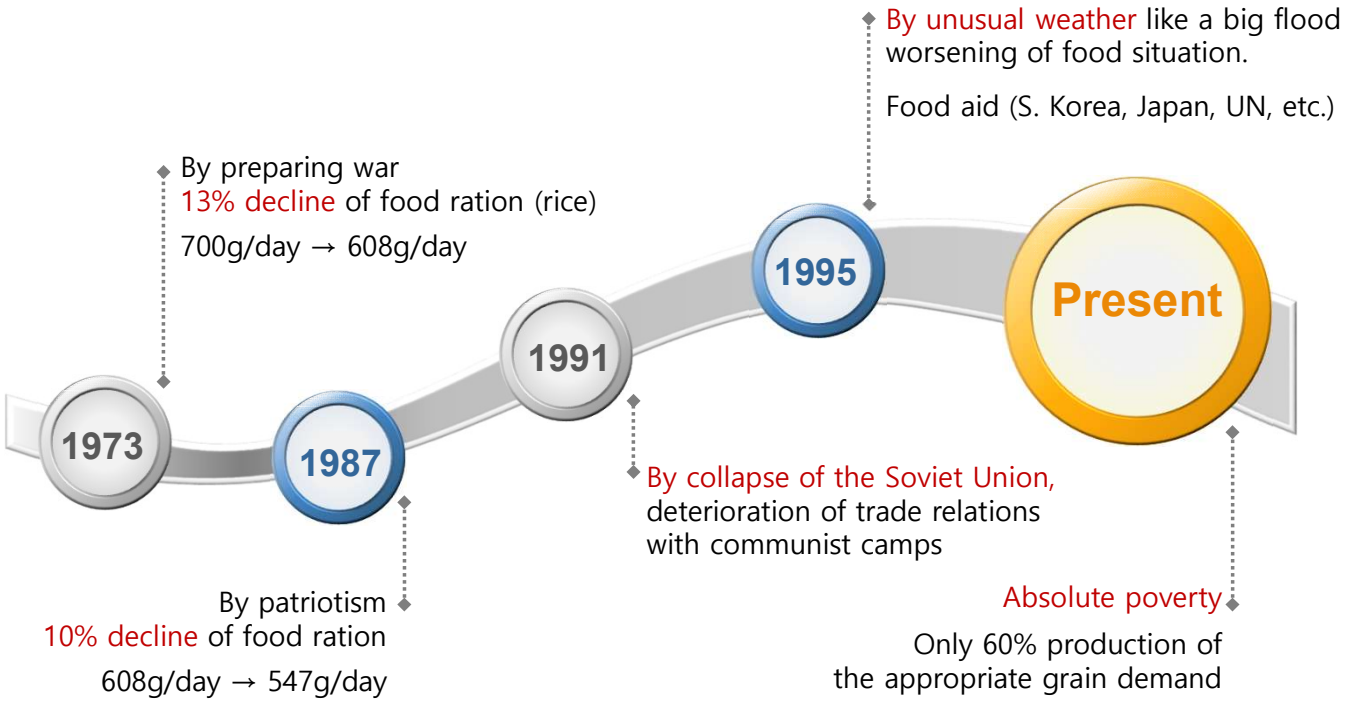


PART 2.

Food security for Korea

Ⅶ. Food situation in two Korea

7.1 Food crisis of North Korea



Food shortage of N. Korea is expected to continue

because of inefficiency of agricultural system, shortage of agricultural materials (fertilizers, pesticides, etc.), and contradiction of economic regime

7.2 Aid of North Korea by South Korea

1995
Free aid of rice 150,000 tons

After 2000
Loan (10 year-grace, 20 year-repayment, interest rate: 1%/year)

1995 ~ 2007
Rice 2.5 million tons, Corn 0.2 million tons

2008
- The Korean government interrupted food & fertilizer aid to N. Korea (Worsening of the two Koreas' relationship)
- Provide aid for vulnerable group (infants) through government, private and international organization

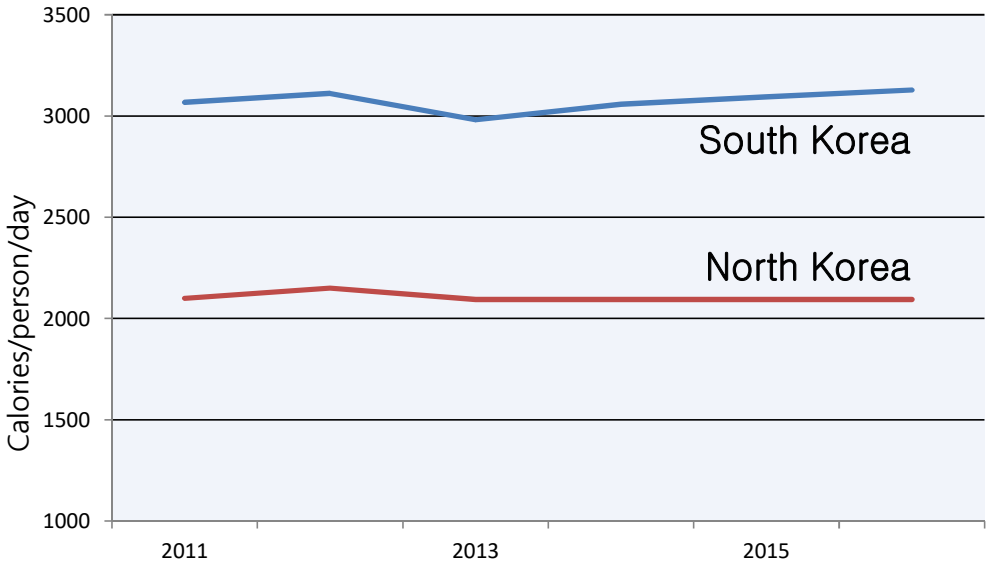
2009
Supply vaccine and hand sanitizer for swine flu

After 2010
No further aid as sanctions were imposed on North Korea due to the sinking of the Cheonan vessel

7.3 Change of Food energy supply of Korea

➢ Energy supply (kcal/person/day) of Korea

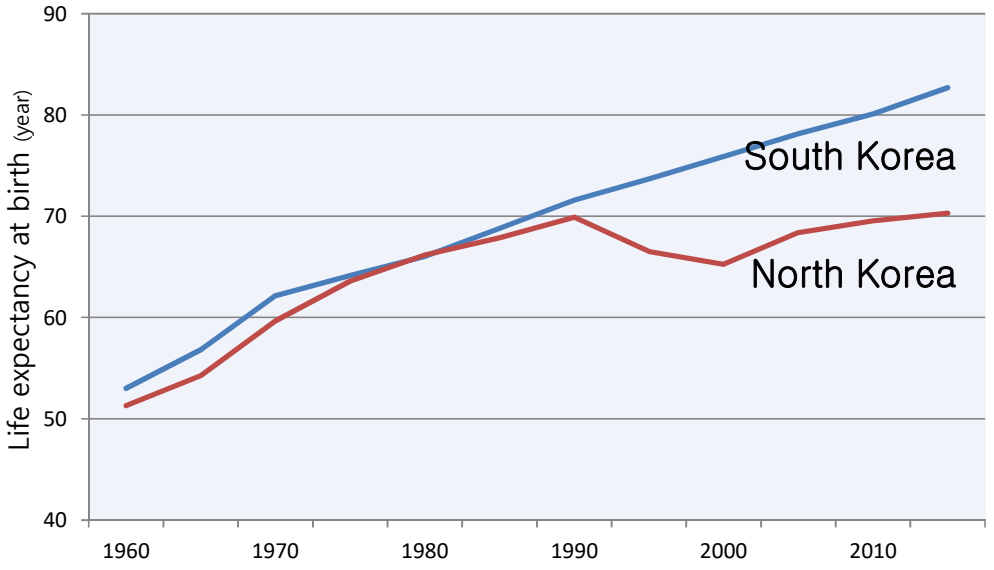
The food energy supply of North Korea(2017) was 2/3 of the supply of South Korea



7.4 Change of Life expectancy at birth of Korea

➢ Life expectancy at birth (year) of Korea

The recent Life expectancy at birth of North Korea (2017) was 10 years shorter than Life expectancy of South Korea



7.5 Food and nutrition situation of North Korea

- Vulnerable(weak) groups were more than 7.6 million people
  - Children, pregnant & nursing women, the elderly, the disabled, and tuberculosis patients

- The UNICEF/WFP/N. Korea survey on 2013

  - One-third of pregnant women are malnourished and anemic
  - Percentage of underweight children under 5:
    - Urban- 13.2%
    - Rural – 26.7%
  - Food shortage in rural areas is more serious than in urban areas

UNICEF (United Nations Children's Fund)

WFP (World Food Programme)

7.6 Food and nutrition situation of South Korea

- **Increase adult diseases** by nutritional excess and overweight

- Face high level of **food dependence** on overseas import
  because of food waste and lowered food self-sufficiency
  - **Flour**: 100% imported
  - **Edible beans**: 30% self-sufficiency, 70% imported
  - **Feed grains**: Less than 3% self-sufficiency, 97% imported

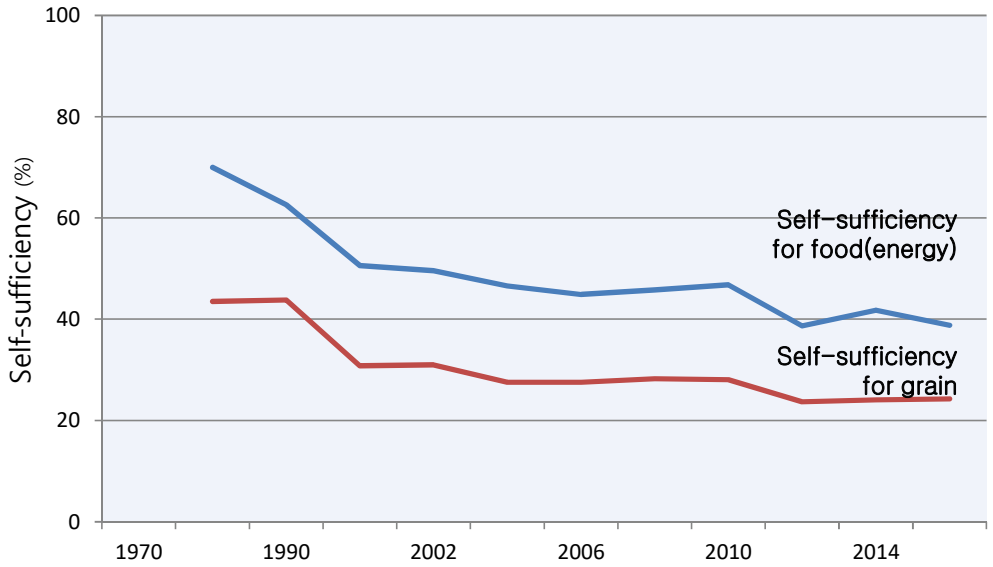
- Reduced **rice consumption** by westernization of diet

- Increase in **flour consumption** due to intake of instant noodle

7.7 Change of food self-sufficiency of South Korea

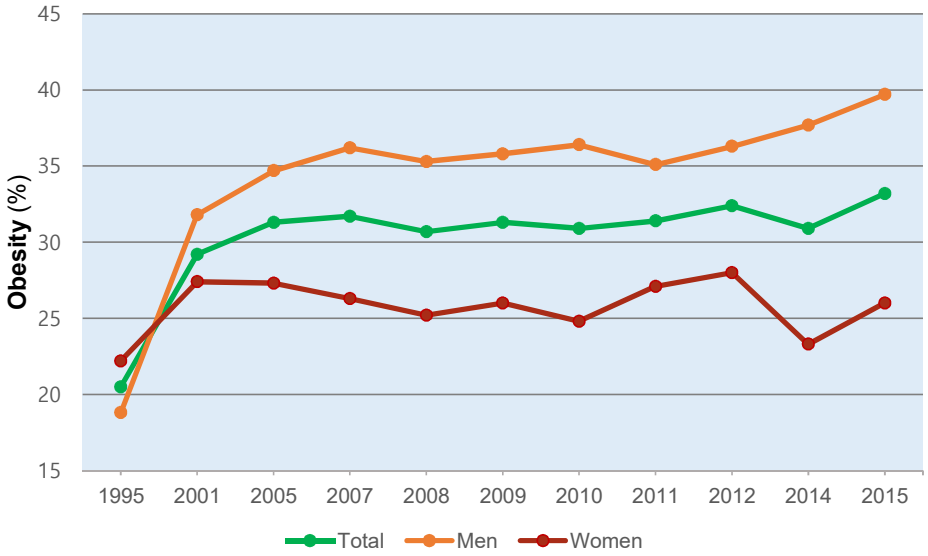
➢ **Food self-sufficiency of South Korea**

Decline of total food self-sufficiency



7.8 Obesity in South Korea

- In 1995 : Men: 18.8%, women: 22.2%, and <u>total: 20.5%</u>
- **In 2015** : Men: 39.7%, women: 26.0%, and **<u>total: 33.2%</u>**



Increase of obesity population
by westernization of diet,
increased food intake,
and excessive ingestion of animal
foods

7.9 Assessment of nutritional anthropology of Korea

- South Korea : High obesity rate by high fat intake, Low self-sufficiency of food
- North Korea : Malnutrition and tuberculosis patients due to lack of food & energy intake

	S. Korea	N. Korea
Farming population (1000 person)	1,367 (2018)	2,930 (2014)
Ratio of farming population (%)	4.9 (2018)	11.7 (2014)
Average food intake (g/person/day)	**1,300**	**500 (+)**
Energy intake (kcal)	**2,400**	**1,600**
Component ratio of energy (Carbohydrate : protein : fat)	65 : 15 : 20	80 : 12 : 8
Self-sufficiency of grain (%)	26	63
Average height (cm, men/women)	173/159	166/155
Change of weight (%)	obesity rate of adult, 33	chronic malnutrition, 42
Incidence rate of tuberculosis / mortality rate (person / 100,000 person)	90/8	344/25
GDP per person (US $, 2019)	**29,743**	**648**
Political system	open free liberal democracy	closed communitarianism

Ⅷ. Food policy projects for Korea unification

8.1 Food policy projects for Korea unification

- Legislation of 1.2 million tons of rice holding program based on Trust-building process policy
  - **Storage of Rice:**
    - Storing 0.6 million tons of rice annually for 2 years
      and then releasing **the reserved rice** to processing industry

8.1 Food policy projects for Korea unification

- Implementation of rice coupon system to improve the welfare of the poor
  - Set the **welfare system** for poor people in **S. Korea**

8.1 Food policy projects for Korea unification

- Increase rice production

  - To generate rice demand because of **rice storage(1.2 million tons)** for unification,

    rice coupon system, and **policy support of rice processing industry**

  - **Requirements of 4.8 million tons of rice** production annually in S. Korea

  - Current Rice production(2013): 4 million tons

  ➡ **Additional demands for 800,000 tons** of rice each year

8.1 Food policy projects for Korea unification

➢ Plan for self-sufficiency in soybean

- **Traditional Korean diet based on rice and soybean dishes**
  - Soybean sprouts, tofu, soybean paste soup, etc.
  - **Need to self-sufficiency of rice and soybean**

- **Self-sufficiency of soybean in S. Korea :**
  - 1990 (60%) → 2013 (29.1%)

- **N. Korea is suitable for production of soybean :**
  - Geography of N. Korea is mostly mountainous, and wide field area
  - Need of conversion of corn field into soybean field.

8.1 Food policy projects for Korea unification

➢ Improve self-sufficiency of animal feeds

- Self-sufficiency of animal feeds in S. Korea (2009)
  - Feed grains: usage (8.8 million tons), self-sufficiency 2.1%

➡ **Main reason of decline in self-sufficiency of foods** in S. Korea

- **Set Limit** of animal population per farmland area

- Development of compulsory **self-sufficiency of animal feeds** to a certain level

- Reasonable **licensing system** for livestock industry

8.1 Food policy projects for Korea unification

- Develop food industry for security of food in case of an emergency
  - Enhancement of **national competitiveness** of food industry
  - A plan for **balanced development** of food industry in two Koreas
  - Need for **transport systems** along the major ports in N. Korea

Thank you