Green Revolution of Korea and Its Knowledge Sharing to Africa

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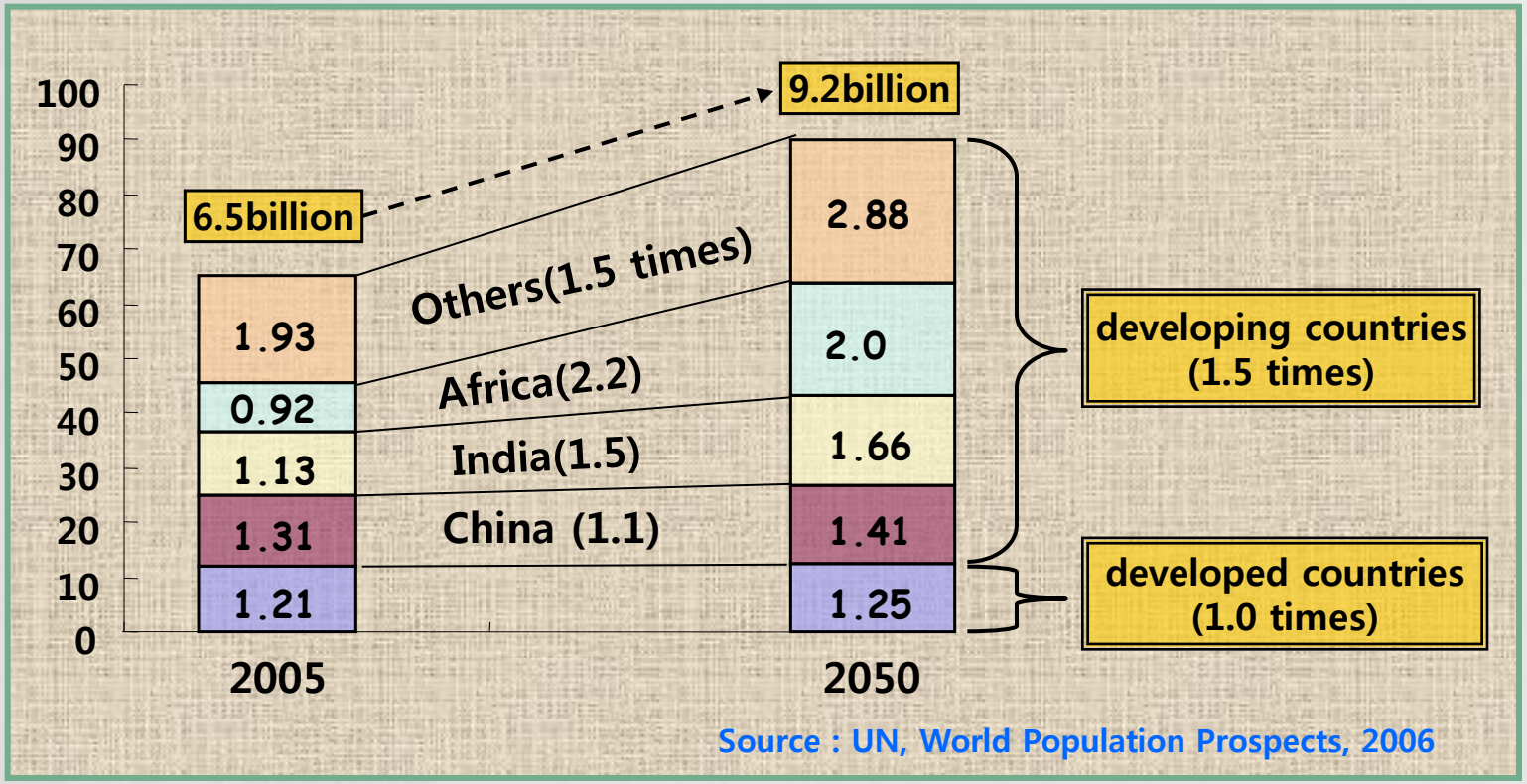
Ⅰ. Global Food Situation and Africa

1. Global Population Growth

☐ Outlook of global population growth

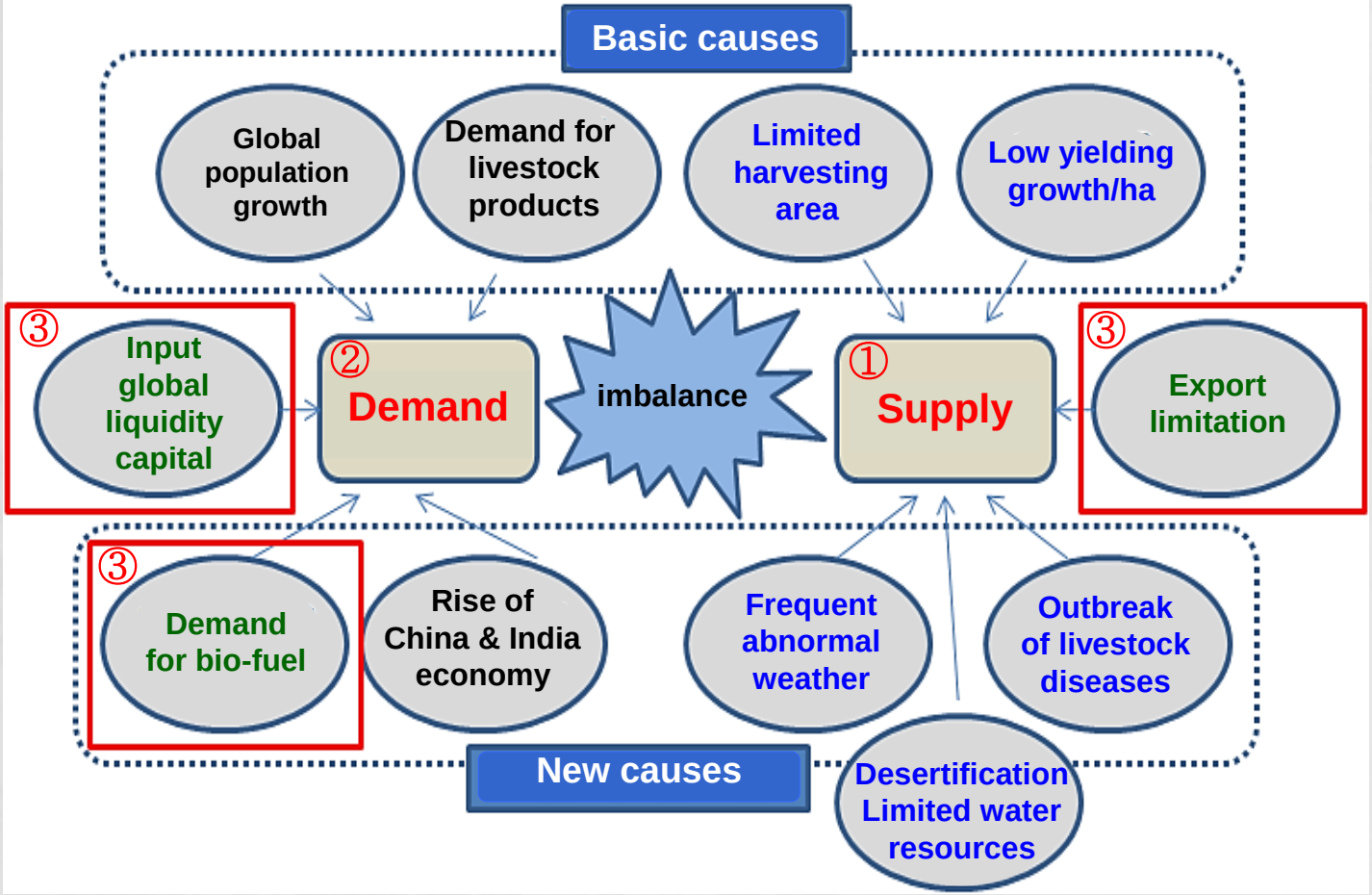
- (2005) 6.5 Bil → (2050) 9.2 Bil [41.5% increase]

➔ Preparedness is required to deal with global food crisis for 2050



Source : UN, World Population Prospects, 2006

2. The Causes of Food Crisis(2008) : ① supply shortage, ② increasing demand, ③ distribution inequality



➔ **The possibility of unstable global grain prices and short term grain trade stop**

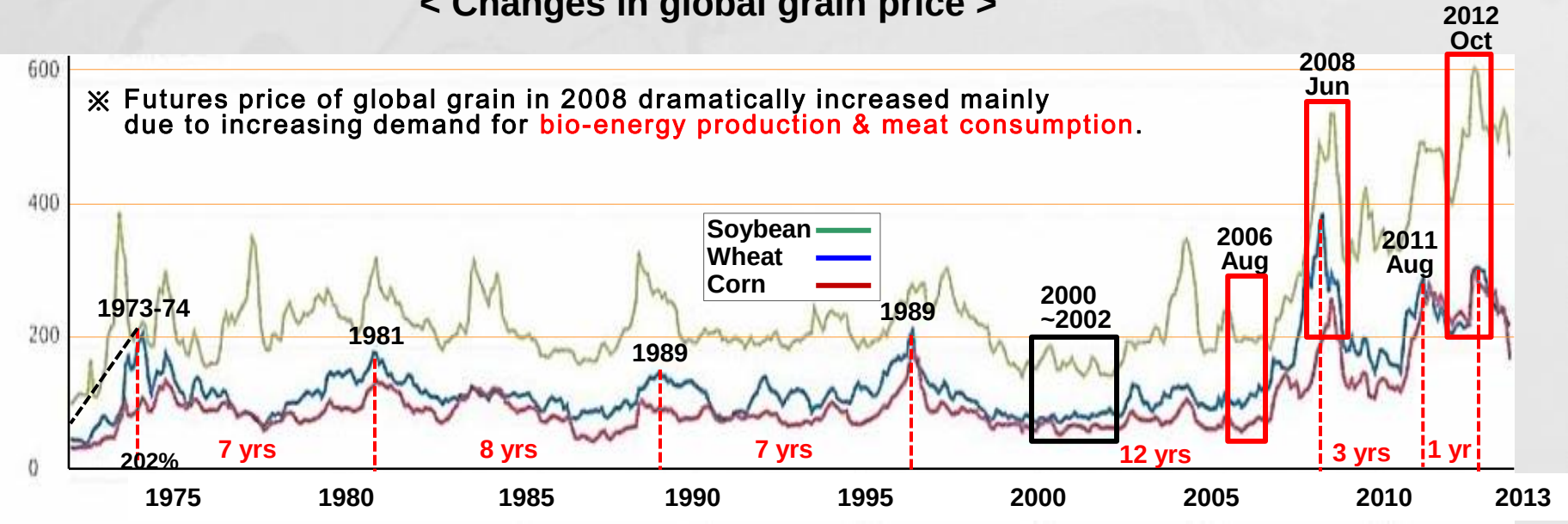
3. Price and Demand for Global Grain

□ Price Trend of Global Grain

○ Since 1970, seven times of periodical price hike happened

- Increasing grain price trend and rapid fluctuation period of price hike
  : (before 2008) 7~12 years period → (after 2008) 1~3 years

< Changes in global grain price >

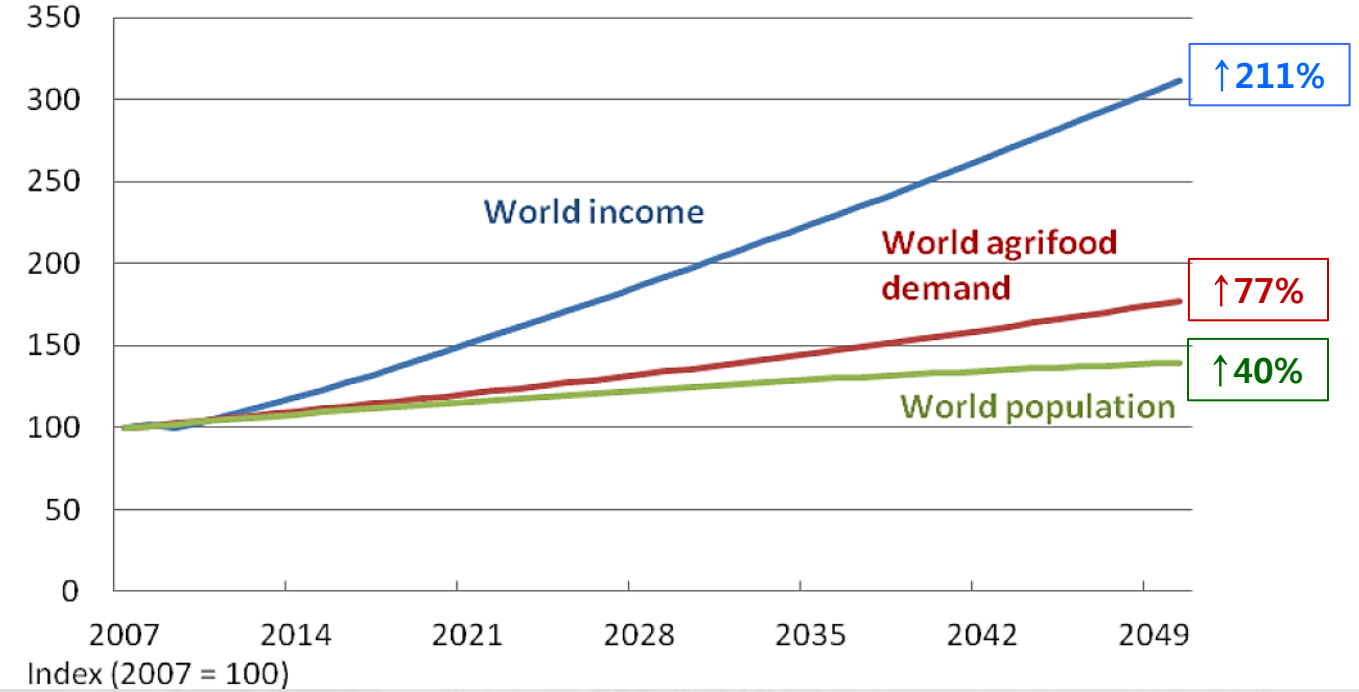


*Source : Chicago Board of Trade(CBOT) (2013. 8)

☐ Demand for Global Grain and Population Forecast (2007 → 2050)

- ○ Population will increase to 40%, and Net income will rise to 211%
- ○ Demand for global agrifood in 2050 will increase to 77% compare to 2007

➔ Demand for gain is expected to increase from 2.1 B tons to 3.0 B tons in 2050



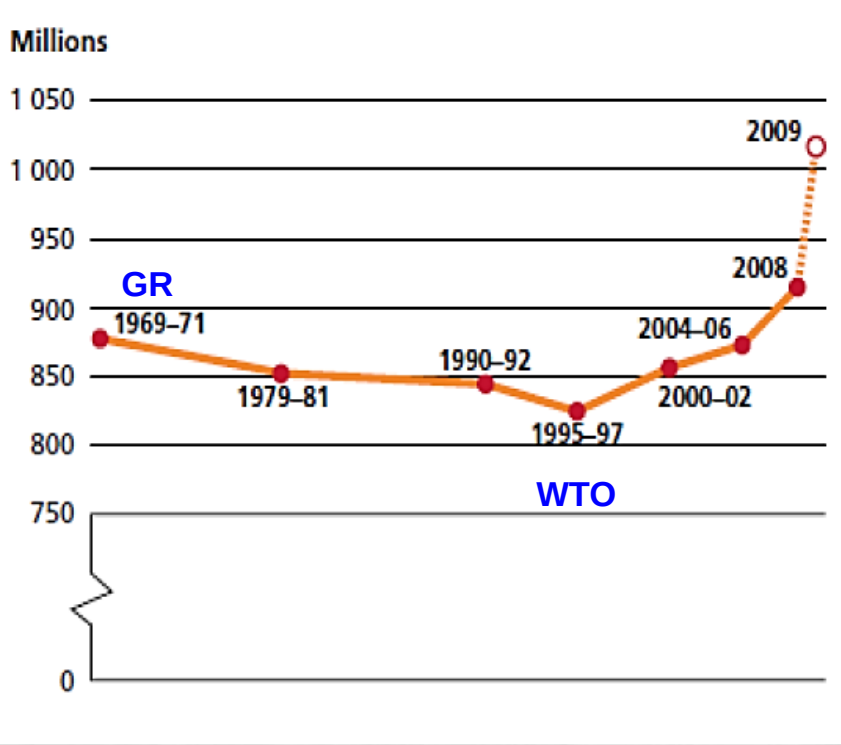
*Source: Yong-Taek Kim (2013)

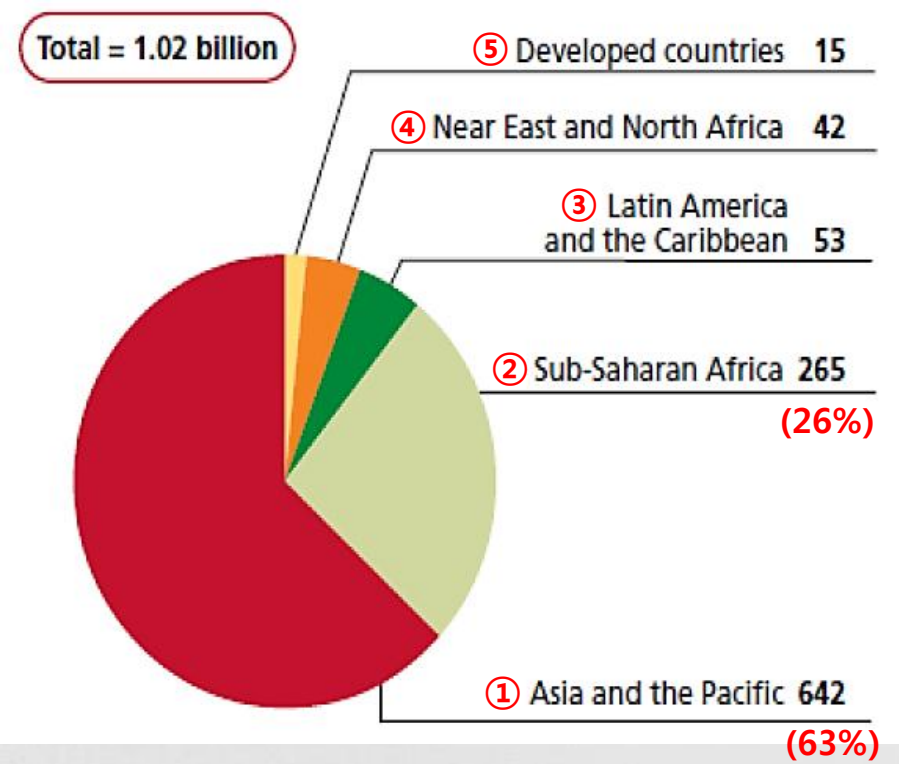
4. Food Crisis in Africa

□ World Distribution of Undernourished People

○ **World undernourished population(2009)**

- **1,020M people (Asia Pacific 63%, Sub-Saharan 26%)**
- **Increased dramatically since 1995 after launching the WTO**





*Source: FAO Annual Food Outlook Reports (2009)

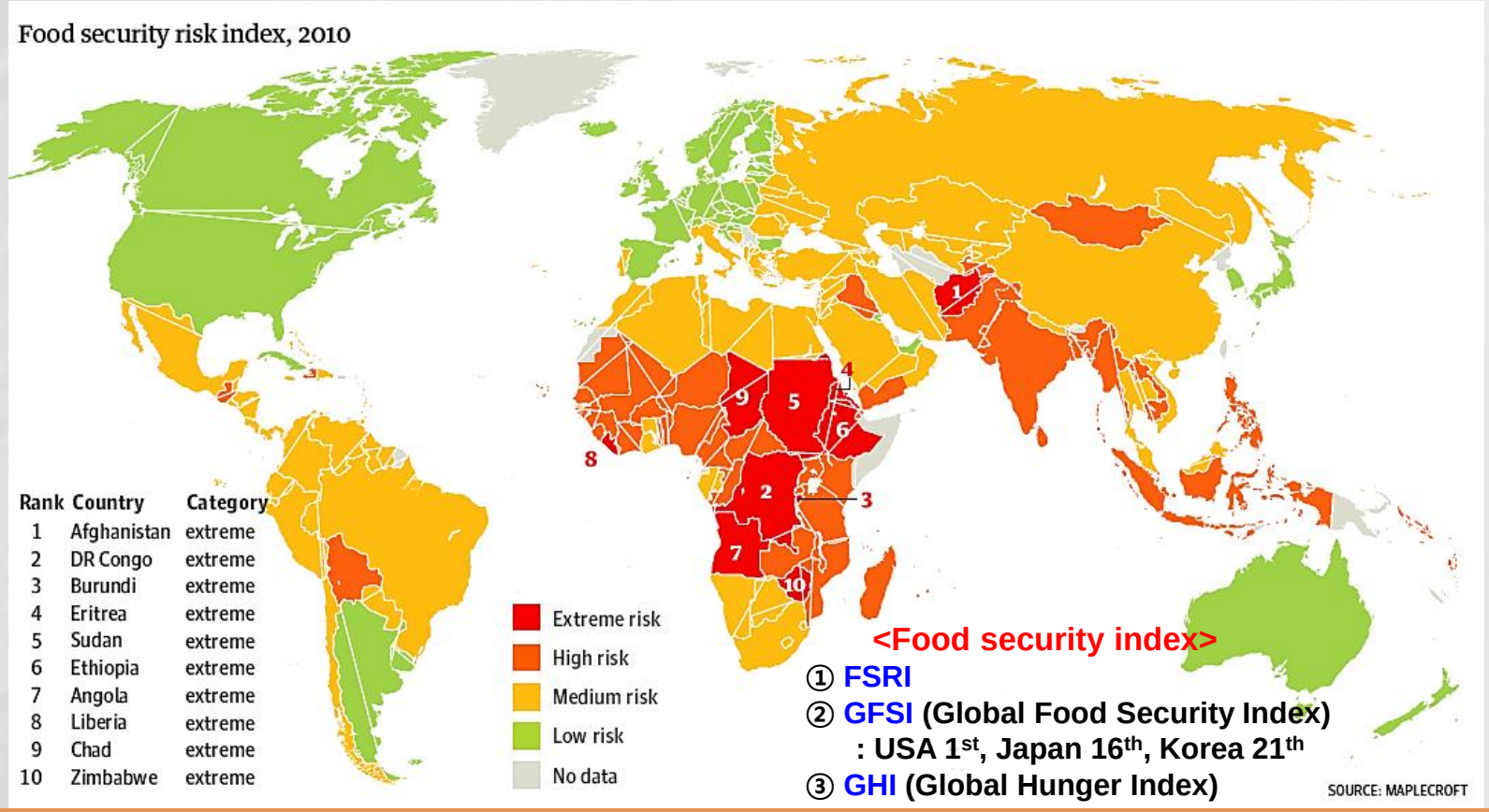
☐ Food Security Risk Index(FSRI) Distribution

○ **Evaluation Index of FSRI : 4 categories, 18 sub-categories**

- **The 4 category indices : Nutrition / Health of the population, Availability, Safety and Access of food**

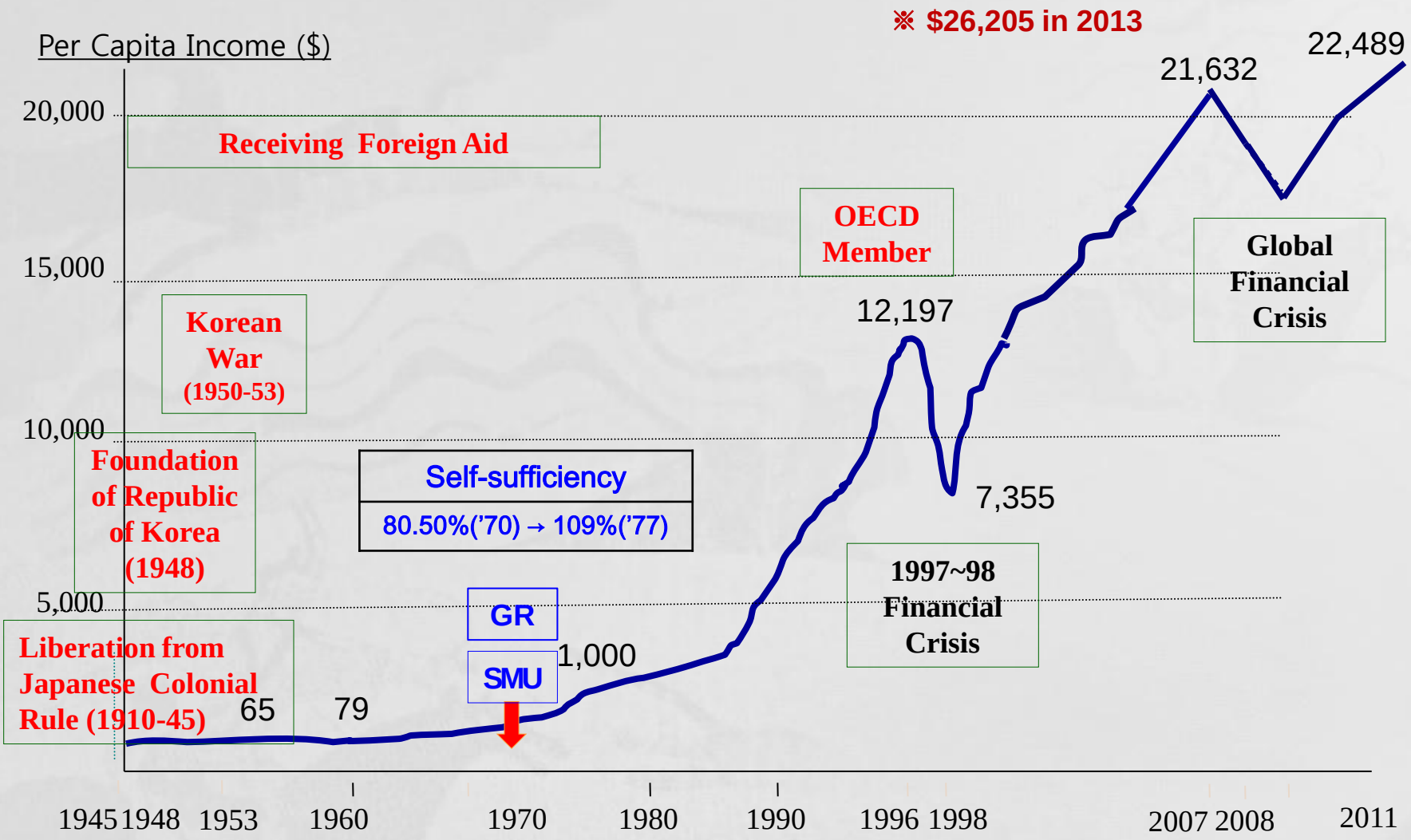
○ **Ranks of FSRI (Maplecroft, 2010) : Afghanistan(1st place), DR Congo(2nd), N. Korea(19th)**

➔ **Sub-Saharan countries are suffering from the severe food shortages**



Ⅱ. Experience of Green Revolution(GR) in Korea

<Changes in GDP per Capital in Korea>



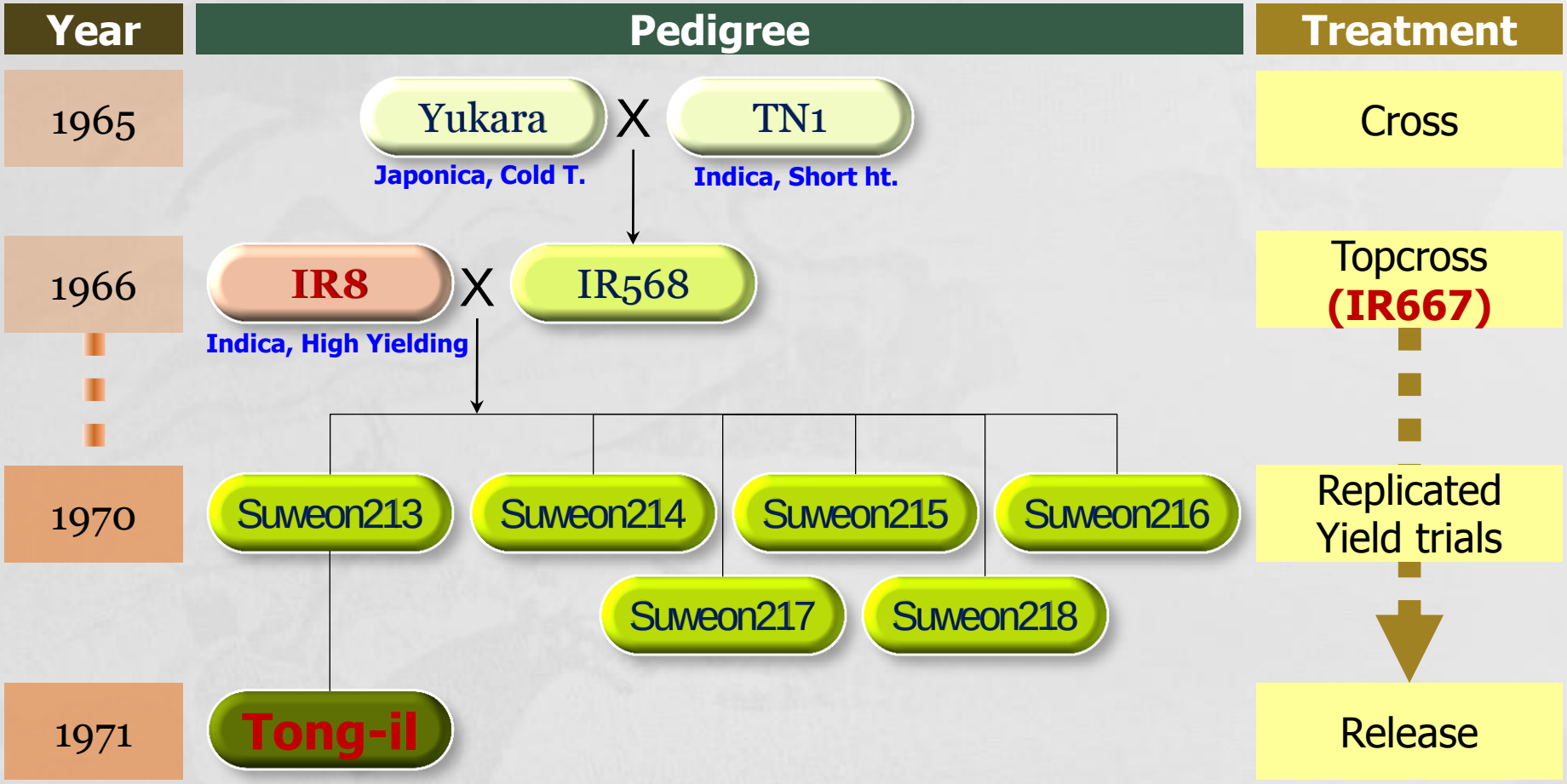
How Korean people achieved the self-sufficiency of rice for the short term?

- ♣ Developed Tongil- type rice varieties, high yielding potential
- ♣ Strengthened Agricultural research & extension linkage system
- ♣ Changed Agricultural policy strategies

1. Development of High-yielding Variety, "Tong-il"

☐ Breeding Passage of 'Tong-il' Variety

- ◯ Three-way cross : IR8 // Yukara / TN1
- ◯ Rice generation shortening through shuttle breeding with IRRI
- ◯ Rice seed multiplication in IRRI



☐ Achievement of Rice Self-sufficiency

○ **RDA developed the high-yielding rice variety, "Tongil" in 1971.**

※ **Rural Development Administration (RDA) is the central government organization responsible for agricultural research and extension services in Korea.**

○ **Achieved self-sufficiency of rice by "Tongil" in 1977**

Items	1971	**1977**
● Cultivated area of TI-type varities(%)	**0.02**	**54.6**
● Yield potential (t/ha)		
- Japonica varieties	**3.37**	4.23
- Tongil-type varieties	5.01	**5.53**
● Rice growth-production (mil. ton)	4.0	6.0
● Self-sufficiency of rice (%)	**83**	**109**

→ **Achieved self-sufficiency by 109% within 7 years**

: A miracle success history in the world

2. Improvement of Cultivation Technologies

☐ **Flooded nursery for Japonica rice, 1960s**

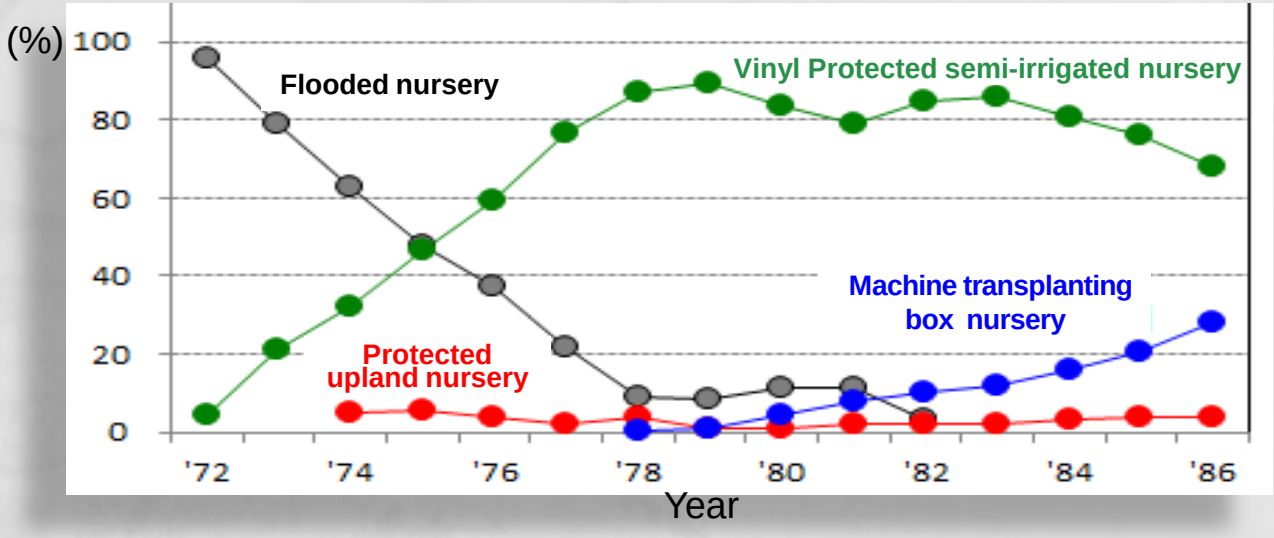
○ Seeded in the flooded condition at **low temperature**

→ Poor seedling growth, short growth duration

☐ **Developed vinyl protected nursery for TI varieties**

○ Seeded on the wet bed and covered up **vinyl tunnel (high temp.)**

→ Healthy seedling growth, optimum growth duration **(20~30 days early)**



Increase of vinyl protected nursery for Tongil-type rice

: ('71) 0% → ('75) 47% → ('79) 90%

☐ Development of Rice Production Technology

○ **Optimum cultural practices**

- **Seeding & transplanting times**: 20~30 days early than before
- **Transplanting method** : scattered T. → row T. ⇒ uniform growth
- **Planting density** : widen planting → dense P. ⇒ ↑ panicles
- **N application** : 80 → 150 kg/ha ⇒ ↑ growth & yield

○ **Efficient pest control**

- **Pesticide application** : 2~3 → 6~7 times regular/ simultaneous

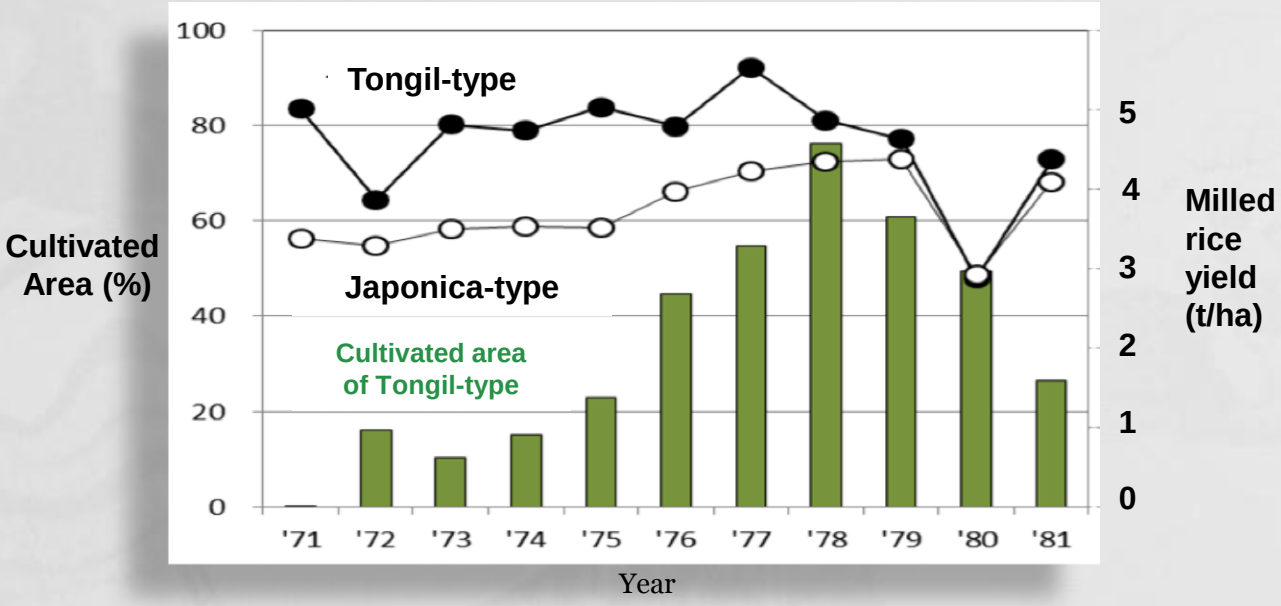
○ **Soil fertility improvement**

- **Low-productive paddy soil : 67.4%**
- **Developed comprehensive soil fertility improvement**
  - Tillage : 8 → 18cm Organic matter : 10 → 30 t/ha
    Silicate : 0 → 3 t/ha Soil dressing : 0 → 100 t/ha

➔ **Developed "a comprehensive high-yielding cultivation technologies" for Tongil-type varieties**

3. Extension for New Varieties and Technologies

☐ Dissemination of Tongil-type Rice



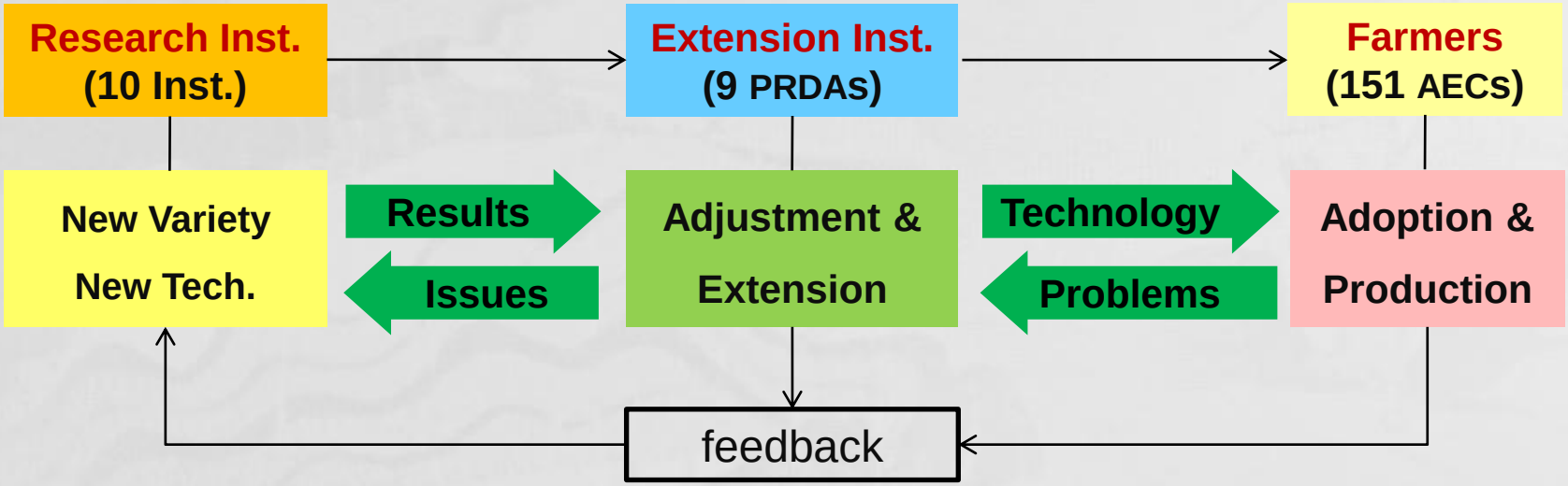
○ Cultivated area for Tongil-type (%) : ('71) 0.02 → ('75) 23 → ('78) 76 → ('81) 27

○ Achieved highest yield (1977) : national average 5.53t/ha

⇒ Self sufficiency of rice (109%)

☐ Efficiency research & extension linkage system

: Two missions (Re. & Ex.) in one national organization, RDA



※ **Research Inst.** : **10 National Institutes** on Crop, Horticulture, Animal, Basic researches, **RDA**
Extension Inst. : **9 provincial RDAs**, **151 city/county Agricultural Extension Centers, RDA**

➡ **FAO recognized Korean research & extension network as the most efficient system in 1985.**

4. Strengthened Agricultural Policies

(1) Organization expansion

○ MAF : ('73) Food Bureau, Grains Management Bureau for Tongil vars.
('76) Farm Land Dev't Bureau & F. L. Management Bureau

○ RDA : ('62) 10 research institutes, 9 provincial RDA, 151 city/country AECs

➔ **Setup administrative systems supporting Tongil varieties**

(2) Innovation of agrarian system

○ Agrarian Reform Act (March 10, 1950)

- **Principle** : ① Land-to-the-tiller
② Land expropriation with compensation
③ Land redistribution with payment

→ Independent farm : ('45) **35%** → ('50) **88.2%**

⇒ Satisfied the land hunger of farmers,
inspired agricultural productivity and democratized rural society

○ Farm Land Conservation Act (1972)

- Designation of absolute farm land('75) : 50.8% of total land

➔ **Improvement of agricultural production base & productivity**

(3) Building agri. production base

○ 1960s : ↑ in irrigation, drainage, land consolidation / reclamation

○ 1970s : Creation of "Comprehensive large-scale agri. dev't projects"
(dam + irrigation + drainage + land consolidation, etc.)

➔ **Promoting agri. infrastructure building for rice production**

(4) Fertilizer production

○ Built fertilizer factories by domestic & foreign funds (1961~)

○ Achieved self-sufficiency of fertilizer (1975) : **102%**

➔ **Sufficient fertilizer supply led to the ↑ productivity of TI vars.**

(5) Grain policy

○ 1960s : **Low rice price policy** (state purchase < market price)
* U.S. surplus grain aid, PL480(1956~64) : **10%** of domestic production

○ 1970s : **High rice price policy** (1970~77, 23% annual increase)
Double-tired rice price system (autumn / spring)
→ Increased productivity of Tongil-type vars.

➔ **↑farmer's income and stabilization of consumer's price**

5. Leader's Role and Administrative Supports

☐ **Established "Food Production Situation Room"** ('73~)

- **Presidential house(BH)** ⇒ MAF, RDA, all agri. org.
- Role : report & direct on farming situation and weather

☐ **Phased farming : 7 stages**

- Helping farmers in transplanting : 2 mil. peoples
- Production quota : Set target of rice production & area

President, Park Chung-Hee

☐ **Awarded farms with good harvest**

- Gave **US$250** as an incentive to farms producing yield **over 6 t/ha**
- High-yielding farms: **3,765** farm households ('73) → **53,808** ('76)

➔ **The President showed great encouragement and gave strong supports to achieve the self-sufficiency of rice.**

➔ **Farmers believed the government and the agri. policies.**

[Three World's Success Cases in Green Revolution]

- Importance for the GR of RDA's case -

① **CIMMYT : High-yielding wheat - Sorora 64 (1964)**

※ The developer, Dr. Norman Borlaug, received Nobel Peace Prize in 1970.

② **IRRI : Rice of miracle - IR8 (1966)**

※ The developer, Dr. Henry Beachell, won World Food Prize in 1996.

③ **RDA : High-yielding rice - Tongil (1971)**

※ Development of "Tongil" was recognized as the first top R&D achievement for the last 50 years in Korea, 2009.

→ **These new high-yielding varieties were increased about 50% of productivity compared to traditional varieties.**

These 3 cases had led the world's Green Revolution in 1960s~1970s.

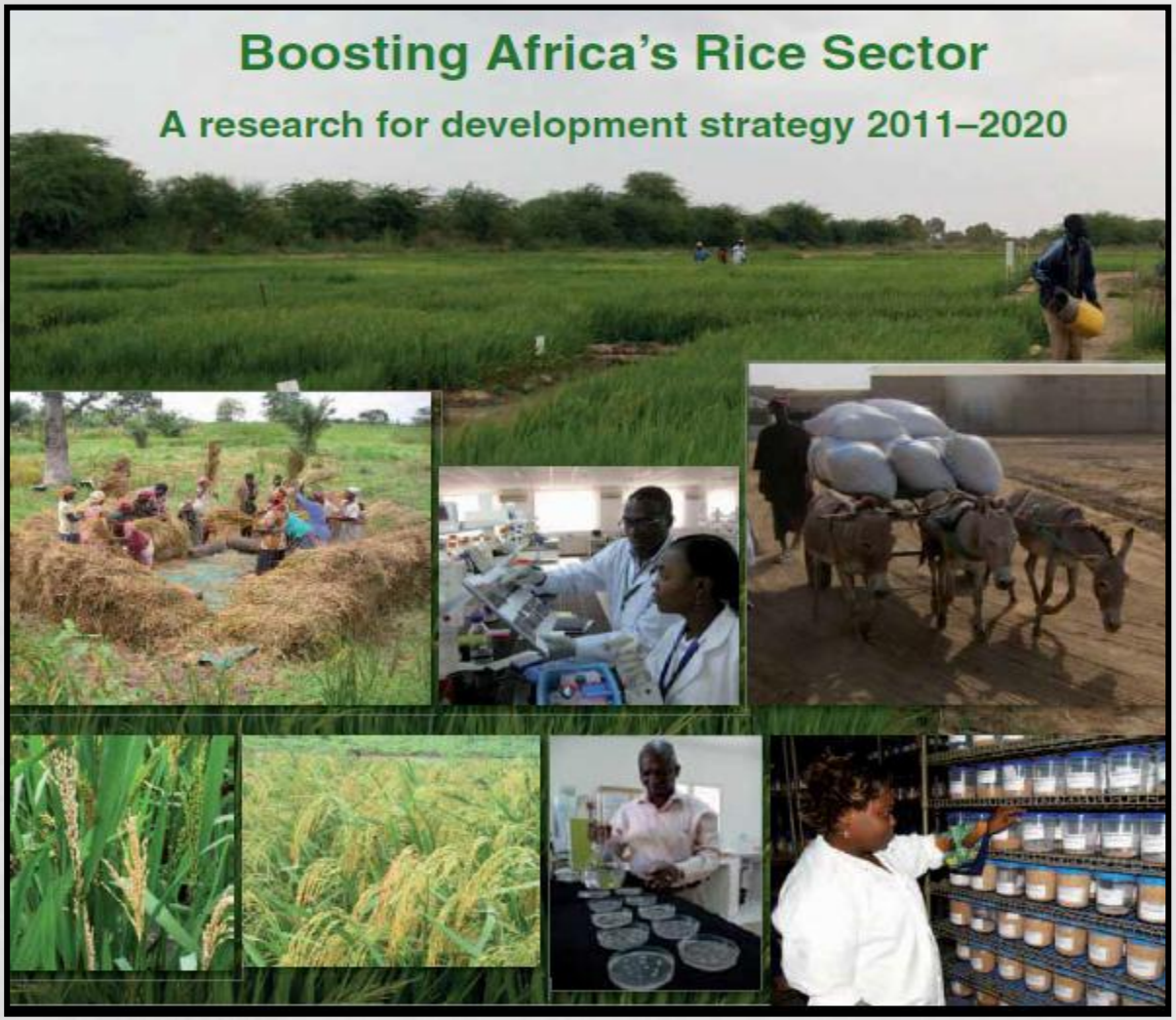
※ **CIMMYT and IRRI are international agricultural research organizations while RDA is a national organization, which draws more attention from other developing nations.**

→ **RDA : " R&D + Extension + Agri. Policy + Administration "**

IRRI

R D A

Ⅲ. Rice Development in Africa



1. Organizations Related with Rice in Africa

☐ **Research institute : "Africa Rice Center" (AfricaRice)**

- Mission : to contribute to poverty alleviation and food security in Africa, through research, development and partnership activities of the rice sector

- the former WARDA renamed in recognition to its increasing role in SSA

- including **25 Africa member states** and **6 Africa Rice Stations**

- one of the 15 international agricultural research centers supported by the CGIAR (IRRI, etc.)

☐ **Regional organization : AGRA, FARA, WEIARD, etc.**

☐ **Regional economic community : EAC, ECOWAS, SADC, etc.**

2. Africa Rice Center (AfricaRice)

☐ **AfricaRice Member State : 25 States**

1970 Founders (11): Burkina Faso, Cote d'Ivoire, The Gambia, Ghana, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone and Togo

1971 Benin

Nigeria

1977 Guinea Bissau

1978 Guinea Conakry

1983 Chad

1991 Cameroon

2007 Central African Republic

Republic of Congo

Democratic Republic of Congo

Uganda

2008 Gabon

2009 Egypt

2010 Madagascar

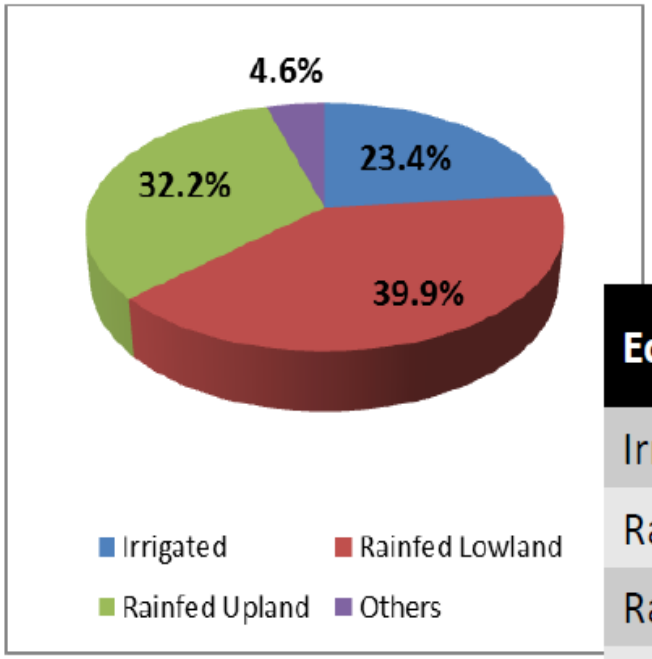
2013 Rwanda

☐ AfricaRice Research Station : 6 Stations

6 stations :
Senegal (Saint Louis),
Cote d'Ivoire (Bouaké, Headquarters),
Nigeria (Ibadan),
Benin (Cotonou, temporary HQ),
Tanzania (Dar es Salaam/Morogoro),
Madagascar (Antanarivo/Antsirabe)

3. Rice Production Environments in Africa

Share of area per ecology



Diagne et al., 2013

Ecology	Yield (ton/ha)
Irrigated	2.2
Rainfed Lowland	1.9
Rainfed Upland	1.2
Others	2.0

Actual yields are far below yield potential due to numerous constraints in rice production systems

Urgent Task: Increase rice production in Africa

4. Development of Rice Variety

☐ **Target Traits in Rice Breeding in Africa**

Agronomic Traits	Abiotic Stress Tolerance	Biotic Stress Tolerance	Grain Quality
• Grain Yield • Duration • Plant Height • Shattering	• Drought • Submergence • Heat • Cold • Salinity • Fe toxicity • P-deficiency	• Blast • Bacterial Blight • RYMV • AfRGM	• Shape • Milling % • Chalkiness • Amylose cont. • **Preference**

- **Target traits have to be fine-tuned**
- **A map with essential traits (including grain quality) needs to be developed**

☐ Cultivated Area for Different Rice Varieties (2009)

1. Variety Release

Very few improved varieties

Type of Variety	Area (1000ha)	%
Local varieties	3,427	33.8
NERICA	791	7.8
Other AfricaRice varieties	301	3.0
Improved NARS varieties	146	1.4
Other improved varieties	1,519	15.0
Unknown	3,962	39.0
Total	10,146	

2. Seed System

Dominance of informal seed production systems

Traditional Varieties

90% Informal System

10% Formal System

Improved Varieties

75% Informal System

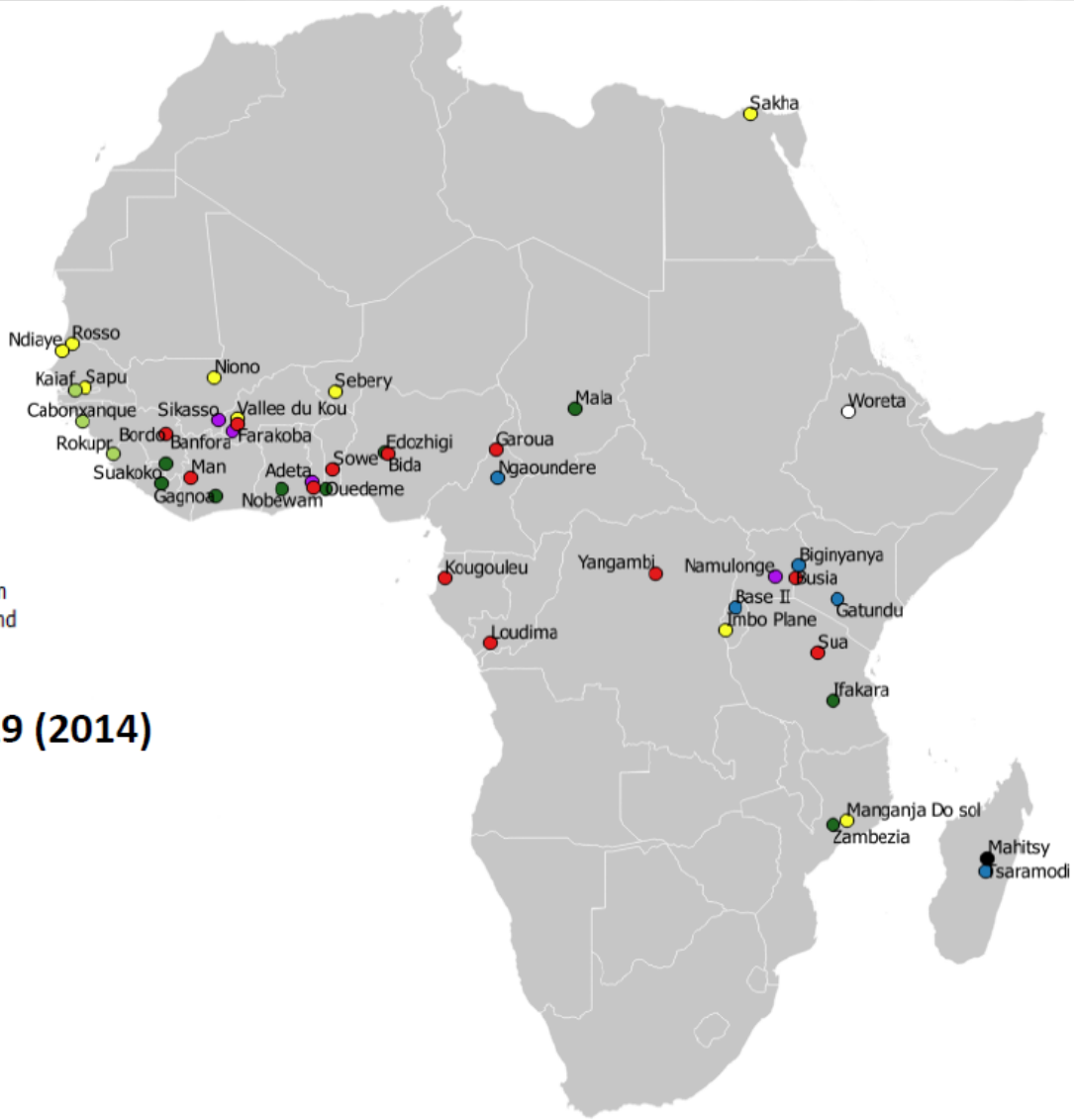
25% Formal System

※ Survey for 16 countries and involving 30,000 rice farming households in 2009

☐ Africa-wide Rice Breeding Task Force

Rice Growing Environment

- High Elevation
- High Elevation and Rainfed Upland
- Irrigated Lowland
- Mangrove
- Rainfed Lowland
- Rainfed Lowland and High Elevation
- Rainfed Lowland and Rainfed Upland
- Rainfed Upland



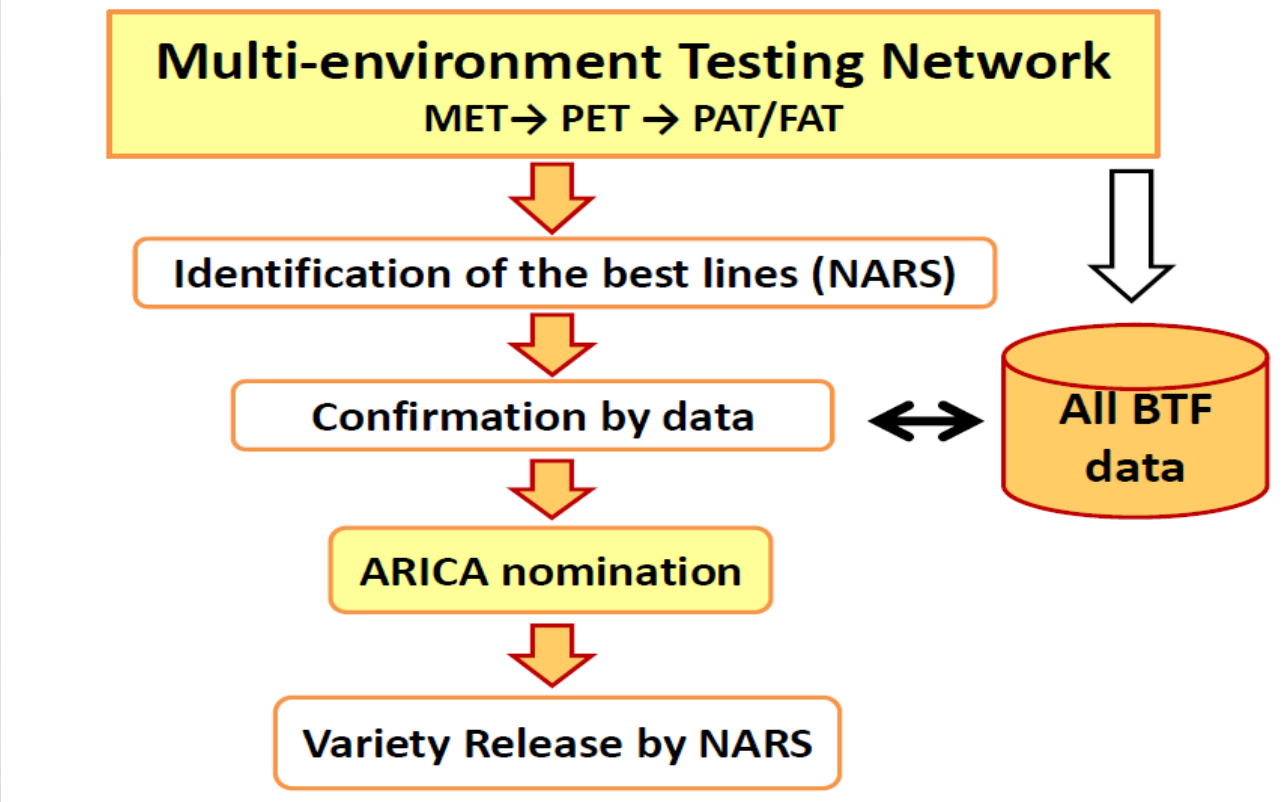
Participating countries = 29 (2014)

Evaluation sites in 2014

- MET 33
- PET 58
- PAT/FAT 85

☐ ARICA(Advanced Rice for Africa) Nomination

※ **Internal breeding activities** : AfricaRice, IRRI, CIAT, JIRCAS, CIRAD, NARS in Africa

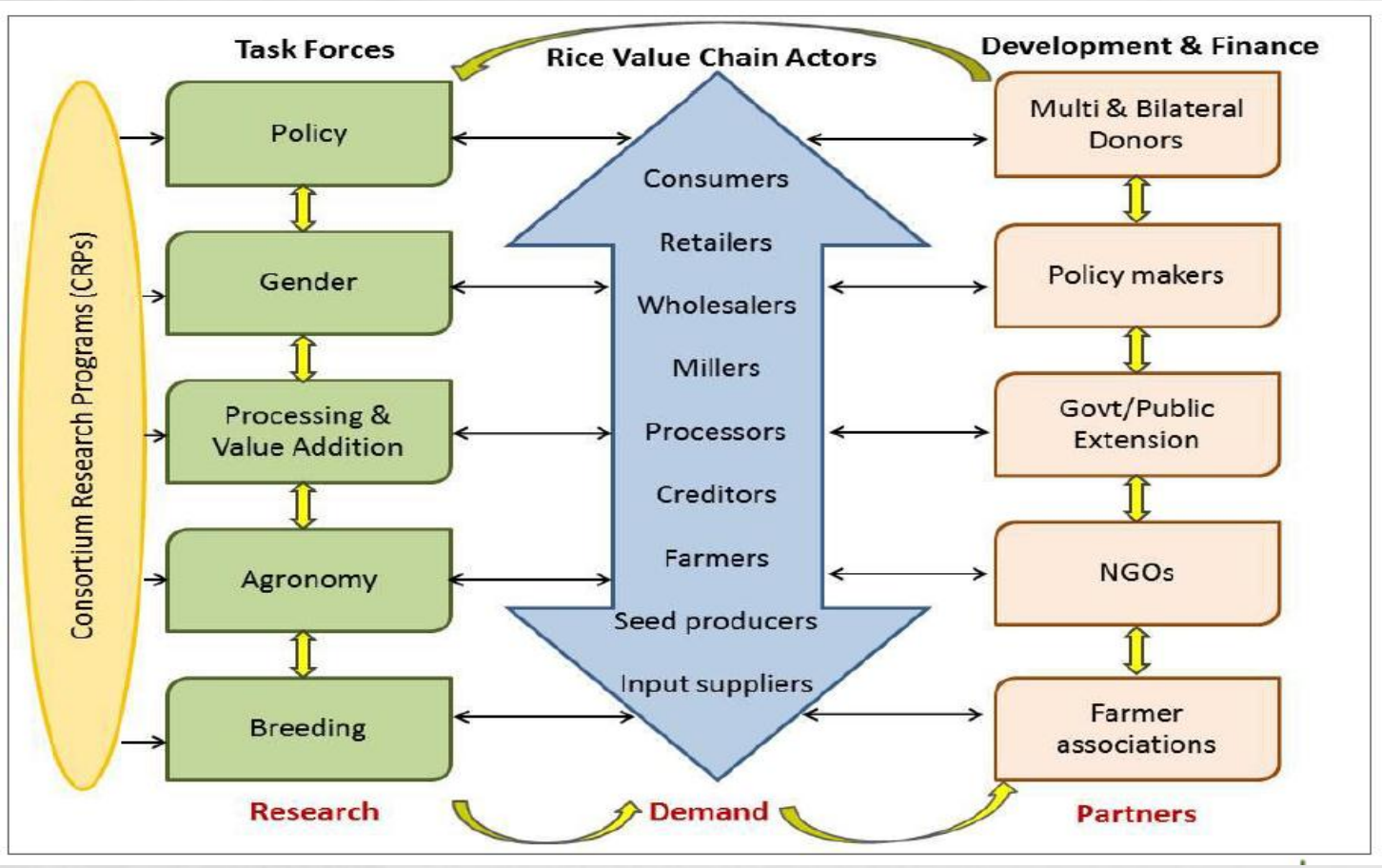


※ **ARICA was nominated 11 varieties (ARICA 1 ~ 11) in 2013 and 2014.**

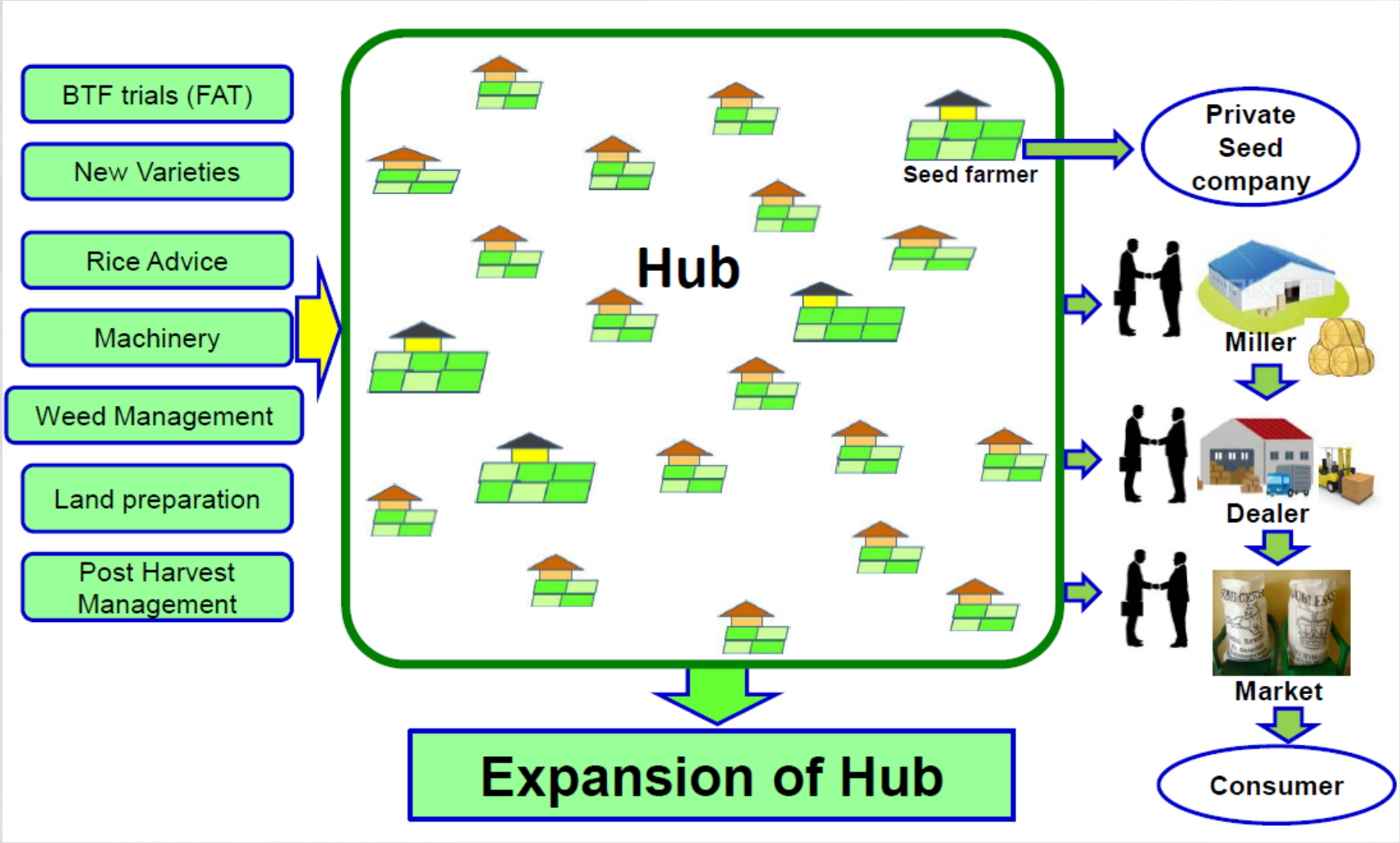
5. Dissemination of ARICA through the Hubs

☐ Rice Sector Development Hubs

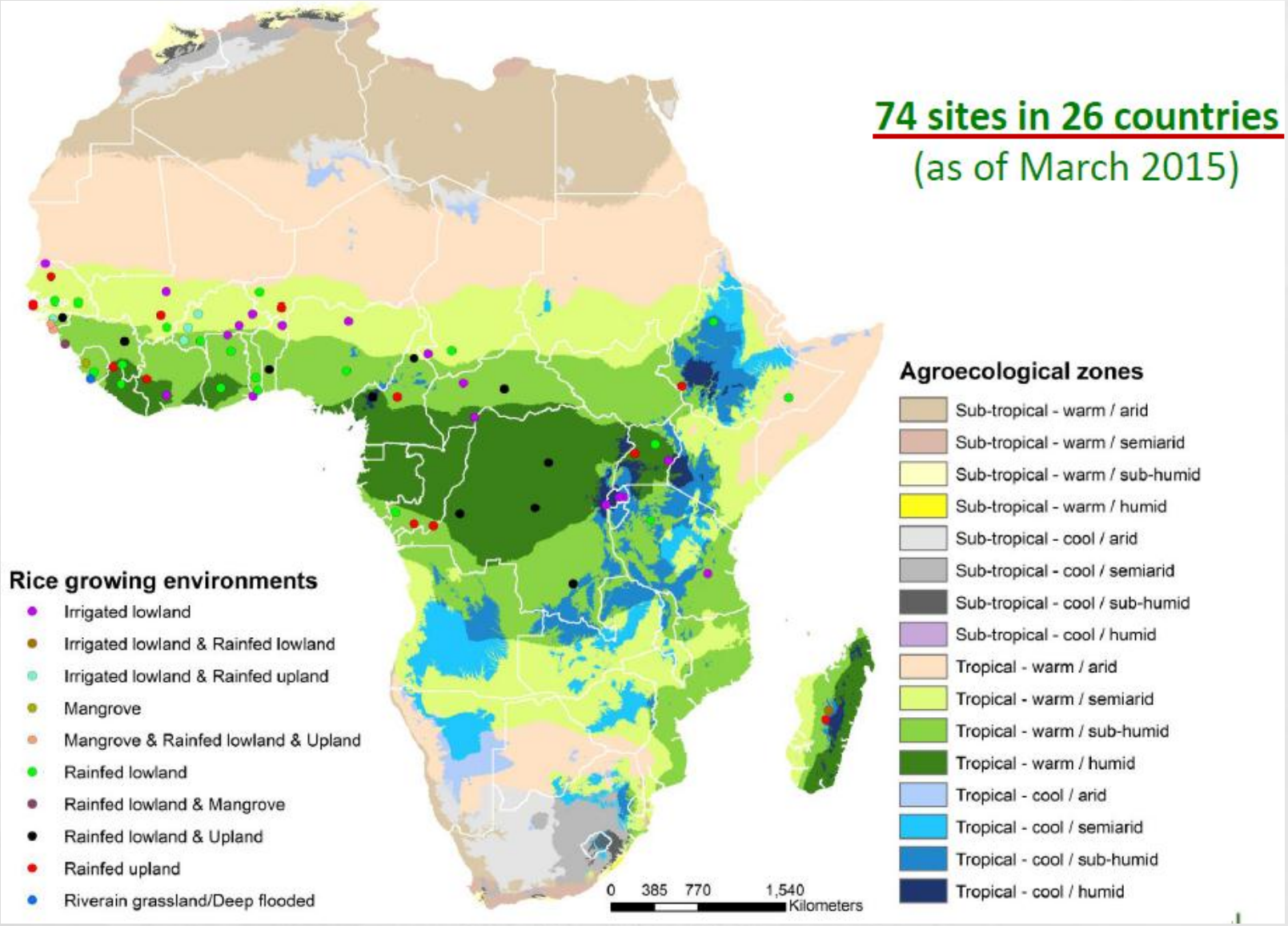
※ **Hubs** : Connecting R&D partners



<26 countries> <74 sites>



☐ Sites of Rice Sector Development Hubs



Ⅳ. Strategic Approach for Sustainable GR in Africa

Goal: Sustainable GR in Africa

Targets
Development of high-yielding varieties
Improvement of production technologies
Dissemination of new varieties and tech.
Introduction of advanced R&D systems
Strengthen of agricultural policies

- 25 member states
- 6 Stations
- 74 Hubs

- Supply of materials
- Finance
- Agrarian system

Diligence, Self-help, Cooperation

1. Development of high-yielding rice varieties

GR in Korea	**High-yielding rice variety "Tong-il"**

GR in Africa	**<u>High-yielding</u> with <u>Climate-resilient varieties</u>**

- high-yielding
- drought tolerance
- disease and insects tolerance
- low-fertilizer adaptability, etc.

⇧

KAFACI Rice Projects, RDA

2. Improvement of production technologies

GR in Korea	- Vinyl protected semi-irrigated nursery - Comprehensive high-yielding production tech.
GR in Africa	- Optimum production technologies for different countries, regions and Hubs - Cultivation method, Pest control, Soil management, Mechanization, etc. ※ A small organically grown crops-livestock farming cycling system is recommended

⇧

18 Centers of KAFACI, RDA

3. Dissemination of new varieties and technologies

GR in Korea	Efficiency research and extension linkage systems (10 Nat'l Research Institutes – 9 Provincial RDA – 151 AECs)

GR in Africa	① The sites of Rice Sector Development Hubs - 74 Hub sites in 26 countries ② Modification of the research and extension linkage system in Korea - Training for farmers, information services, demonstration farm, etc.

4. Introduction of advanced R&D systems

GR in Korea	Setup R&D system : 10 national research institutes, RDA

GR in Africa	Advanced national R&D systems are essentially required in the countries - Strengthened the national agriculture R&D system - International cooperation (IRRI, RDA, etc.), Scientist exchange, Project development, Germplasm introduced, etc.

5. Strengthen of agricultural policies

GR in Korea	- Introduction of various rice price policies, - Building agricultural production infrastructure, etc.

GR in Africa	- Development of appropriate agricultural policies based on the increase of farmer's income - Price policy, irrigation system, fertilizer production, - Introduction of incentive system for high-yielding farmers, etc.

A phytotron, delivery room of the GR
감사합니다!
Thank you!