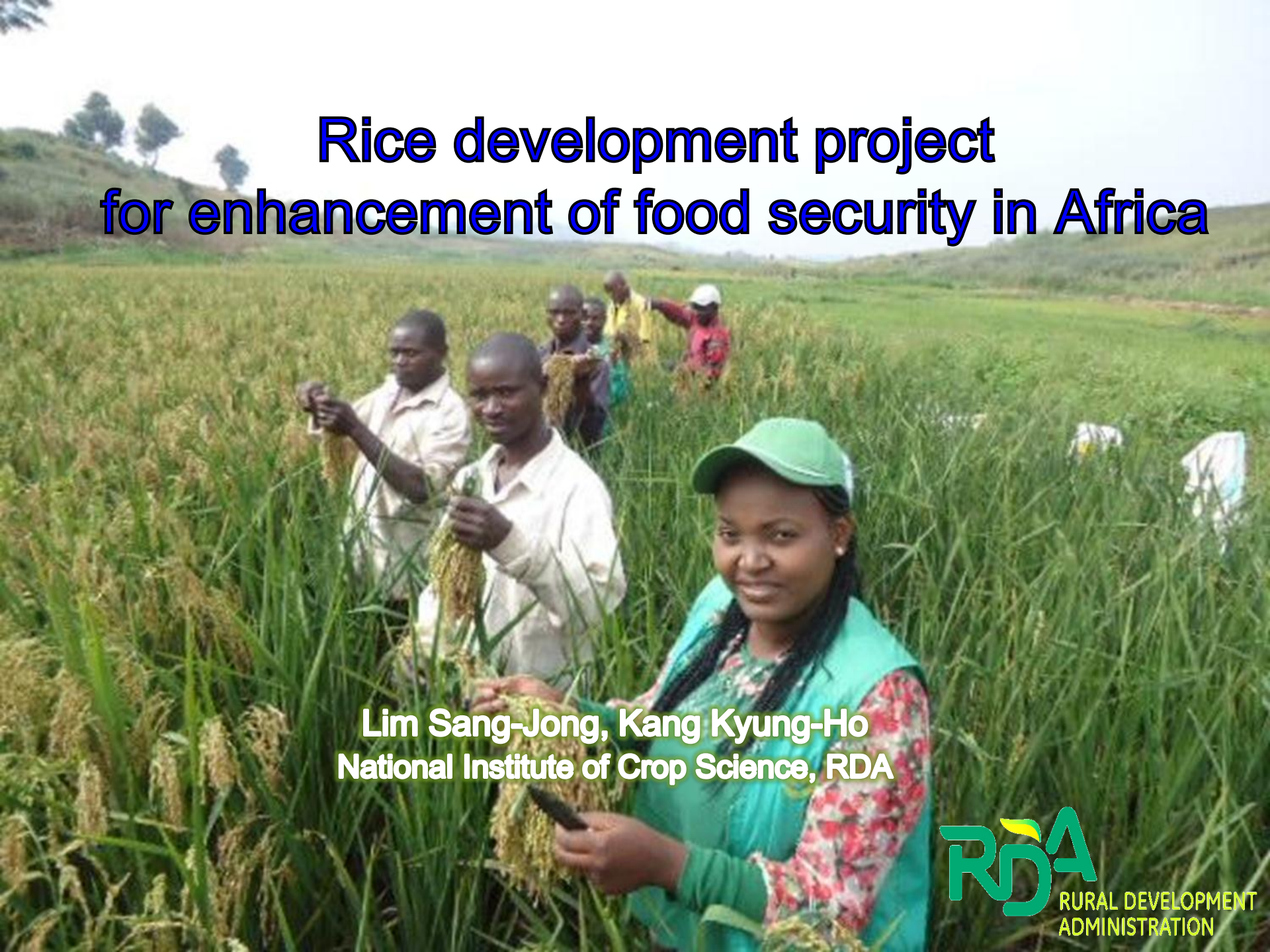
Rice development project for enhancement of food security in Africa



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RDA
RURAL DEVELOPMENT ADMINISTRATION

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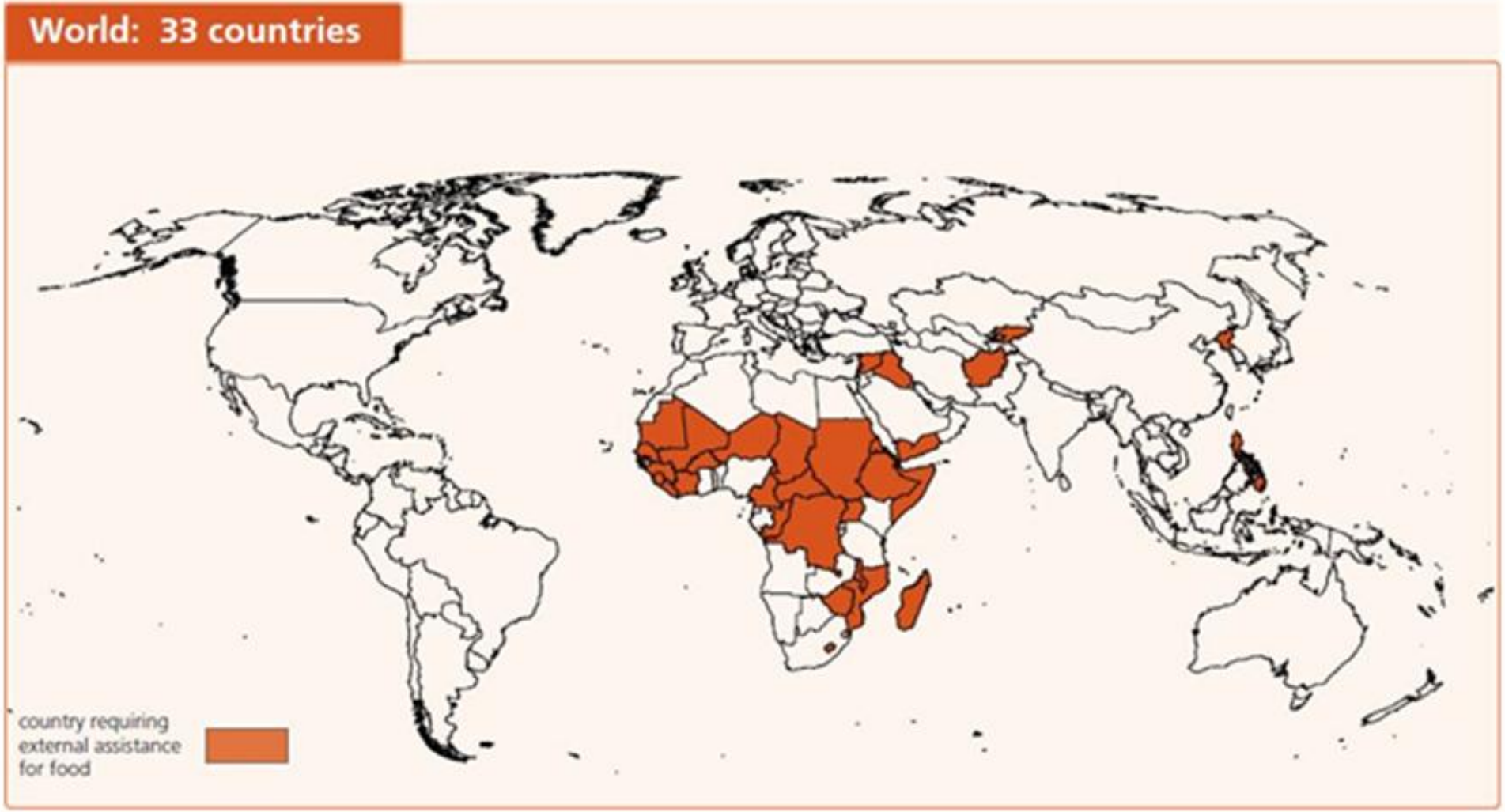
Low income food deficit countries in the world



FAO, 2014: 805 million hungry people in the world and 98 percent of them are in developing countries. 227 million are in Africa.

– Korea FAO association –

Low-income food deficit countries in Africa: 26 countries

국가	내용
중앙아프리카 공화국 ▼	◦2013년 작물생산량은 내전으로 인해 전년도 수준에서 급감 ◦지난 11월 식량지원 필요인구는 농촌인구의 약 30%인 130만톤으로 추정되었으며, 2013년 12월 악화된 소요사태로 인해 국내난민은 71만4,000명으로 급증
짐바브웨 ▼	◦2013년도 국내 수확량 감소 및 2014년도 불충분한 옥수수 공급량으로 특히 남부 및 서부지역의 식량안보 상황 악화 - 2014년 4월 수확기 시작 전까지 약 220만명이 식량불안에 놓일 것으로 추정되며, 이는 2013년 동기 167만명에서 증가한 것임
부르키나파소 ■	◦말리에서 유입된 난민은 국내식량시장에 부담 가중(2013년 11월 기준 약 5만명 추정)
차드 ■	◦수단 다르푸 지역, 중앙아프리카공화국 및 나이지리아 북부(46만7,000명 이상)에서 유입된 난민과 귀화한 차드 난민(35만명)으로 인해 국내식량 공급 부담 가중
지부티 ■	◦약 7만명이 심각한 식량불안상황에 놓여있고, 이들은 주로 7~9월 평년 강우량을 하회한 동남지역 목초지에 거주하며 인도적 지원에 의존
에리트레아 ■	◦경제적 제약으로 인해 식량불안에 취약
기니 ■	◦수입가격이 하락하면서 최근 수개월간 식량접근이 개선되었으나, 지난 몇 년간의 식량가격상승 및 인플레이션의 지속적인 영향을 극복하기 위해서는 식량지원 필요
라이베리아 ■	◦내전피해 복구 지연, 사회적 서비스 및 기반시설 부족, 시장접근성 약화와 더불어 코트디부아르에서 유입된 난민(2014년 1월 현재 약 58만명)으로 인해 지속적인 국제지원 필요
말라위 ▼	◦2013년도 옥수수 수확량이 평년 수준을 상회함에도 불구, 2013/14년도 약 190만명이 연간 식량필요량을 충족하지 못할 것으로 추정 - 지속적인 옥수수 가격 상승 및 일부지역의 생산량 부족이 식량불안 견인
말리 ■	◦내전으로 북부지역으로의 물품 공급에 차질이 생겨 대규모 인구이동이 발생했으며, 이로 인해 2011년 가뭄으로 이미 심각했던 식량안보상황이 더욱 악화 - 2013년 11월 현재, 국내 난민 28만3,000명, 주변국 난민 16만9,000명 이상으로 추정 ◦2013년 작황은 평년 이하 수준이었으며, 약 330만명이 식량불안위기에 놓인 것으로 추정
모리타니 ■	◦동남부지역에 약 6만7,000명의 말리 난민 유입 ◦상대적으로 높은 국내식량가격의 영향이 지속되고 있으며, 약 37만명이 식량불안위기에 놓인 것으로 추정
니제르 ■	◦최근 지속적 식량위기로 인해 가계자산 고갈 및 부채 증가 ◦2013년 작황은 평년 이하 수준을 기록했으며, 약 420만명이 식량불안위기에 놓인 것으로 추정
시에라리온 ▲	◦최근 몇 달간 수입 가격하락에 따른 식량접근 개선에도 불구, 지난 몇 년 간의 식량가격 및 전체 물가상승의 영향 극복을 위해 지속적 지원 필요

국가	내용
시에라리온 ▲	◦최근 몇 달간 수입 가격하락에 따른 식량접근 개선에도 불구, 지난 몇 년 간의 식량가격 및 전체 물가상승의 영향 극복을 위해 지속적 지원 필요
카메룬 ■	◦최근 몇 년간 북부 및 극북지역에서 계속된 이상기후로 인해 농업활동이 제한 ◦이는 국지적 흉작으로 이어져 약 61만5,000명의 식량불안.영양불량인구 발생
콩고 ■	◦2012년 수도에서 발생한 폭발사고와 홍수 피해 복구에도 불구, 여전히 21만6,000명(인구의 8%)이 식량불안에 직면(3만7,000명의 식량섭취수준 "불량", 17만9,000명 식량섭취수준 "경계")
코트디부아르 ■	◦2011년 선거이후 내전으로 인해 수천명의 난민이 발생했으며, 대부분 라이베리아 동부(2014년 1월 현재, 약 5만8,000명)로 유입
콩고민주공화국 ▼	◦식량지원 필요인구는 2013년 12월 기준 약 670만명으로 추정(2013년 6월 대비 5% 증가) ◦2013년 12월 기준, 국내 난민은 290만명으로 추정(2013년 6월 대비 12% 증가)
에티오피아 ▲	◦전반적 식량안보 상황은 개선되었으나, 약 240만명은 여전히 인도적 지원 필요
레소토 ■	◦전년도 생산량 회복에 따른 식량안보개선에도 불구, 2013/14년도 식량불안인구는 22만3,000명 추정
마다가스카르 ■	◦2013년도 쌀 생산량 감소 및 가격상승으로 식량안보상황 악화 ◦메뚜기 떼 및 열대성 태풍 Haruna로 곡물 피해를 입은 남서지역의 식량안보가 특히 우려
모잠비크 ■	◦2013년도 양호한 곡물 수확량으로 전반적 식량안보상황 개선 ◦그러나 높은 곡물가격은 여전히 식량에 대한 접근성을 제한
세네갈 ■	◦2013년도 곡물 생산량은 평년 대비 8% 감소할 것으로 추정되며, 약 220만명의 인구가 식량불안에 놓임
소말리아 ▲	◦긴급지원 필요인구는 약 60만명으로 2013년 말 87만명에 비해 감소
남수단 ▼	◦2013년 12월 처음 발생한 내전으로 인해 심각한 식량불안인구는 370만명으로 급증
수단 ■	◦인도적지원 필요인구 330만명으로 추정
우간다 ■	◦지난 2년간 생산량이 평년 수준을 하회함에 따라 주로 Karamoja 지역의 약 10만명이 심각한 식량불안상태

FAO 2013년 12월 보고서와 식량안보상황 비교
■변동 없음(23) ▲개선(4) ▼악화 (6)

출처: FAO 한국협회

Causes of food insecurity in Africa
: Poverty and food shortage

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poverty ➔ low agricultural productivity ➔ food shortage ➔ malnutrition, disease etc

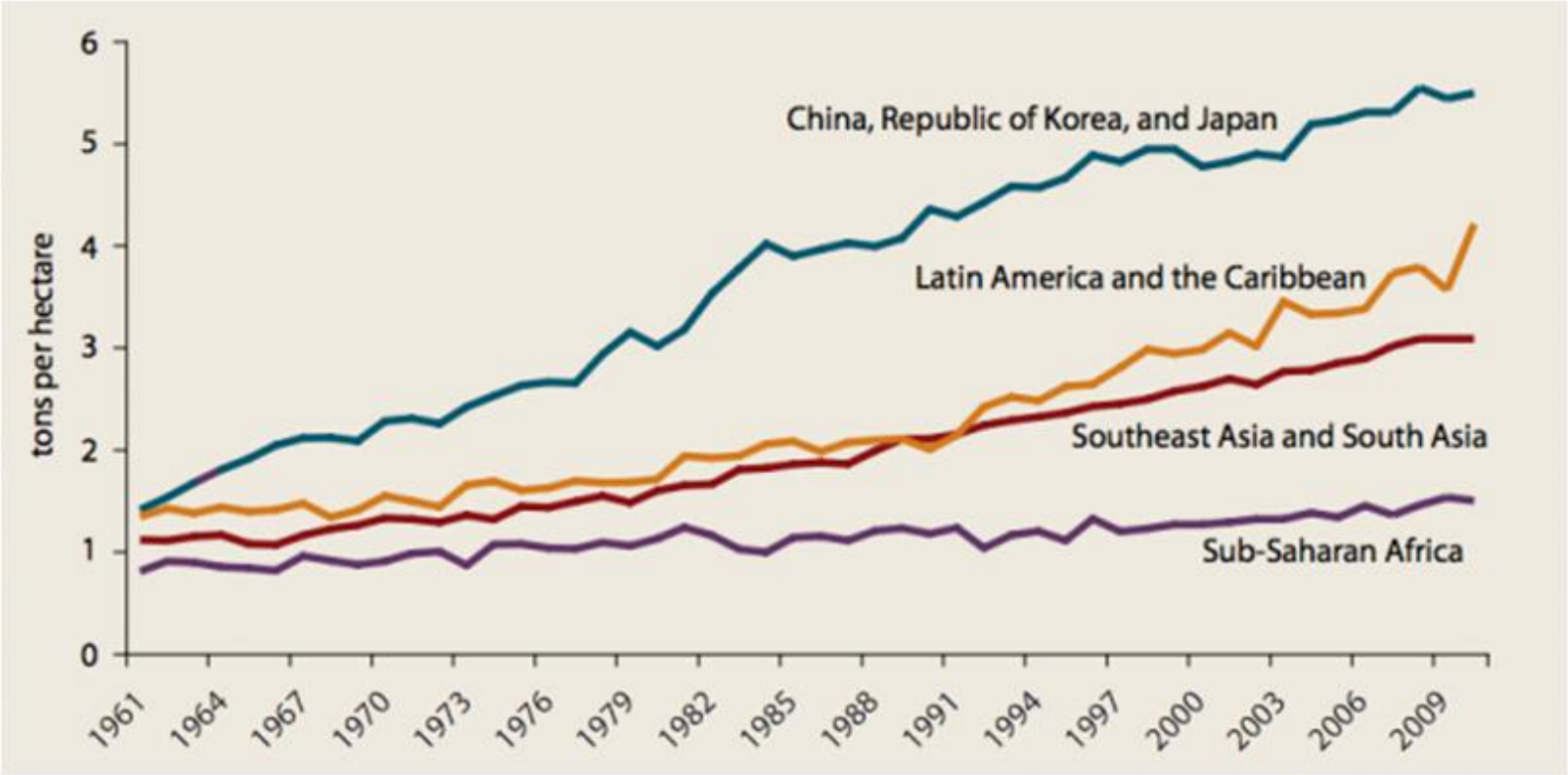
- 121million sub-Saharan Africans lived on less than US$1.0 a day
- Poverty constrains farming households to invest in agriculture: fertilizers, agro-machines etc
- **Climatic fluctuations**, especially **droughts** followed by floods, which reduce the amount of food produced locally
  - ➔ Only 4% of cropland is SSA is irrigated, compared with a global level of 20%
- **Population growth**: 1.1 billion (2013) ➔ **2.4 billion (2050)**

  * In SSA, 926 million is to grow to 2.2 billion in 2050
- **Corruption, Conflict, civil war** and **ethnic unrest** aggravates poverty
- Mismanagement in handling food supplies, and trade policies
- Food insecurity and malnutrition are linked to disease in a vicious cycle

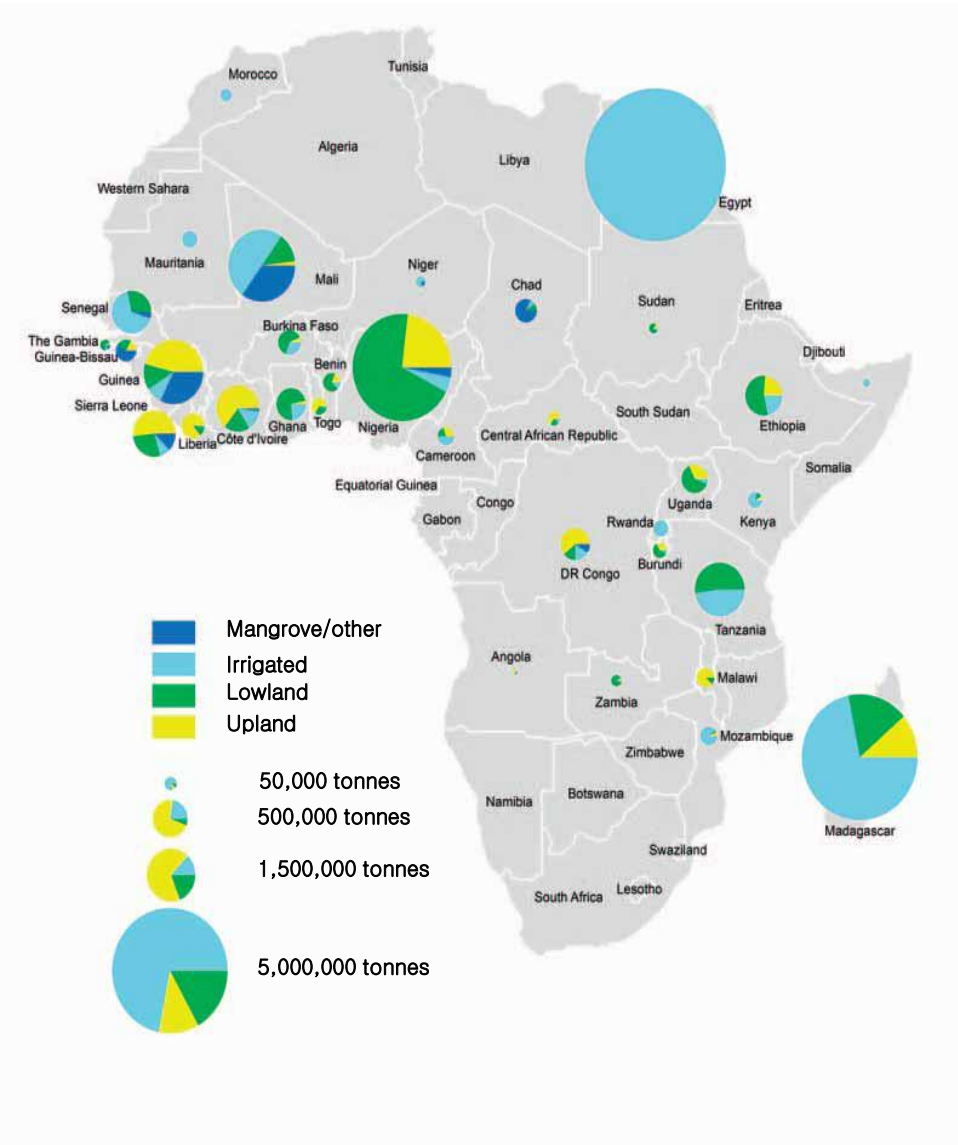
  : malaria, measles, persistent diarrhoea, and pneumonia, HIV&AIDS

Africa needs green revolution in crop production

Crop yields measured as weighted averages of yields for wheat, rice, and coarse crops by world regions, 1961-2010 – World Development Report (2013)[9]



Africa and Rice: Constraints and opportunities



- Rice is a major staple food in Africa
  : 39 countries (72%) with about 800 million people produce and consume rice among 54 countries

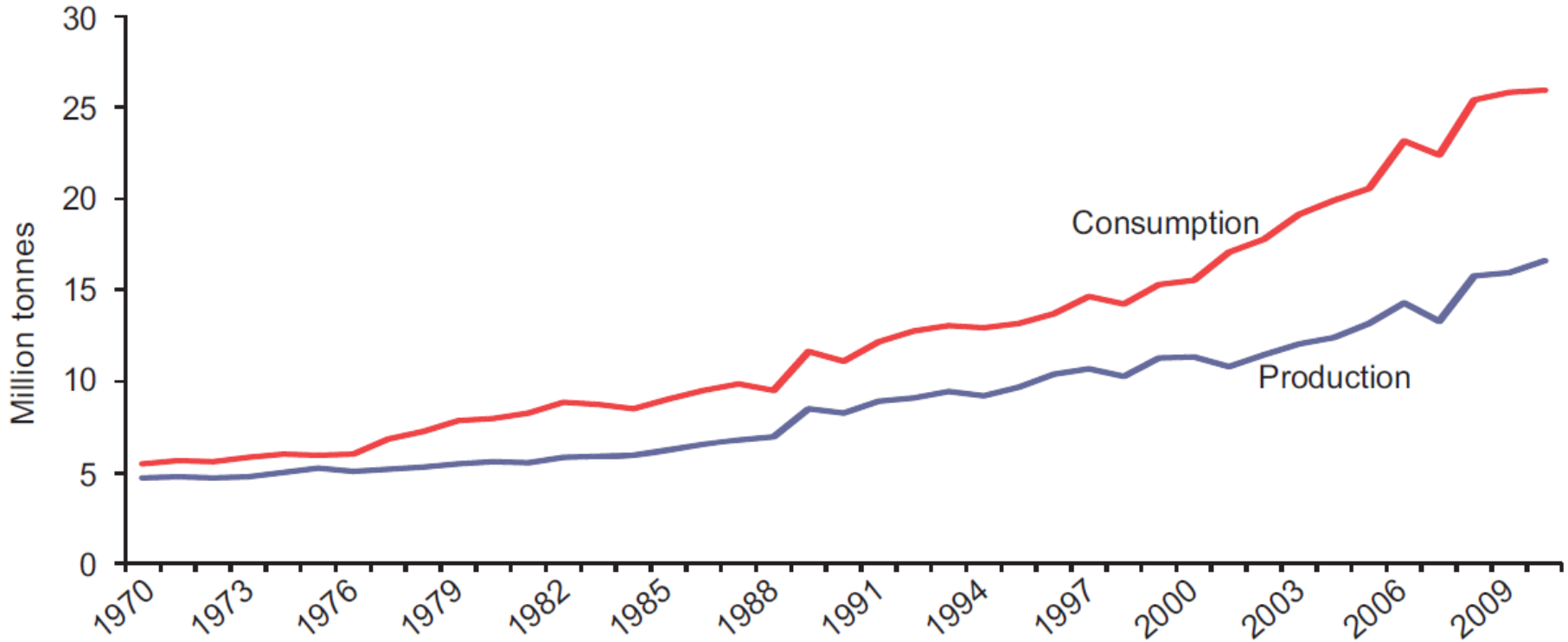
- Rice production depends primarily on the small-scale farmers, particularly women

- Rice is highly versatile and cultivated in different ecosystems

❖ In 10 million ha of rice land of SSA, upland(40%), rainfed lowland(37%) Irrigated (14%), Mangrove and deep-water (9%)

❖ Lowland rice offers great prospects for expansion and intensification for future rice production
: Available rainfed low land: 138 - 238 million ha

Africa and Rice: Rice is the strategic crop for food security

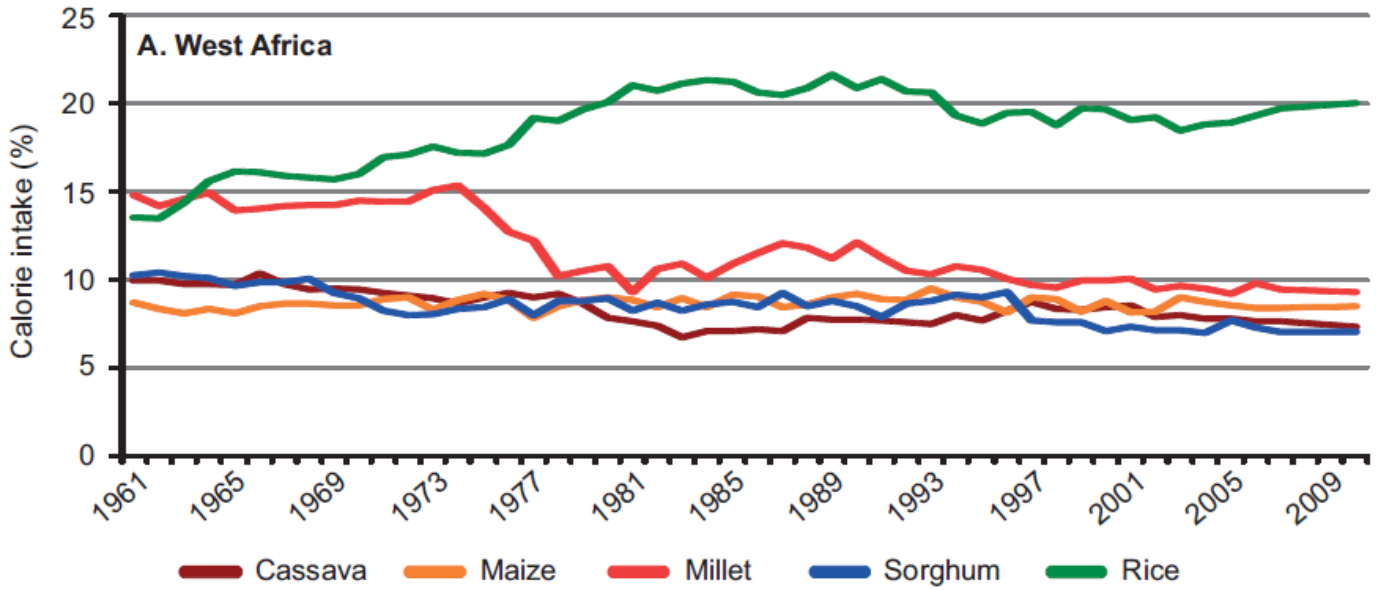


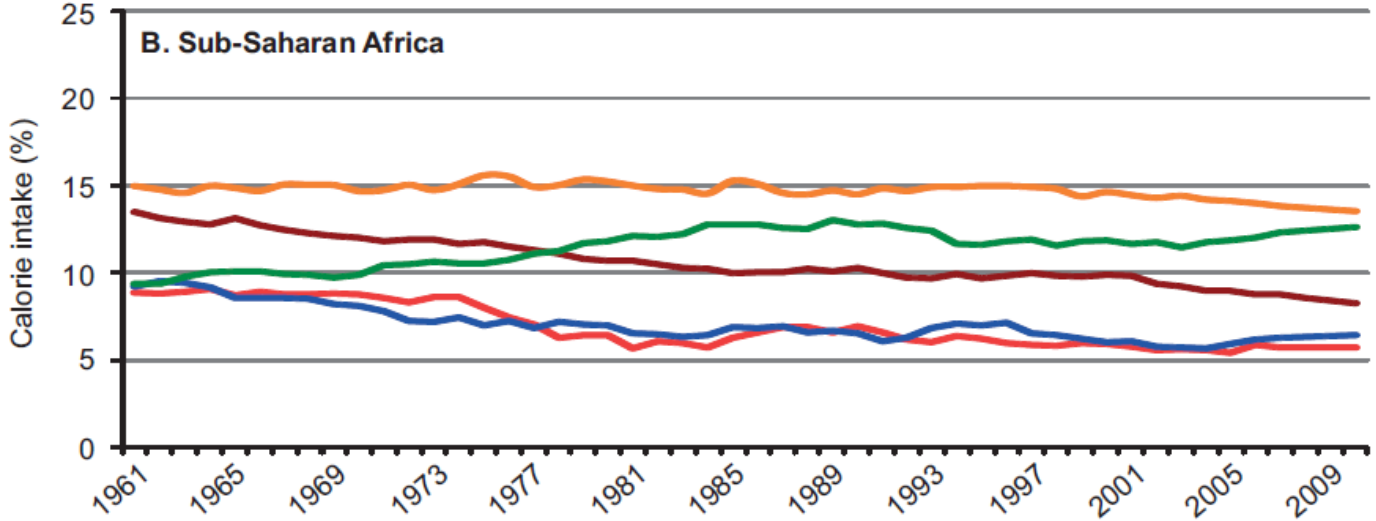
- Rice demand increased at faster rate (4.0%) than rice production (3.3%)
- Nearly 37% of rice consumed in SSA is imported

  ; 9.68 million tons of milled rice at a cost of US$ 5 billion in 2009

❖ **Rice is the most important strategic food for food security and political stability on the continent**

Africa and Rice: Rice is not a luxury food but a daily food





– FAOSTAT 2011 –

Brief History of Green Revolution in Korea

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"After Korean war, Korea suffered chronic shortage of rice until the early 1970s when rice yields were only 2.0 ~ 3.0 ton/h."

"However, rice production has nearly doubled through development of high-yielding rice cultivars, 'Tongil-type', leading to rice self-sufficiency in Korea since 1977."

"Rice self-sufficiency laid the foundation of economic growth and social stabilization in Korea."

" Now Tongil-type cultivars with 7~8 t/ha in milled rice yield are developed for the processed and functional rice ."

The first high-yielding variety in Korea, 'Tongil'

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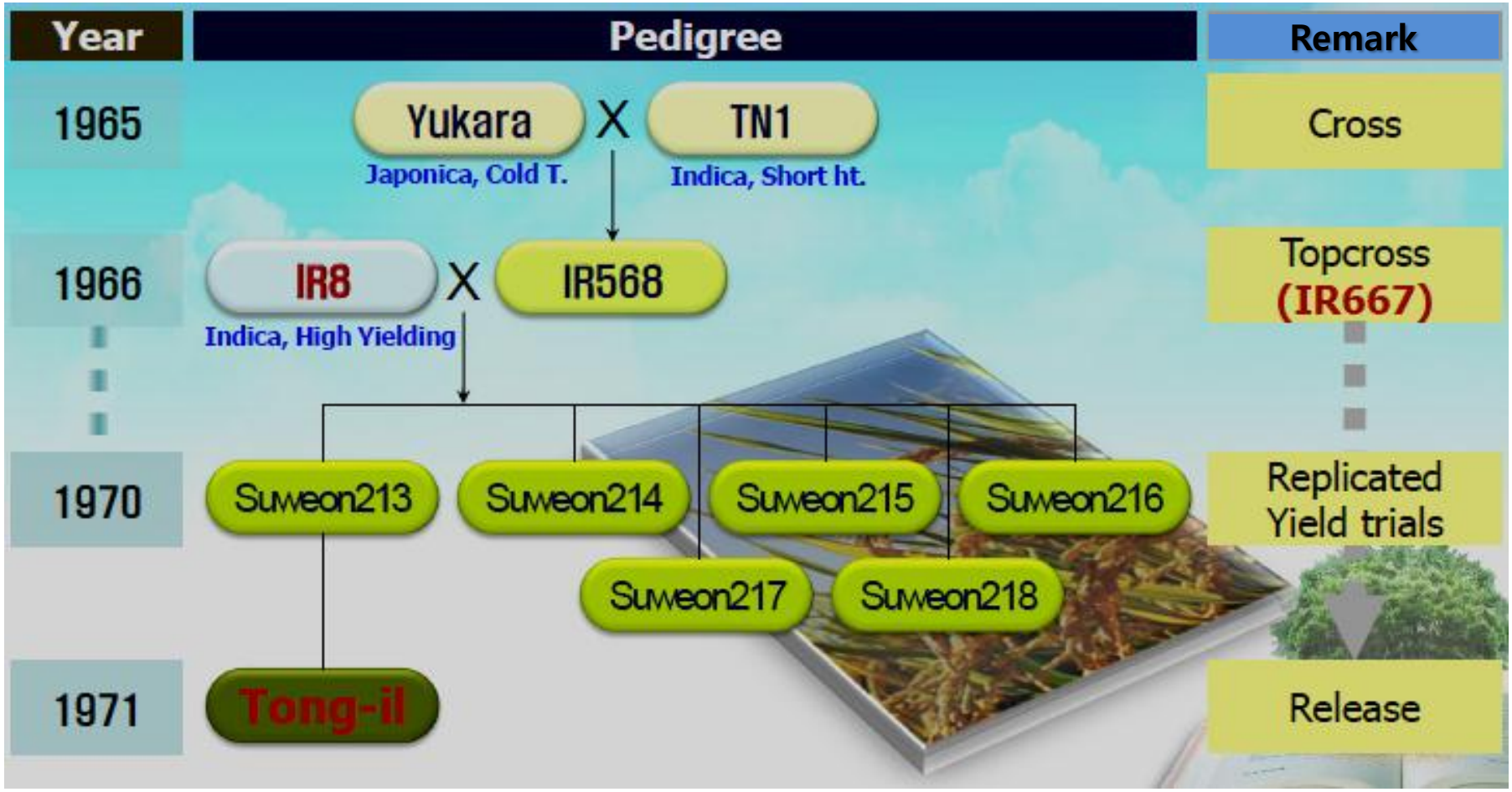
Three way cross of indica //japonica/indica



Semi-dwarf, high-yielding varieties 'Tongil-type'

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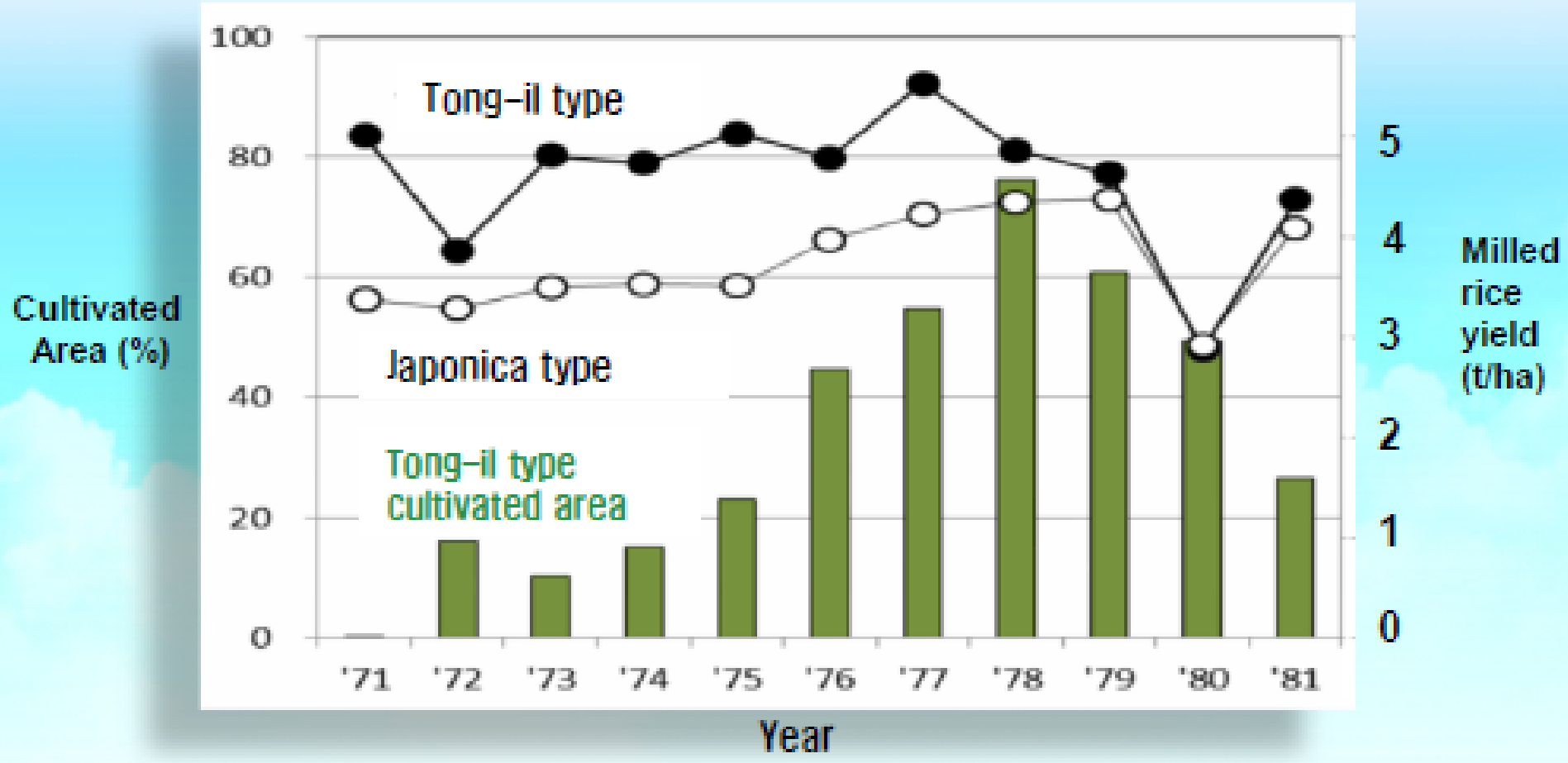
Japonica rice in 1960s
- Tall, susceptible to biotic & abiotic stresses

Tongil-type rice in 1970s –early90s
- 40 varieties bred
- Semi-dwarf(sd-1), resistance to diseases etc

Productivity of 'Tongil-type' rice



- Proportion of Tongil-type rice : ('71) 0.02% → ('78) 78.2 → ('81) 27

* Average yield in rice : 5.53 t/ha (1977) → Self-sufficiency of rice (109%)

Super-yielding rice in KOREA

- 7.01 ~ 7.57 ton/ha in milled rice

Varieties	Year developed	Yield in milled rice (ton/ha)	Genotype
Keunseom	2006	7.19	Japonica/Indica
Dasan 1	2006	7.18	Japonica/Indica
Hanmaum	2004	6.43	Japonica
Hanareum	2002	7.53	Japonica/Indica
Areum	1999	7.41	Japonica/Indica
Deraechan	2008	6.52	Japonica
Boramchan	2009	7.33	Japonica
Palbangmi	2012	7.57	*O.glaberrima*/Milyang23

Japonica Super-yielding lines

Major factors in Green Revolution

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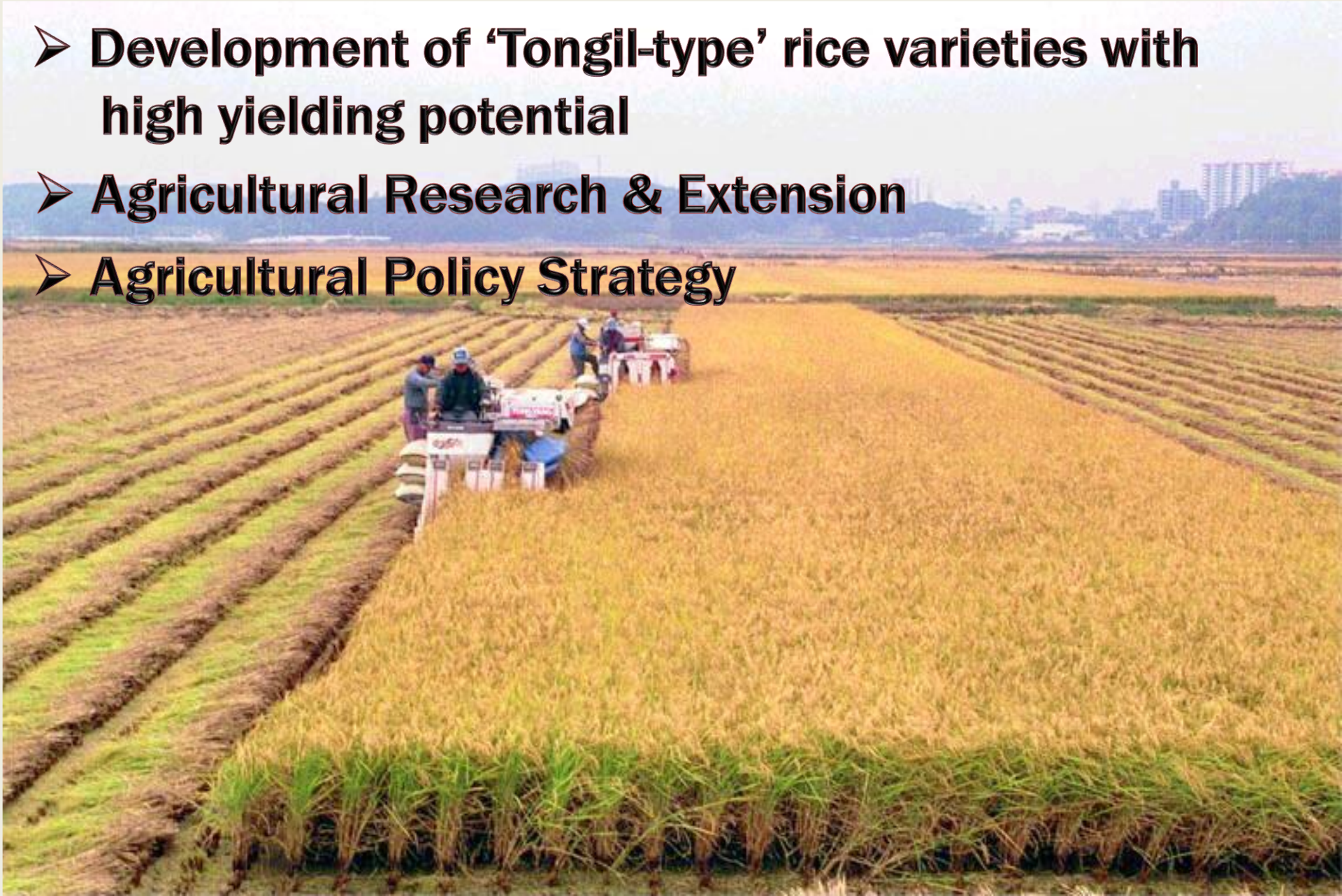
- Development of 'Tongil-type' rice varieties with high yielding potential
- Agricultural Research & Extension
- Agricultural Policy Strategy



Experience of international support

- Rice self-sufficiency and international support
  - 1,000 researchers were trained by International Rice Research Institute since 1962
  - IRRI provided breeding materials
  - Establishment of R&D system by USA
  - Establishment of seed multiplication system by IRRI IBRD

❖ **Korea's Experience on the Green Revolution means**

- Korea started the national development from green revolution after the colonial age and Korean War *(as many other developing countries have experienced)*

- Experience and materials on high-yielding rice development would be a good base for R&D cooperation between Korea and Africa

Directions of Africa Cooperation Project

- To transfer agricultural technology to developing countries
- To increase productivity by using existing abundant labor force
- To improve its own competence in agricultural sector

International Cooperation Programs of RDA

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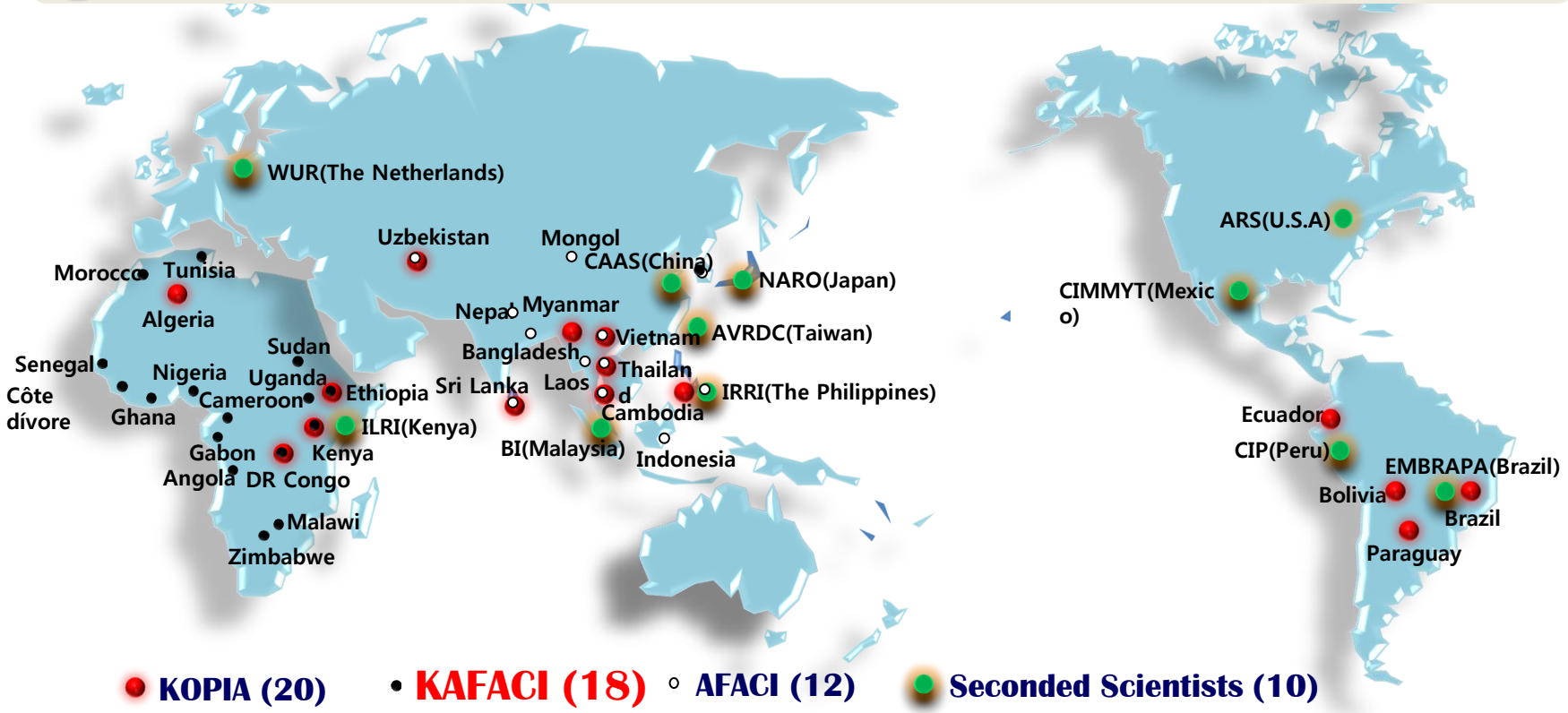
1. **KOPIA Centers** (Korea Project on International Agriculture)
2. **AFACI** (Asian Food & Agriculture Cooperation Initiative)
3. **KAFACI** (Korea-Africa Food & Agriculture Cooperation Initiative)
4. **Training Program & RDA Alumni**



KAFACI Members

18 Members of KAFACI in 2014

North Africa

Morocco, Tunisia (2)

West Africa

Ghana, Cote d'Ivoire, Nigeria, Senegal (4)

East Africa

Ethiopia, Kenya, Uganda, Zimbabwe, Comoros(5)

Middle Africa

Cameroon, Gabon, DR Congo (3)

South Africa

Angola, Malawi, Zimbabwe (3)

Republic of Korea

Currently, KAFACI has 18 member countries

Candidate countries of KAFACI

Rwanda, Mozambique, Zambia, Tanzania, etc.

KAFACI Rice Projects as of 2014

Country	KAFACI Project	Project Title	RDA institution
Cameroon	Country	Development of High-Yielding Rice Cultivar Adaptable to Cameroon	NICS
DR Congo	Country	Development of High-Yielding Rice Cultivar for Democratique Republique of Congo	NICS
Gabon	Counrty	Application of Rice mechanization Technologies in Irrigated Rice Field in Gabon	NAAS
Ghana	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
Kenya	Country KAFACI-AGRA	Rice Post-Harvest Support for Food Security and Economic Growth in Kenya Enhancement of High-yielding Rice Germplasm in African countries	NAAS NICS
Malawi	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
Mali	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
Nigeria	Country KAFACI-AGRA	Rice Productivity Enhancement Research and Development(Post harvest) Enhancement of High-yielding Rice Germplasm in African countries	NAAS NICS
Senegal	Country	Participative Varietal Selection (PVS) Assisted by markers of Some South Korean rice Varieties in the Senegal River Valley	NICS
Sudan	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
Tanzania	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
Uganda	KAFACI-AGRA	Enhancement of High-yielding Rice Germplasm in African countries	NICS
12country	8 KAFACI-AGRA 6 Country	11 countries: rice breeding 1 country: rice Mechanization (Gabon) 2 countries: rice Post havest (Kenya, Nigeria)	

Note: NICS(National Institute of Crop Science), NAAS(National Academy of Agricultural Science)

Proposal of KAFACI rice project, 2016 - 2024

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Project title	Korea-AFRICA rice development network for enhancement of high-yielding rice germplasm and breeding capacity of rice producing countries in Africa
Project goal	**To improve competence in the public rice breeding program by enhancement of high-yielding rice germplasm and breeding capacity**
Project period (2016 - 2024)	1st stage : 2016 ~2018 for 'Establishment of high-yielding germplasm' 2nd stage : 2019 ~ 2021 for 'Development of high-yielding cultivars' 3rd stage : 2022 ~ 2024 for 'Release of varieties and extension'
Objective of 1st stage (2016 - 2018)	1. To broaden rice gene pools with high yield potential through crosses with Korean and African germplasm for use in African breeding programs 2. To speed up the generation of high-yield elite germplasm in Africa by anther culture technology 3. To promote partnerships and networking between African countries and Korea
Member countries Research Fund	To be determined

Breeding Strategy

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To broaden and accelerate development of high-yielding germplasm in Africa

Inter-varietal crosses between African and Korean germplasm

African germplasm	Korean germplasm
Indicas	Japonica adapted to tropics
Nericas & Aricas	Tongil type cultivars
Indigenous landrace	Wide-cross progenies : *O.glaberrima, O.longistaminata O.barthii*

Anther culture

- Anther culture is the fastest way to provide large-scale genetically-fixed population with a wide range of genetic variation for the diverse environments in Africa

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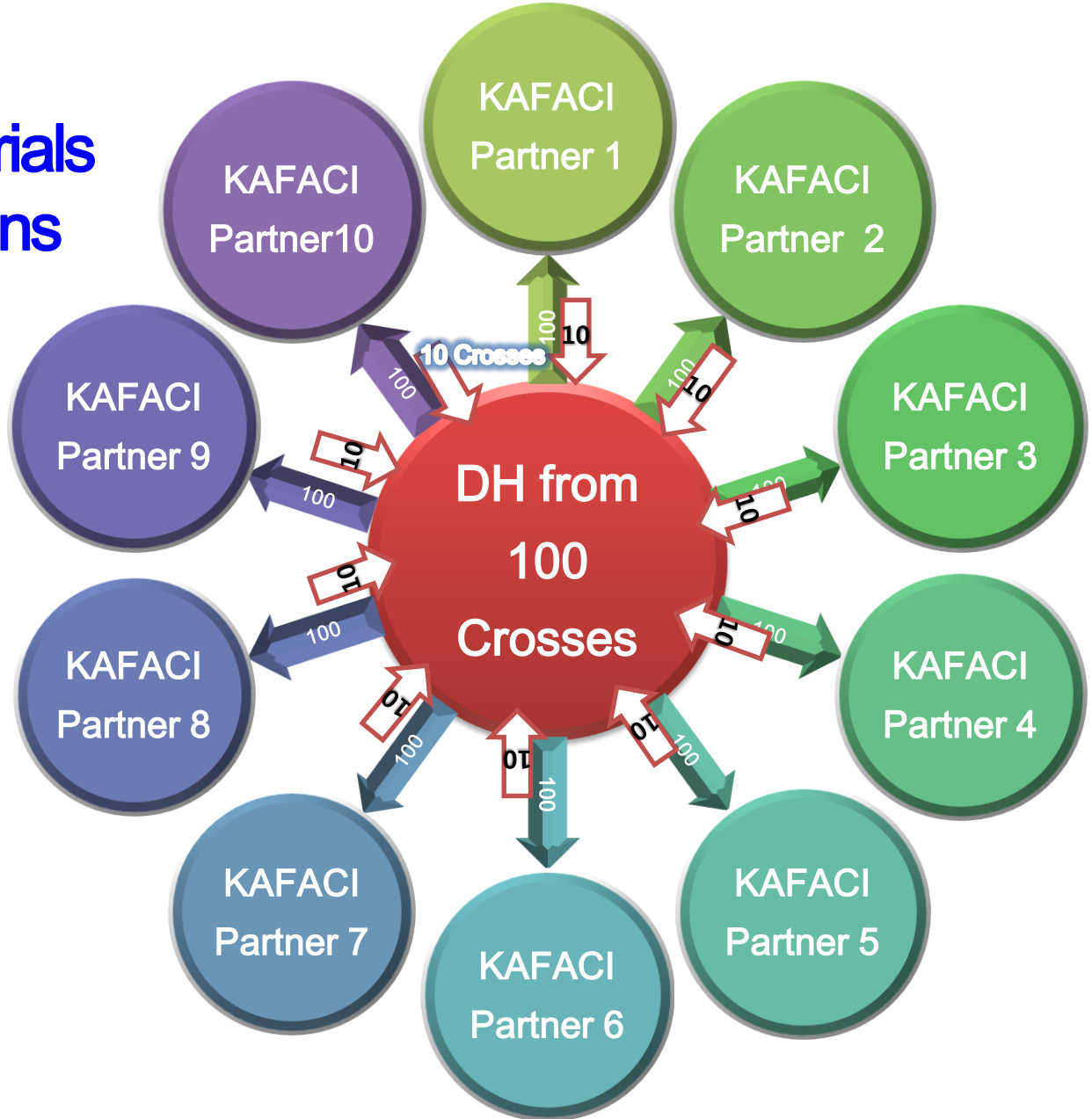
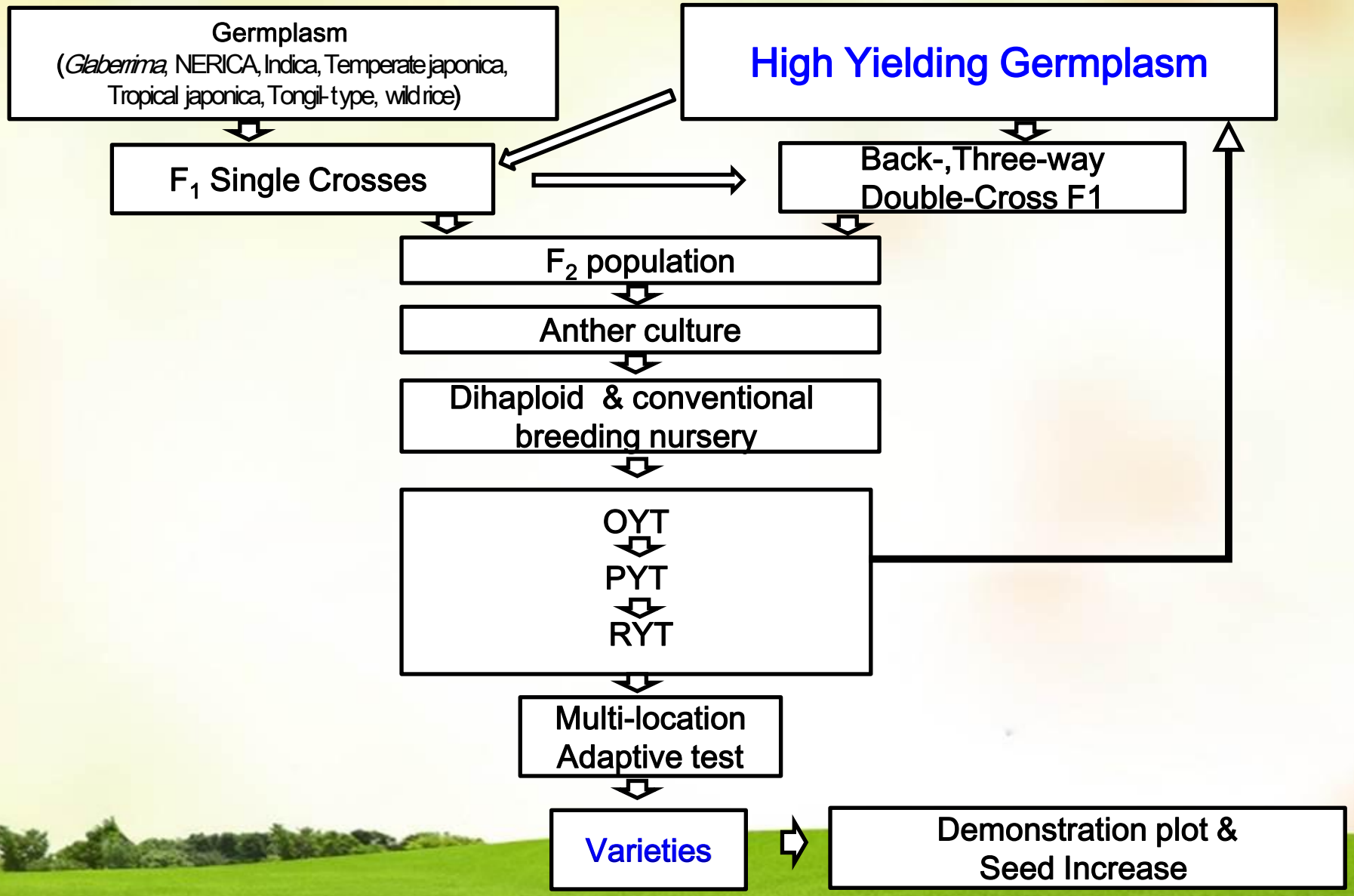
Breeding Strategy

- Sharing breeding materials and informations



Breeding Pipeline



Breeding target

- HIGH YIELD : 5 ton/ha in milled rice
- GOOD PLANT TYPE
  - BIG LONG PANICLE
  - MANY PRODUCTIVE TILLERS
  - STURDY STEM
- EARLYNESS: 100 ~ 130days
- HIGH MILLING RECOVERY
  - MEDIUM LONG GRAIN
- GRAIN QUALITY
  - MEDIUM-HIGH AMYLOSE
  - SOFT, CLEAR ENDOSPERM
- DISEASE AND INSECT RESISTANCE

Improved Tongil type

Breeding Activities in 2013-2015

RDA RURAL DEVELOPMENT ADMINISTRATION

In Korea

1. Shipping 400 Korean germplasm to AGRA for testing in KAFACI members

   - High-yielding japonica DHs adapted to tropics
   - Tongil-type lines from crosses with *O.glaberrima* etc

   * For 2015, 197 eltie lines were sent on 27th April to AGRA

2. KAFACI-nurseries in Korea

   - **DH nursery**: More than **10,000 DH lines established** from the inter-varietal crosses between tropical japonicas and indicas and African varieties
   - **Wide cross nursery**: Advanced introgression lines established from crosses with wild rices (*O.glaberrima*, *O.longistaminata*, and *O.rufipogon)*

Breeding Activities in 2013-2014

3. Production of DH plants by anther culture

- Anther culture was carried out for **F_2 – F_3 progenies** from the inter-varietal crosses made in DR Congo and wide-cross progenies from *O.longistaminata* etc

4. **On-the-job training** at NICS : Aug. 13 ~ Sep. 11, 2013

- 10 KAFACI members participated
- Knowledge and information sharing
- Promising line selection

On-the-Job Training

Knowledge sharing on rice breeding

RDA RURAL DEVELOPMENT ADMINISTRATION

Promising line selection in KAFACI-nursery

Korean germplasm screening in INERA, DR Congo

RURAL DEVELOPMENT ADMINISTRATION

Korean germplasm screening, IRAD, Cameroon

RDA RURAL DEVELOPMENT ADMINISTRATION

Development of Mechanized Rice Complex and Korean japonica cultivation, Avangan, Cameroon

RDA RURAL DEVELOPMENT ADMINISTRATION

Present Challenges in Africa Cooperation

RDA RURAL DEVELOPMENT ADMINISTRATION

- Exchange of breeding materials between Korea and Africa
- Enhancement of rice breeding system in Africa
  - people and infrastructure
  - rice breeding expertise
  - small machinery
- Establishment of optimized cultivation and management practices in breeding field under irrigated conditions in Africa
- Strengthening anther culture team and research fund (Korea)
- Development of breeding lines suited to upland conditions and direct seeding

➡ Needs of on-site experiment in Africa to raise efficiency of R&D activities

Negotiation with AfricaRice for conducting project in Africa

Project title	Korea-AFRICA rice development network for enhancement of high-yielding rice germplasm and breeding capacity of rice producing countries in Africa
Project goal	**To improve competence in the public rice breeding sector by enhancement of high-yielding rice germplasm and breeding team**
Project period (2016 - 2024)	1st stage : 2016 ~2018 for 'Establishment of high-yielding germplasm' 2nd stage : 2019 ~ 2021 for 'Development of high-yielding cultivars' 3rd stage : 2022 ~ 2024 for 'Release of varieties and extension'
Objective of 1st stage (2016 - 2018)	1. To broaden rice gene pools with high yield potential through crosses with Korean and African germplasm for use in African breeding programs 2. To speed up the generation of high-yield elite germplasm in Africa by anther culture technology 3. To promote partnerships and networking between African countries and Korea
Member countries Rsearch Fund	To be determined

세계를 향해 미래를 위해
국립식량과학원 신청사 이전 기념식
Reopening Ceremony of the National Institute of Crop Science
2015년 5월 28일(목)
국립식량과학원
Agreement on International Cooperative
Project for 2015 Rice Breeding & Training
28 May 2015, NICS/RDA Wanju Korea
RURAL DEVELOPMENT ADMINISTRATION
NATIONAL INSTITUTE OF CROP SCIENCE

Thank you