

INVITED PRESENTATION 1

ONION BREEDING AND SEED PRODUCTION IN KOREA

by Cheol-woo, Kim



Onion breeding and seed production in Korea

Cheol-woo, Kim

Bioenergy crop research
center, NICS, RDA, KOREA

ABSTRACT

- Status of onion cultivation in Korea
 - Korea ranked Top 10 in the world in production of onions -1,411,650 metric ton, 2012 FAO.
 - In dry-bulb onion yield per hectare, Korea ranked the first(672,476kg, 1990-2009,USDA)
 - National cultivation area : '14 Year 23,908ha
 - Onion seed market : 29.4 billion \$(import 1.80million-Most varieties of Japan)

- Cultivars of Korea
 - Early maturation type 12%, mid-late maturation type 88%
 - Chief production area in Korea
 - Early maturation type (2,542ha)
: Jeonnam 61% > Jeju 35% > kwangju 3% > kyeongnam 1%
 - Mid-late maturation type(19,552ha)
: Jeonnam 52% > kyeongnam 22% > Kyungpoog 14% > Jeonbuk 7%

- Researches for development of onion cultivars
 - Traditional methods : The Use of cytoplasmic Male Sterility for Hybrid Seed Production
 - Using molecular marker : development pcr marker distinguished cytoplasm and geno type related male sterile and maintainer
 - Research of inter-specific hybrid : to breed pest and disease resistance line

Contents

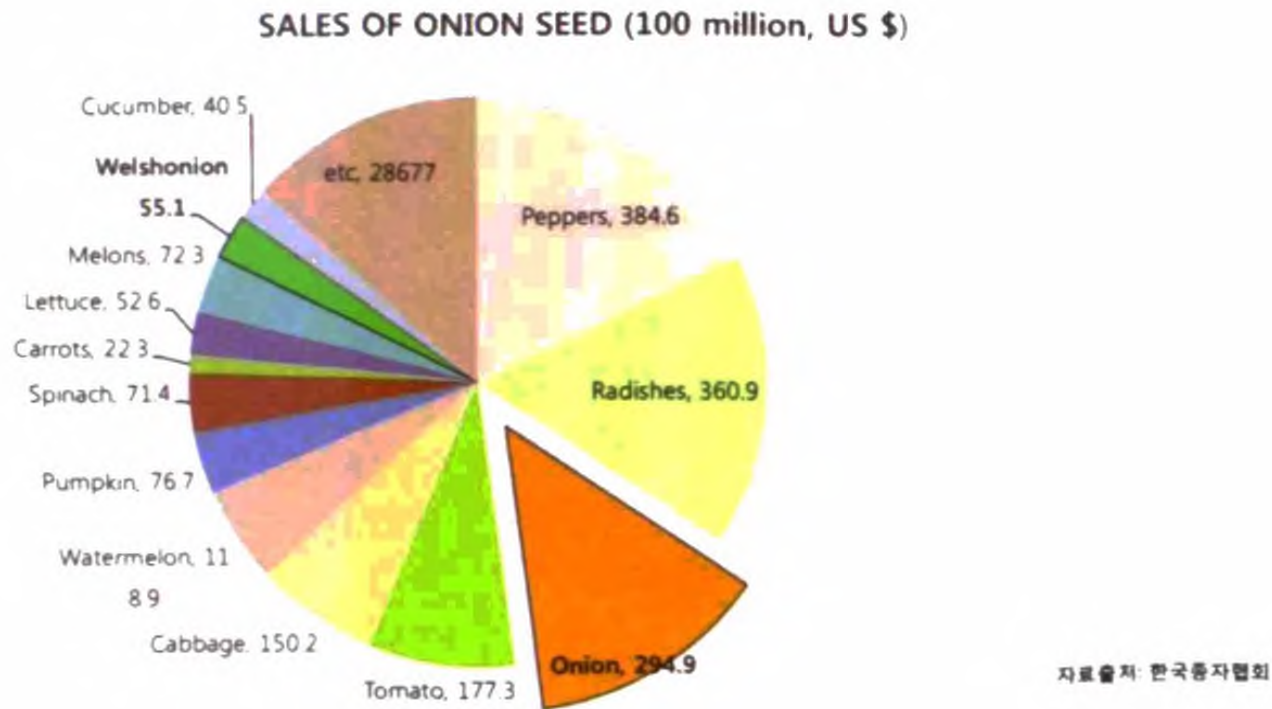
- 01 Intorduction – Status of onion industry in Korea
- 02 Breeding procedure of hybrid seed production
- 03 Research of breed efficiency enhancement
 - Development of molecular marker and use
 - Development inbreed line using of Doubled haploid
- 04 Research of Inter-specific hybrid
- 05 Seed production in south korea



Onion breeding and seed production in Korea

Onion seed market in Korea

- onion seed market in Korea is ranked three, followed by peppers, radishes
- Onion seed market is a 29.4 billion \$



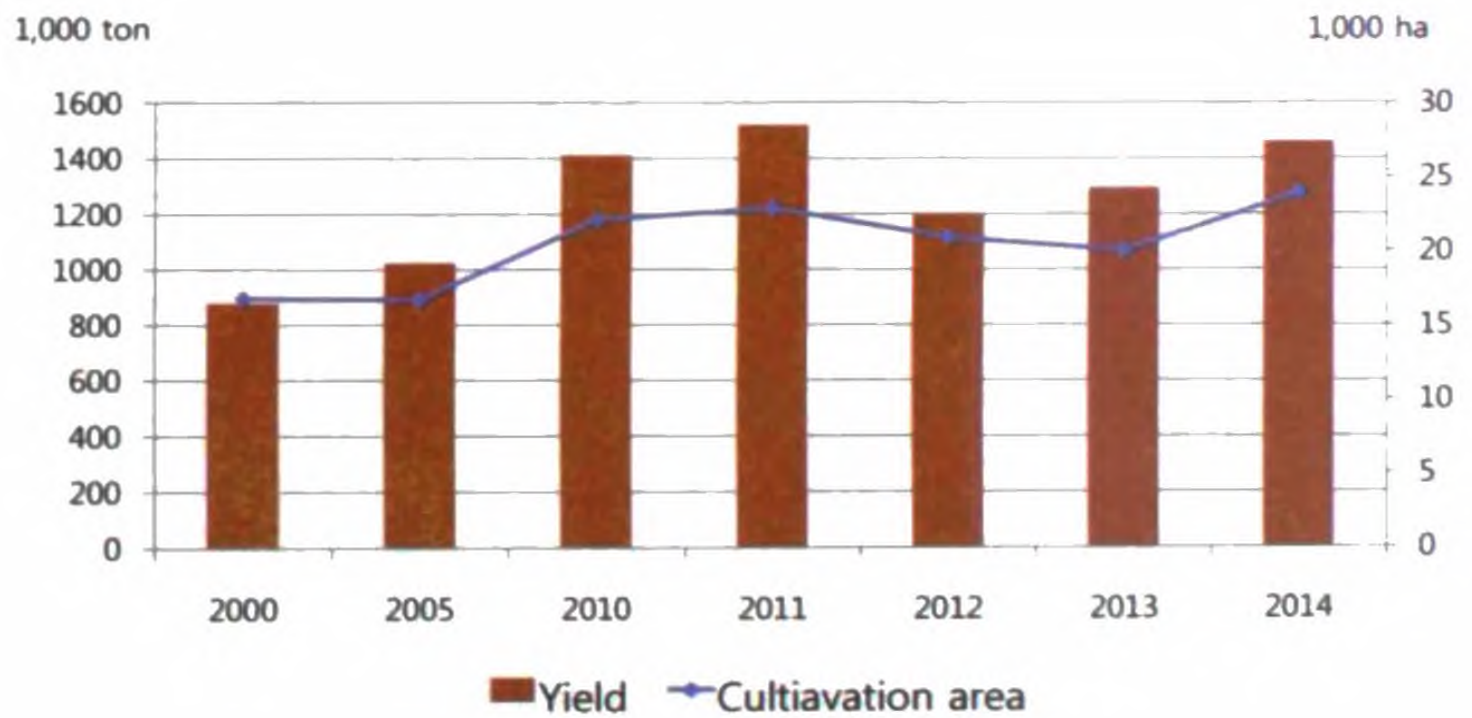
□ Onion seed production in 2013

Year	Domestic		Abroad		Total(kg)
	Yield(kg)	ratio(%)	Yield(kg)	ratio(%)	
1995	20,747	68.5	9,526	31.5	30,273
2000	23,014	40.5	33,788	59.5	56,802
2004	3,208	11.1	25,671	88.9	28,879
2006	6,855	20.0	27,355	80.0	31,210
2007	9,197	19.9	36,994	80.1	46,991
2008	9,234	34.0	29,174	76.0	38,408
2009	7,473	18.9	6,846	81.1	39,568
2010	9,183	50.1	9,174	49.9	18,357
2011	8,768	19.3	36,655	80.7	45,423
2012	14,616	26.5	40,485	73.5	55,101

□ Onion cultivation area according to ecotype



□ South Korea's annual acreage and quantity of onion



Onion breeding and seed production in Korea

South Korea's annual acreage and quantity of onion, 2014

Year	Cultivation Area(ha)	Yield / ha(kg)	Total production(MT)
2002	15,314	6,093	933,095
2003	12,352	6,033	745,203
2004	15,563	6,090	947,797
2005	16,737	6,114	1,023,331
2006	15,315	5,809	889,619
2007	17,751	6,836	1,213,375
2008	15,392	6,725	1,035,076
2009	18,514	7,412	1,372,291
2010	22,113	6,384	1,411,646
2011	22,976	6,616	1,520,016
2012	20,965	5,703	1,195,737
2013	20,036	6,458	1,294,009
2014	23,908		

The two types are grown in accordance with temperature distribution in Korea

○ Early maturation type 12%, mid-late maturation type 88%

○ Chief production area in Korea

- Early maturation type (2,542ha)

: Jeonnam 61% > Jeju 35% > kwangju 3% > kyeongnam 1%

- Mid-late maturation type(19,552ha)

: Jeonnam 52% > kyeongnam 22% > Kyungpoog 14% > Jeonbuk 7%

Onion consumption amount

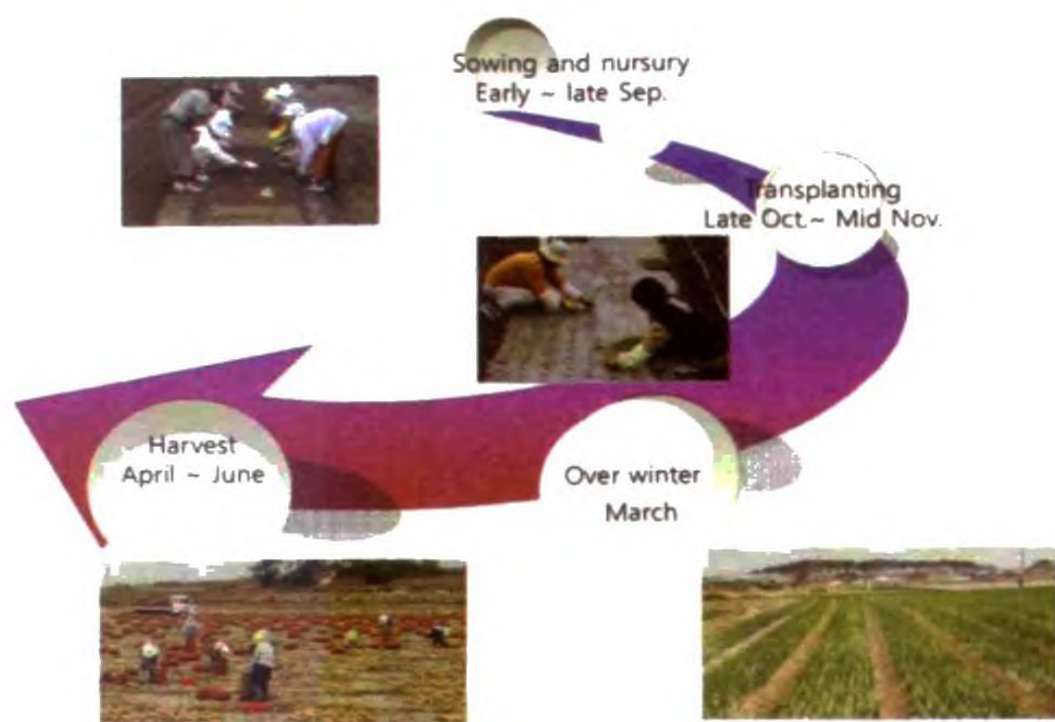
Health food

- World average per capita consumption : 6.2kg
- Libya : 30.3kg
- Korea : 25.5kg
- USA : 9.5kg

Uses of onion in South Korea



❖ Onion life in South Korea



Onion Seed Production procedure in South Korea

- Seedling : late Aug. - Mid Sep. Planting: late Oct. - Mid Nov.



- Harvesting: early April - mid June Mother bulb planting: late Aug. - early Oct



- Seed production: mid-July



02 Breeding procedure of hybrid seed production

onions (*Allium cepa* L.)

- ↳ Major vegetable crop
- ↳ Biennial crop
- ↳ Cross-pollinated crop
- ↳ Vernalization and specific photoperiod requirement for flowering
- ↳ Severe inbreeding depression

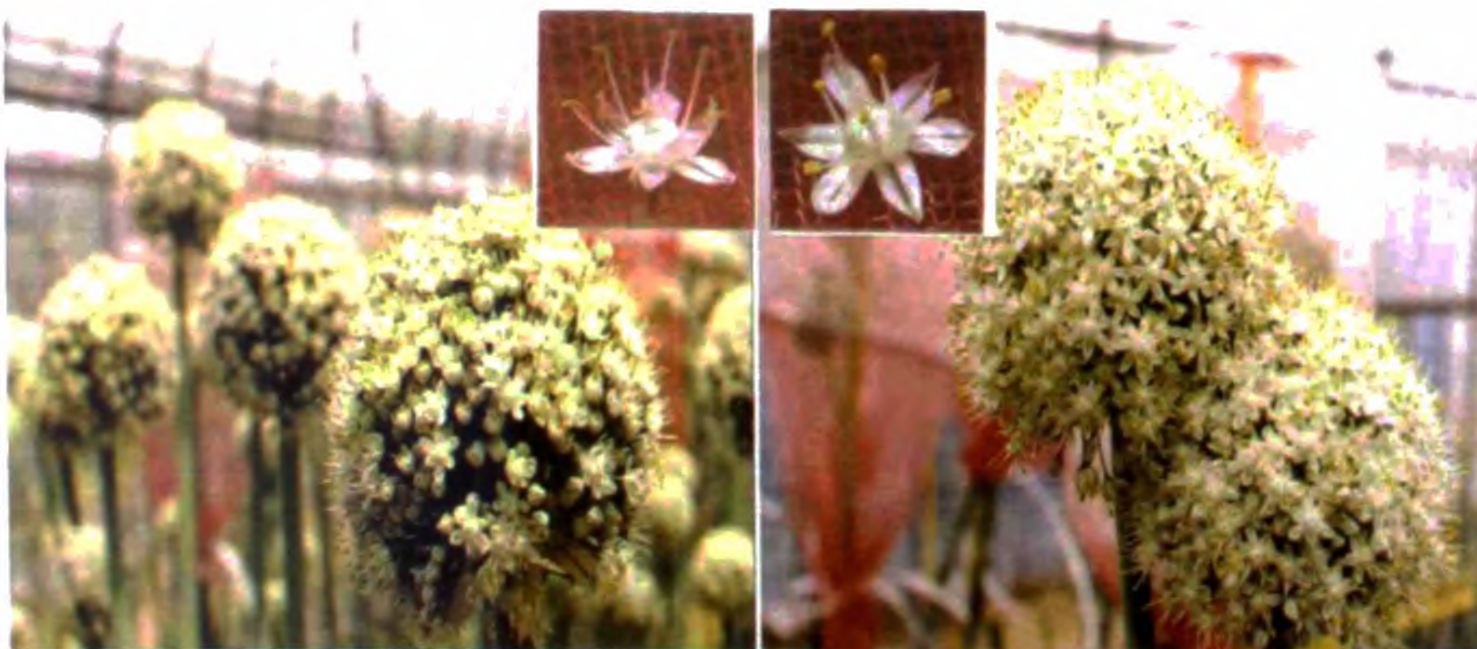
Goal Setting

- How to cultivate the breed type: fixed species (OP), hybrid
- Daylength response
 - Early variety daylength = 11.5 hours
 - mid-late variety daylength more than 14 hours
- Uniformity
- By use
- Disaster Resistant
- Local adaptability

The Use of Cytoplasmic Male Sterility for Hybrid Seed Production

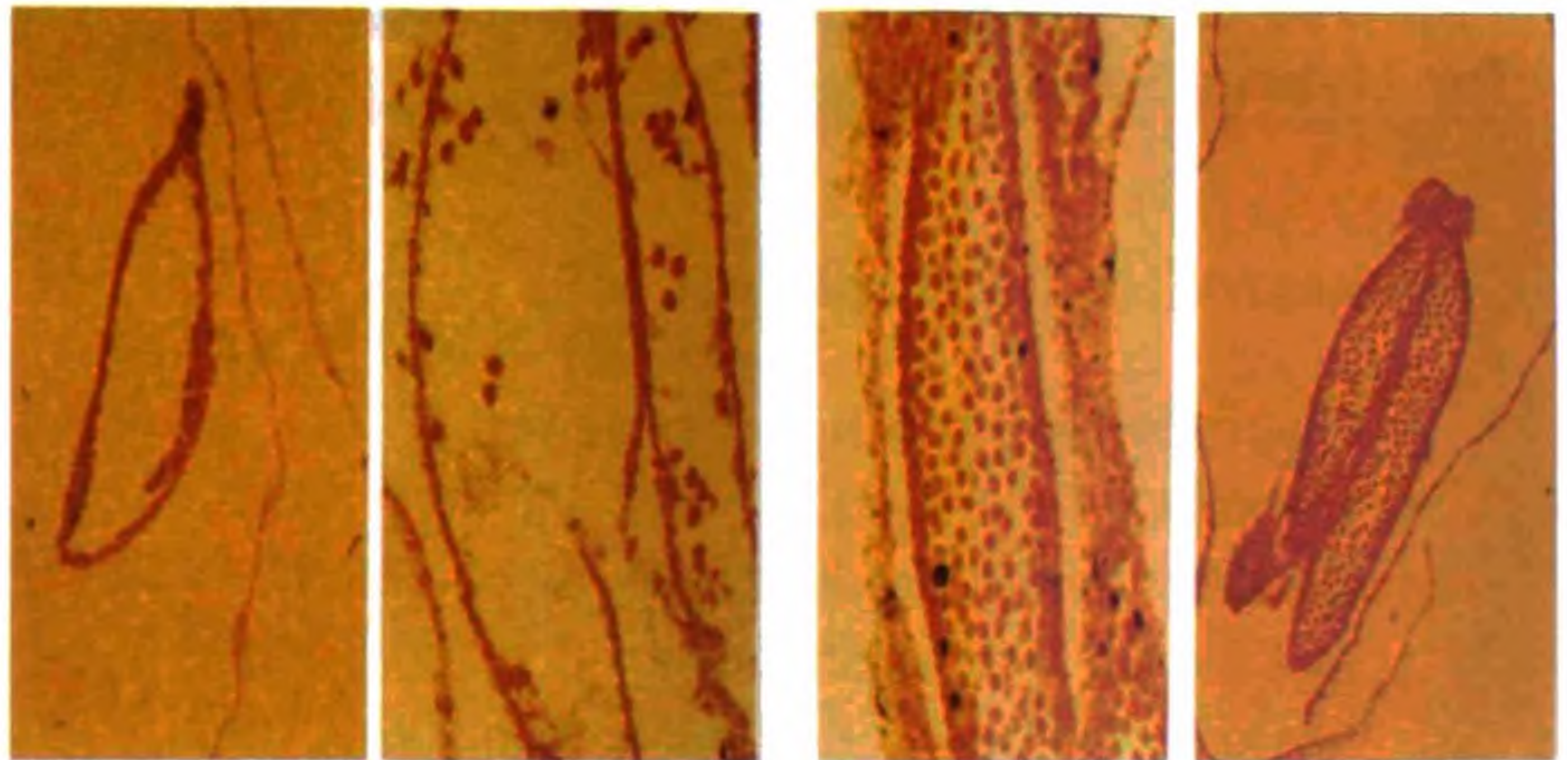
Cytoplasmic male sterility (CMS)

- Controlled by mitochondrial genes
- Maternally inherited
- Used for hybrid production in many crops
 - Onion, carrot, cabbage
 - Corn, sorghum, pearl millet, sunflower, sugar beets



Male sterile (A- line)

Maintainer (B-line)



Male sterile anther

Male fertile anthe

Use backcross breeding method

- Make selection in maintainer
-Also self or sib-mate
 - Plant seed from self or sib-mating
 - Make selection in maintainer
-Self or sib mate
 - Continue
- Cross with male-sterile line
- Cross with male-sterile
- Cross with current male-sterile

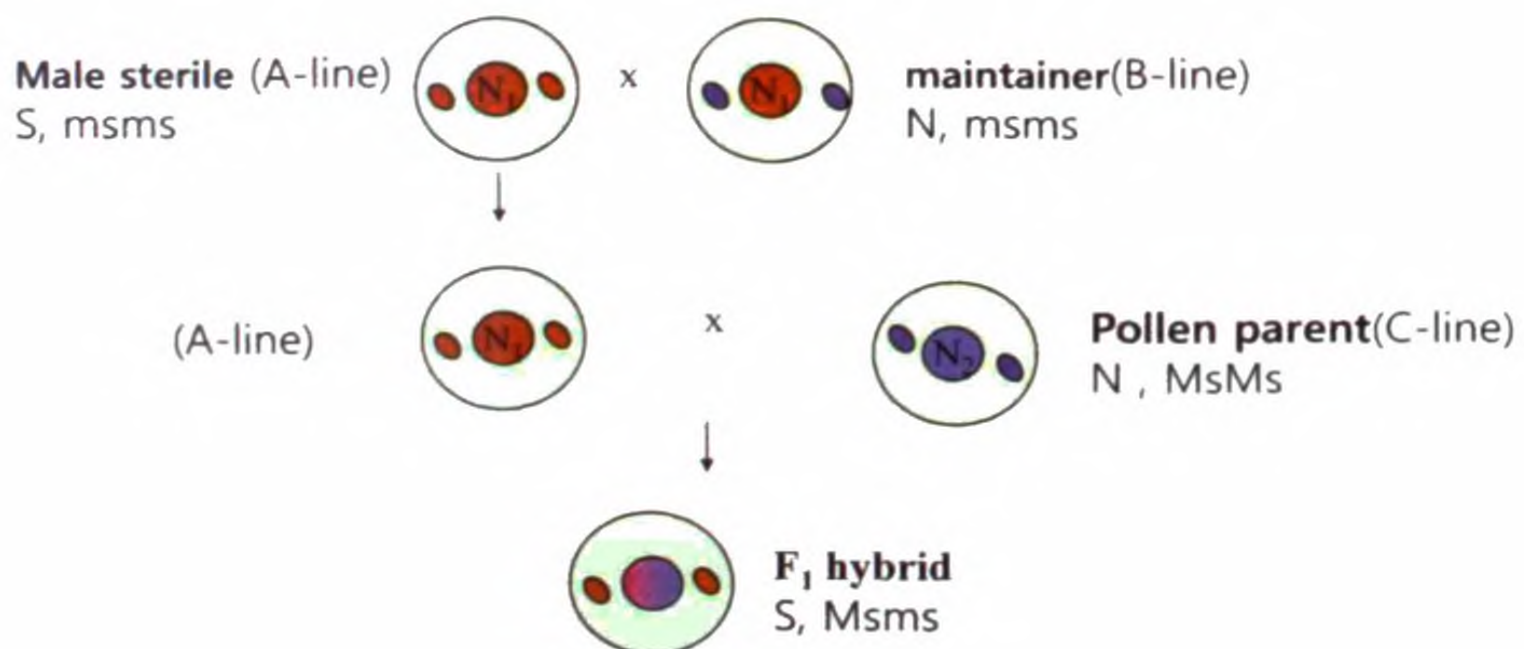
✓ Male-sterile line will look more like maintainer lines

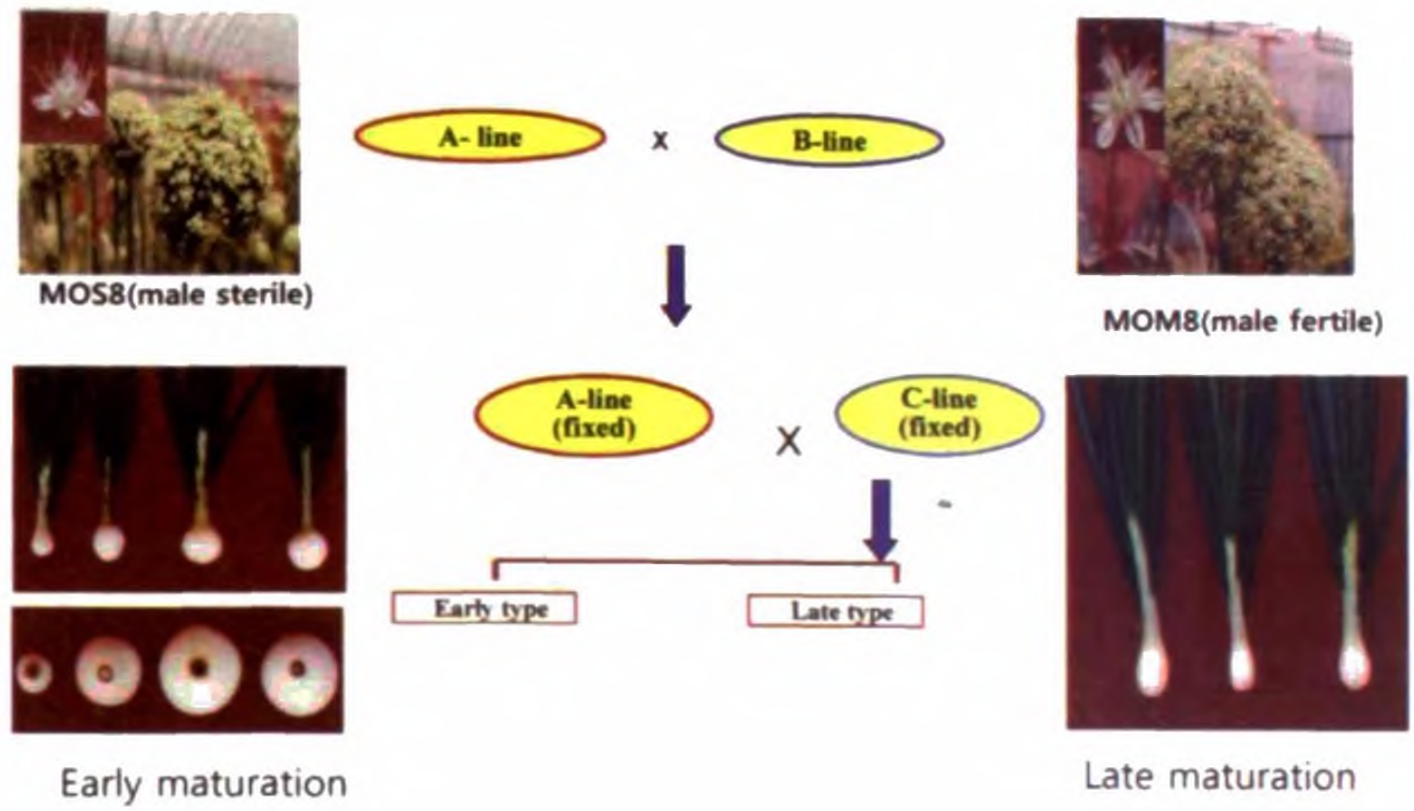
Search for maintainer lines

Unknown plant X Male-sterile (Smsms)

- All sterile progeny (Smsms) then Nmsms
- 50% fertile : 50% sterile then SMsms or NMsmS
- 100% fertile then SMsMs or NMsmS

Simple hybrid with cms and restoration



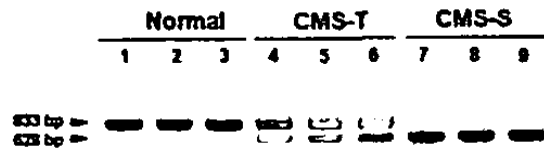


Research of breed efficiency enhancement Development of Shortening generation breeding Tools

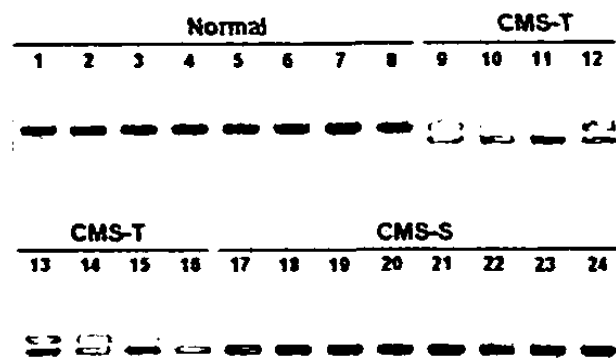
- Development of molecular marker
- Development inbred line using of Doubled haploid

Development of molecular marker for distinguishing 3 onion mitotypes

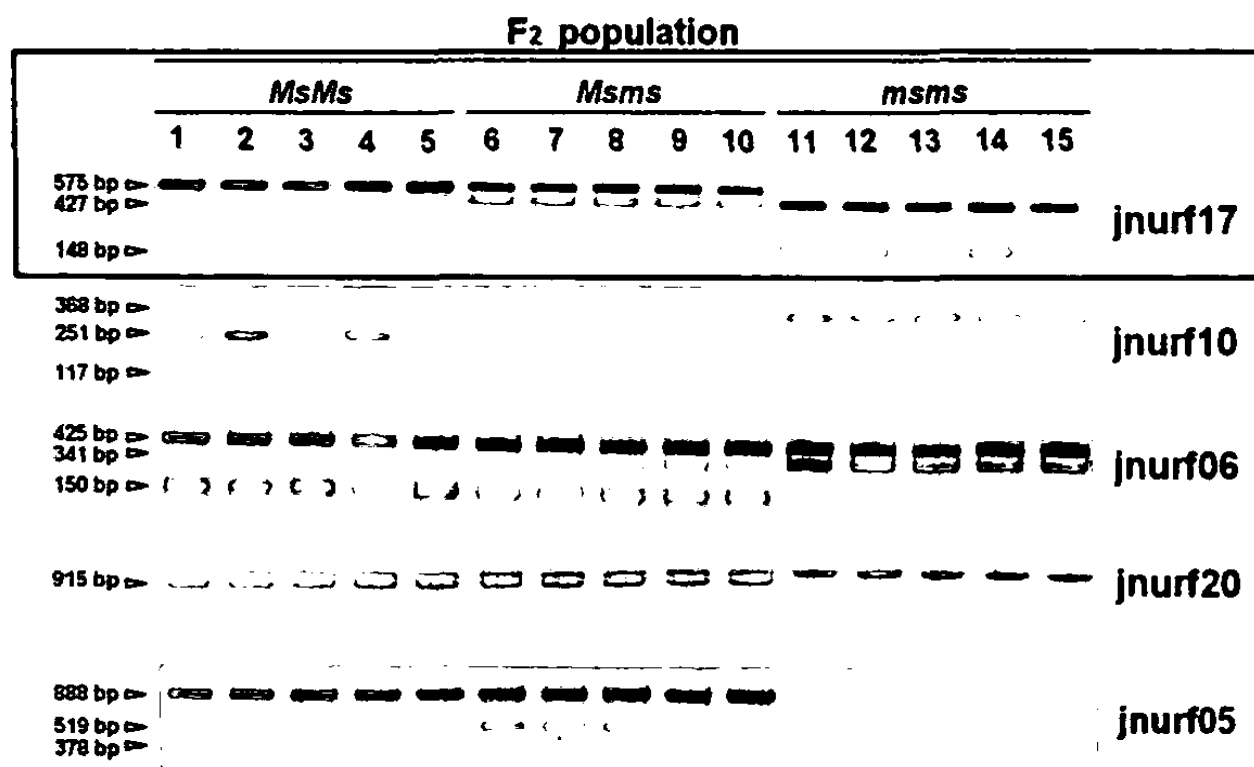
A



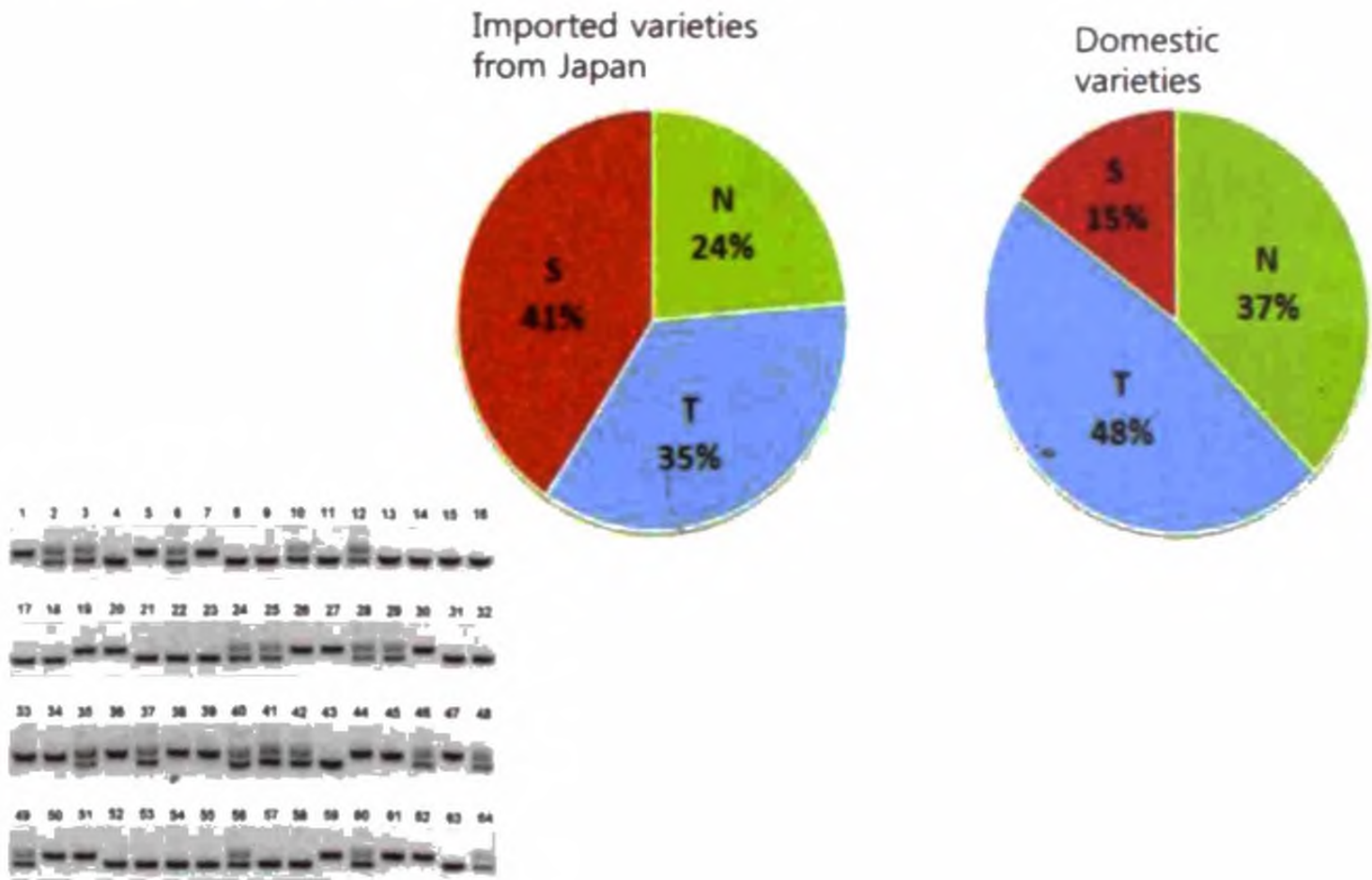
B



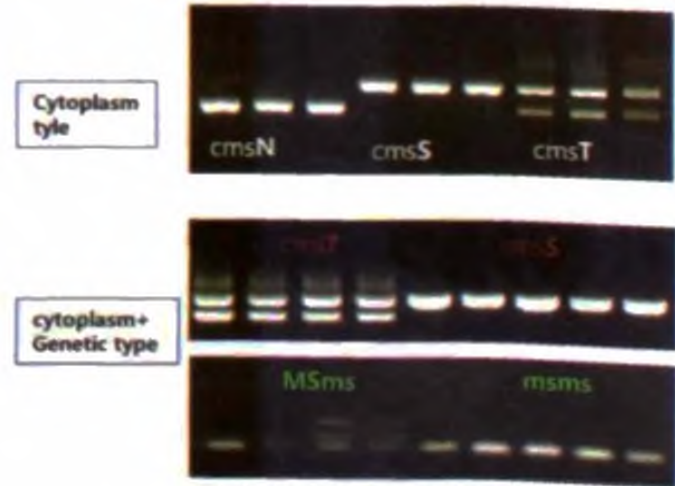
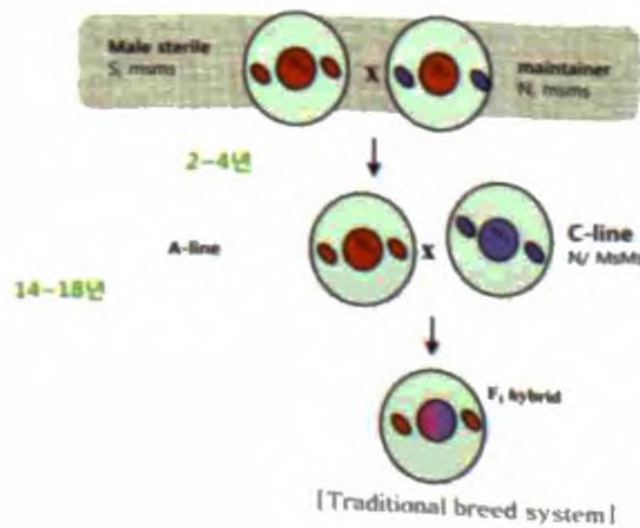
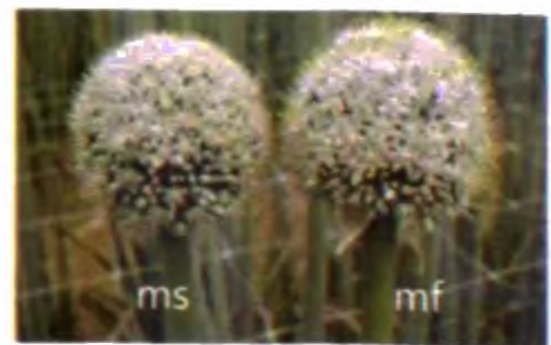
Development of molecular marker distinguishing maintainer



Male sterile type investigation for 116 varieties grown in the domestic



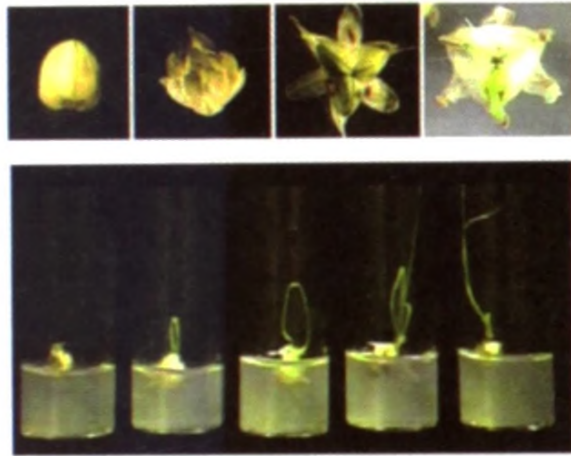
➤ Development of molecular marker distinguishing 3 cytoplasm and genotype



[분자 마커를 이용한 용성불임계세 선발]

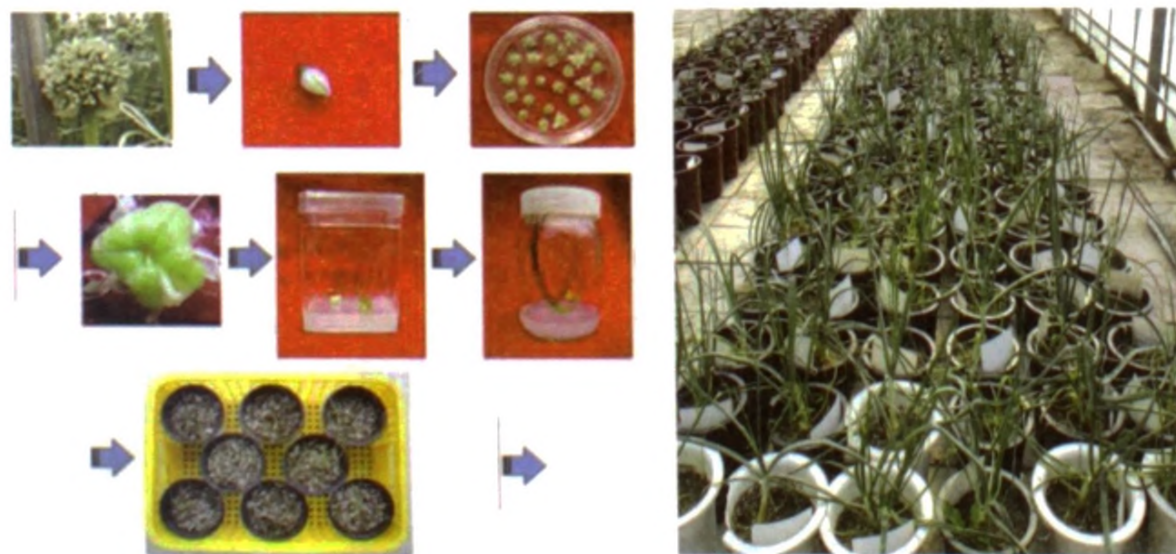
✓ maintainer selection : 4~8years(trational method) → 1 Month

Development inbreed line using of
Doubled haploid (DH line)



Haploid grown through the ovary of onion flower

Development of DH line breed procedure

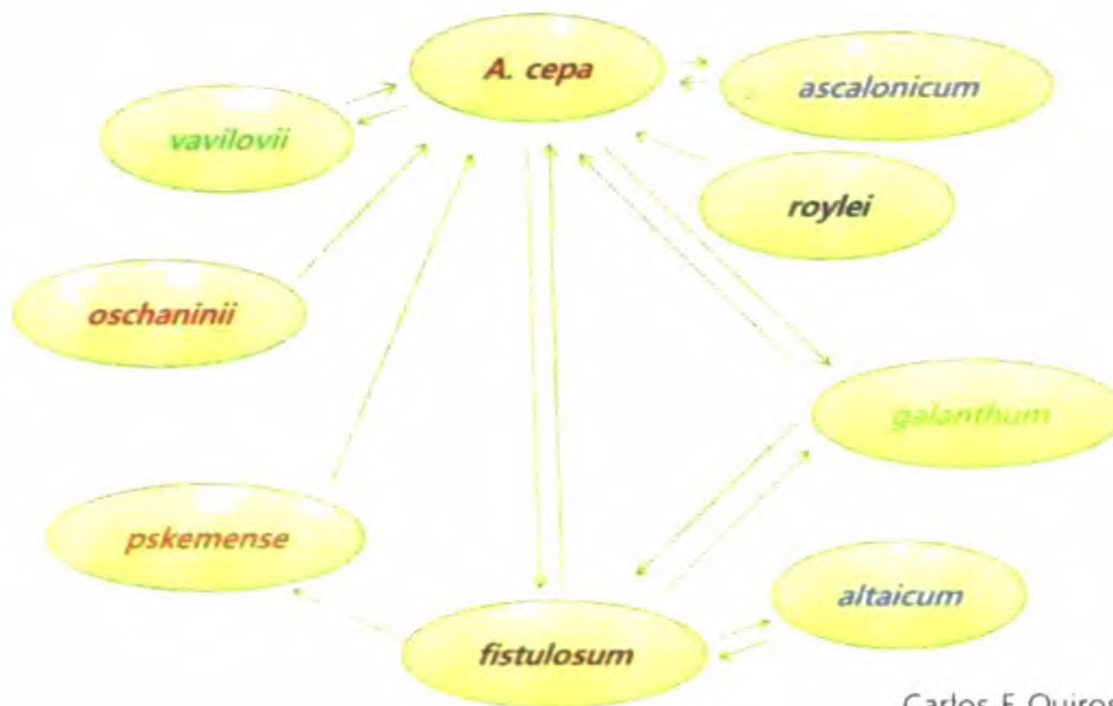


Doubled haploid line induced from immature ovary



line	plant	haploid	2x	3X	4X	5X	mixoploid
835	82	62	20	0	0	0	0
837	5	5	0	0	0	0	0
845	63	42	19	2	0	0	0
851	1	1	0	0	0	0	0
852	32	18	14	0	0	0	0
854	16	9	6	0	0	0	1
856	3	3	0	0	0	0	0
868	10	4	6	0	0	0	0
890	1,415	1,121	234	1	22	2	35
912	12	4	8	0	0	0	0
891	53	40	13	0	0	0	0
895	2	2	0	0	0	0	0
968	330	216	104	2	4	0	4
sum	2,024	1,527	424	5	26	2	40

04. Research of Inter-specific hybrid

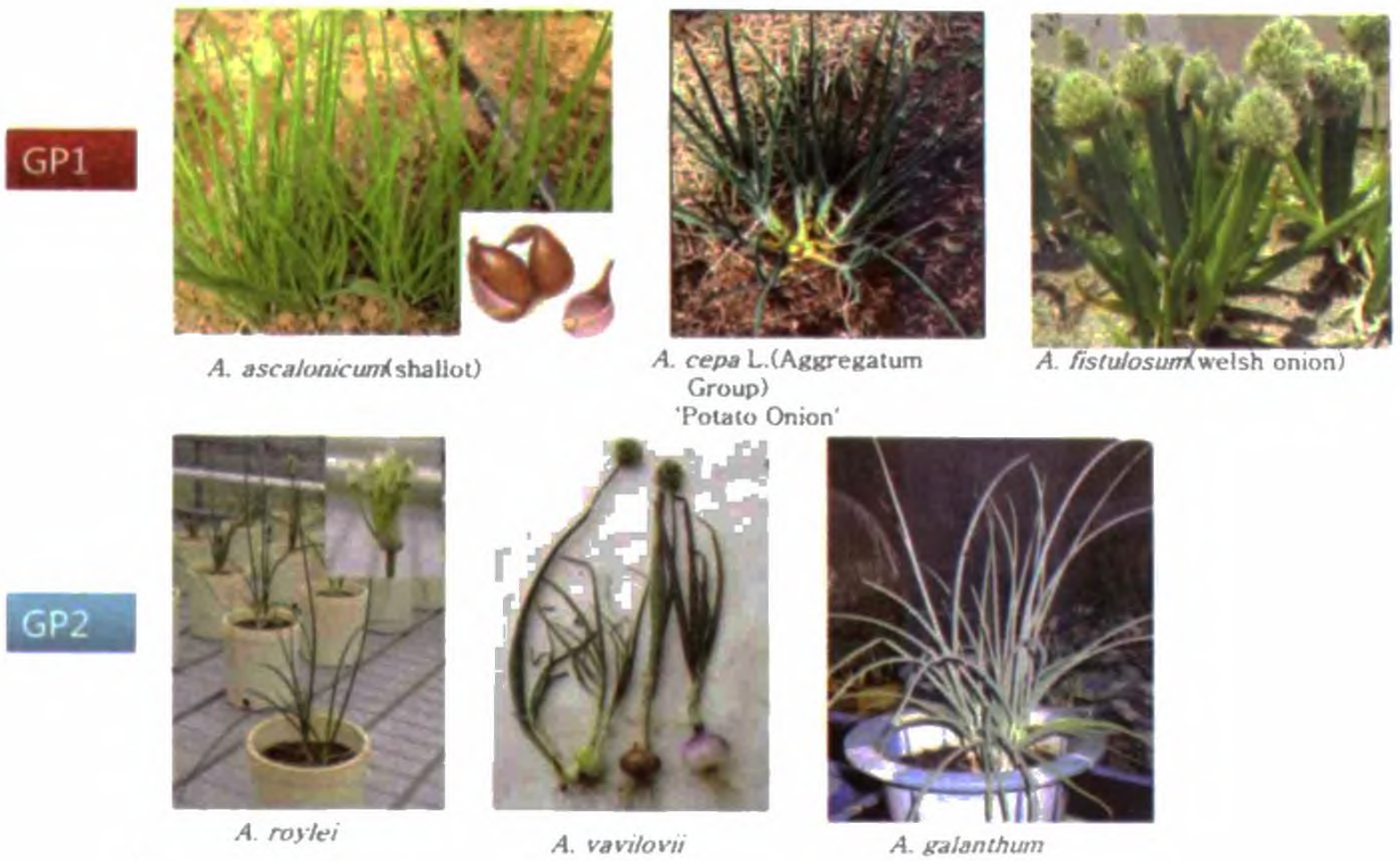


Carlos F Quiros, 2010

Gene pool concept in cultivated *Allium species* based on hybridization (Shigyo, 2007)

A. sativum (Garlic)
A. ampeloprasum (Leek)
A. chinense (Rakkyo)

A. cepa (onion)
A. ascalonicum (shallot)
A. vavilovii



Introgression through interspecific hybrid

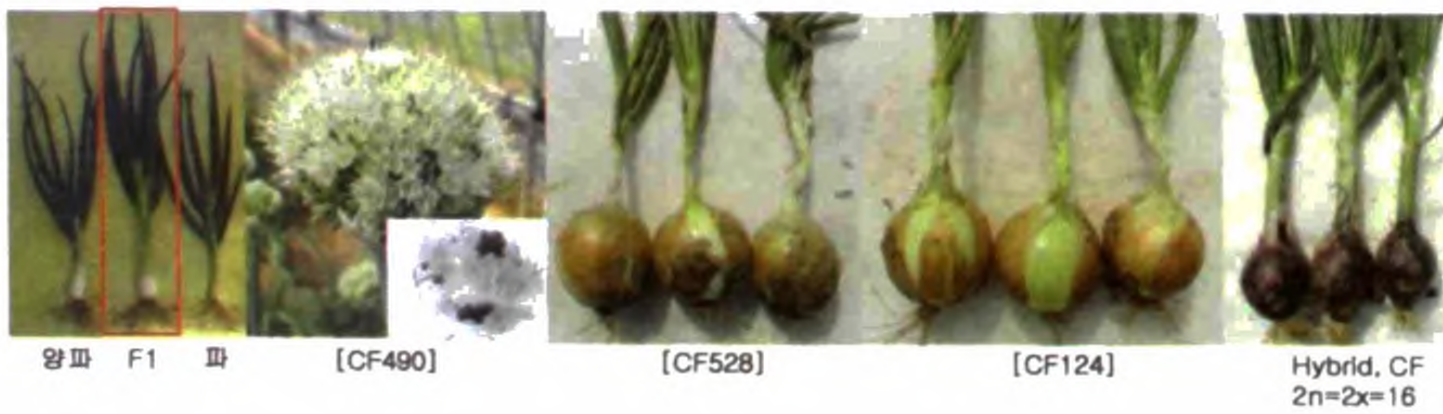
Allium cepa (common onion) × *A. ascalonicum* (shallot)
: to improve storability, functional ingredients



Onion breeding and seed production in Korea



Allium cepa (common onion) × *A. fistulosum* (bunching onion)
 : to introduce disease resistance (leaf blight, pink root, downey mildew etc)



BC₄F₁



05. Seed Production in Korea

The procedure of pollination and seed production



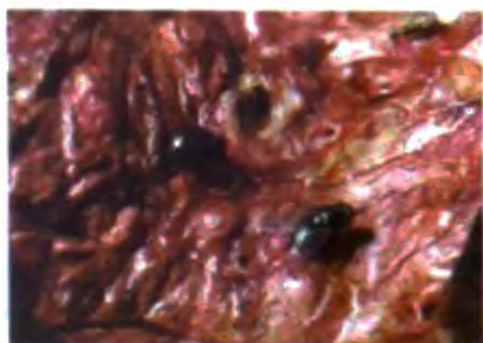
Artificial rearing of pollinator vector
(blow fly, *Lucilia illustris*)



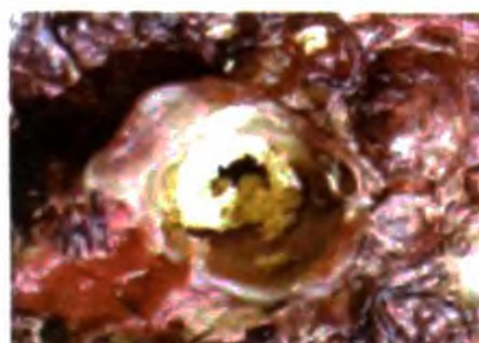
Sand plastic box



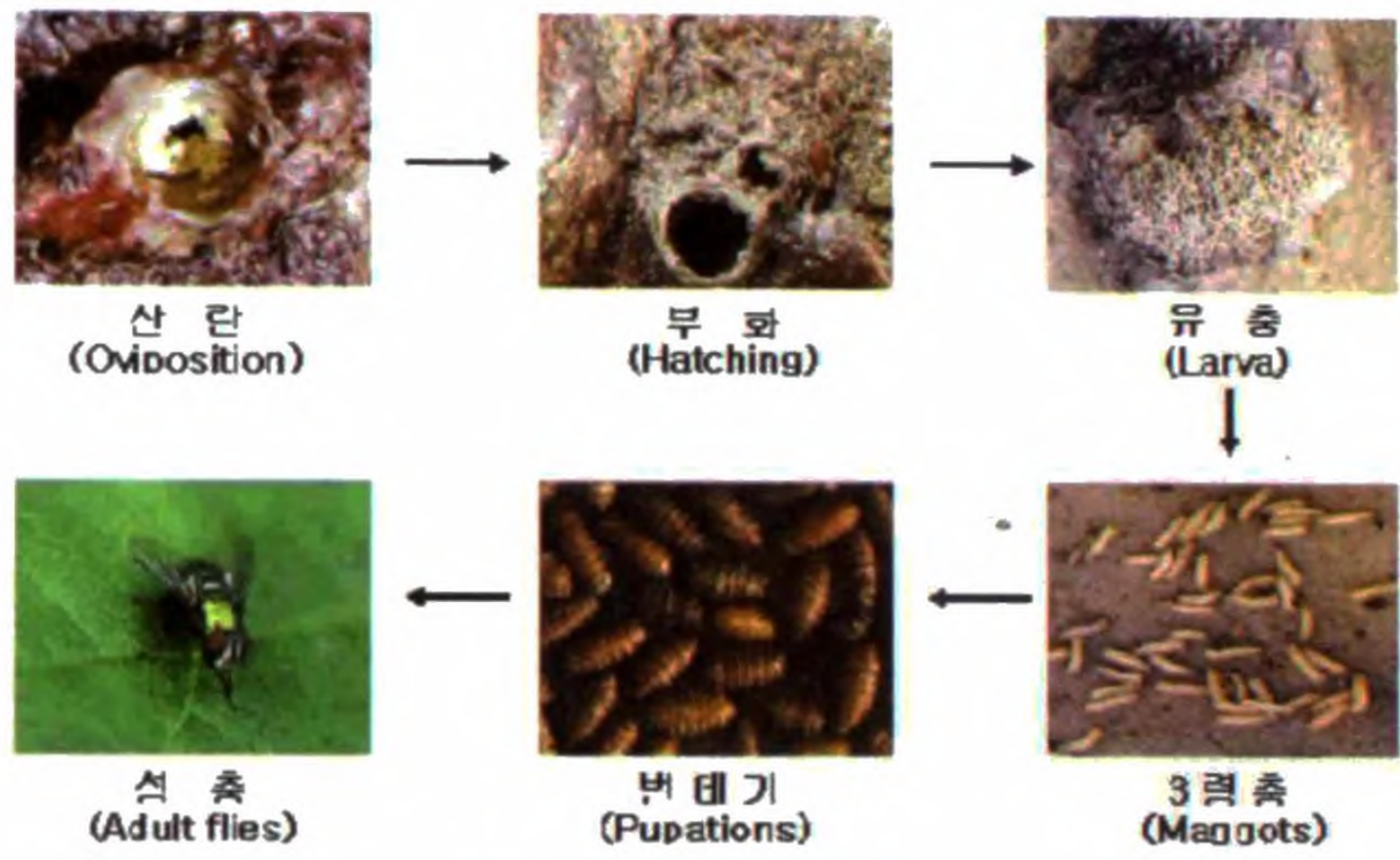
Cattle lung



Attract fly

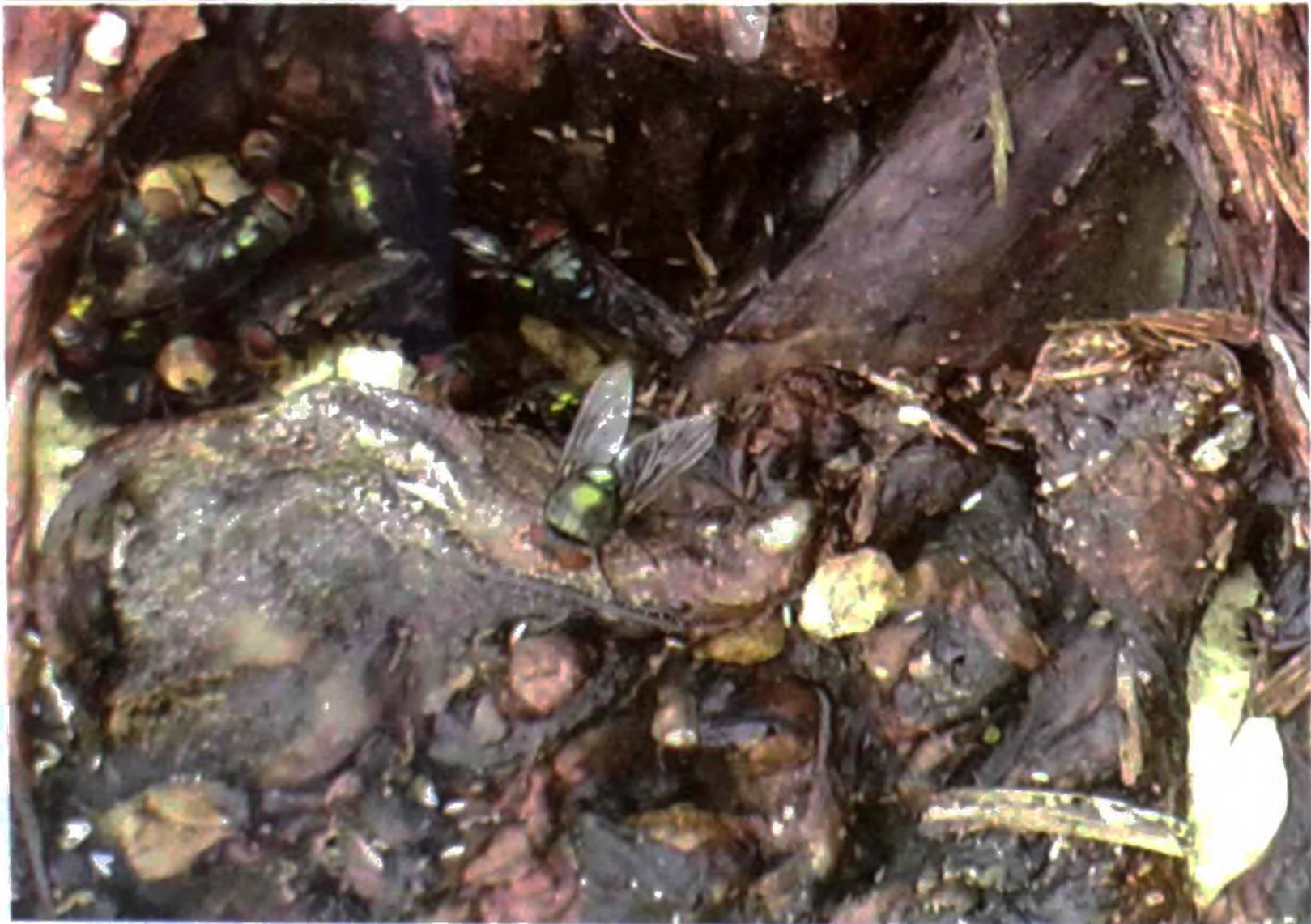


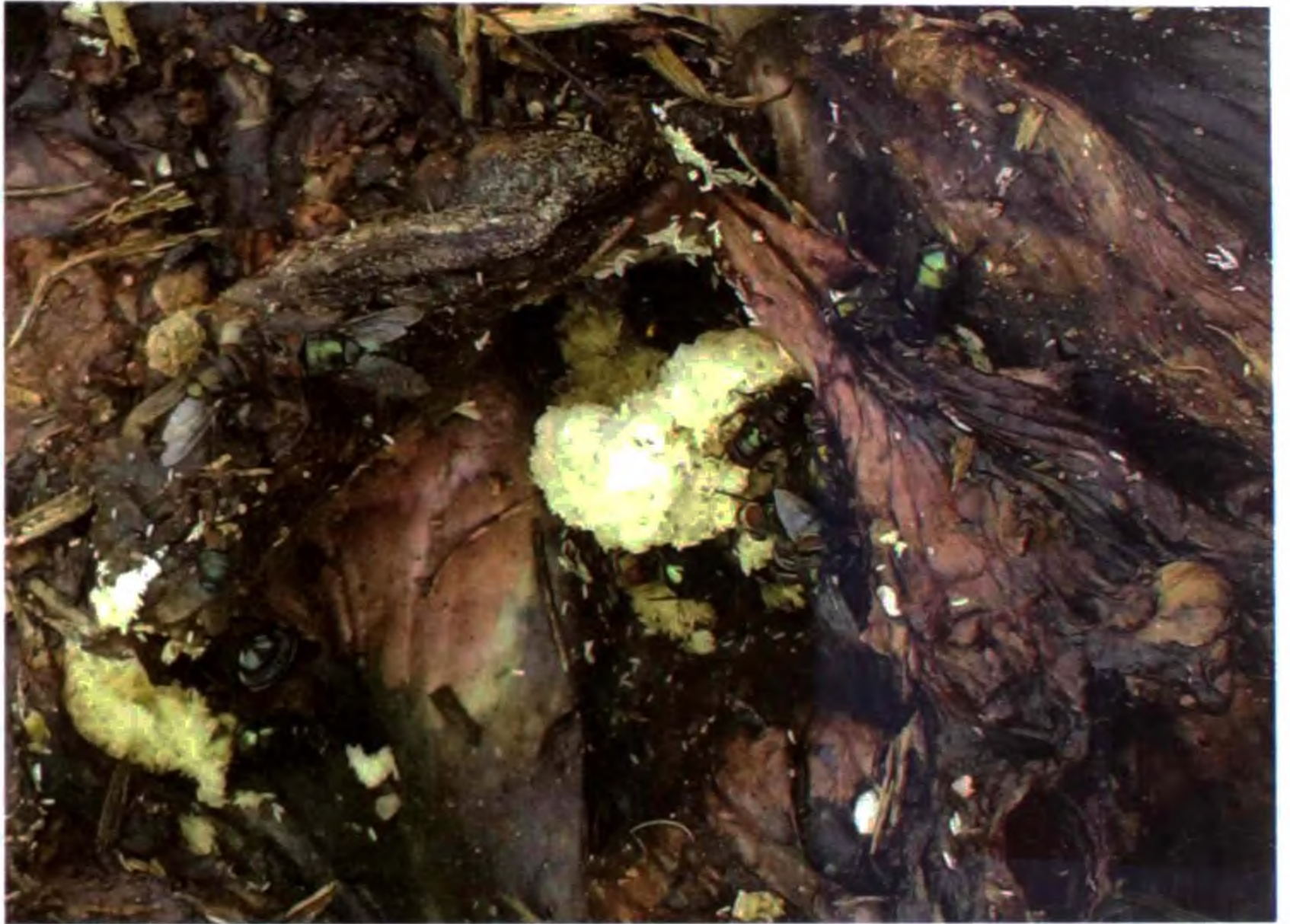
Spawning



Life cycle of blow fly









Lucilia illustris capture



Small net screen house

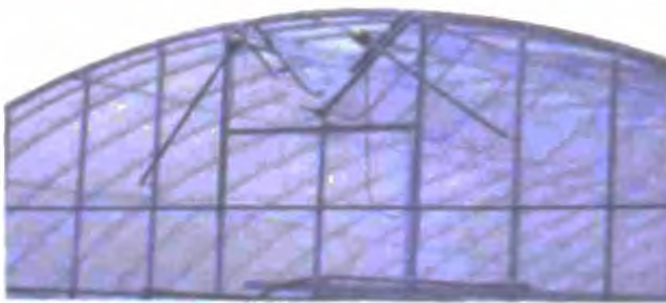


Seed fruition



Selfing

○ Ventilation methods of plastic greenhouse



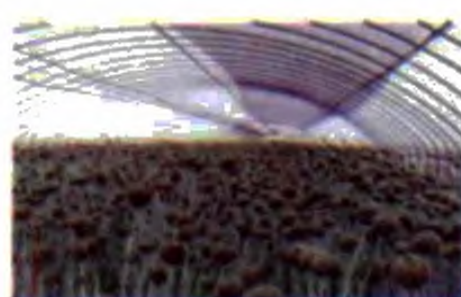
Seed production in farm



shading net on seed production yield

Ventilation method	Flowering Period	No. of flower stalk	Fertility (%)	Seed harvested (t/10a)	Index
Shading net after flowering/100m ²	May 23	4.9	27.7	120.0c ¹	91
Opening skylight/100m ²	May 20	5.2	61.9	189.2a	144
Control(non treatment)	May 22	5.1	35.6	131.9b	100

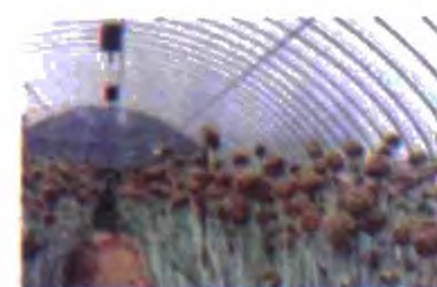
Figure 2



Opening skylight



Shading net after flowering



Control



Thank you

INVITED PRESENTATION 2

INTEGRATED PEST MANAGEMENT FOR GOOD QUALITY ONION PRODUCTION IN KOREA

by Jongtae Lee



Presentation structure

- 1 Bulb onion production in Korea
- 2 Diseases and pest insects
- 3 Integrated pest management strategies in Korea

1 Bulb onion production in Korea

Introduction of Korea and agriculture



General

Land size : 10 million ha (22 mil. ha including N.K.)

Population : 50 million (75 mil. Including N.K. 2010)

Agricultural sector (2013)

Agricultural land : 1.71 million ha (17.1% of land)

- Paddy 56%, upland 44%

Cultivated area per farm household : 1.50ha

Population : 2.8 million (5.64%)

Main bulb onion production areas

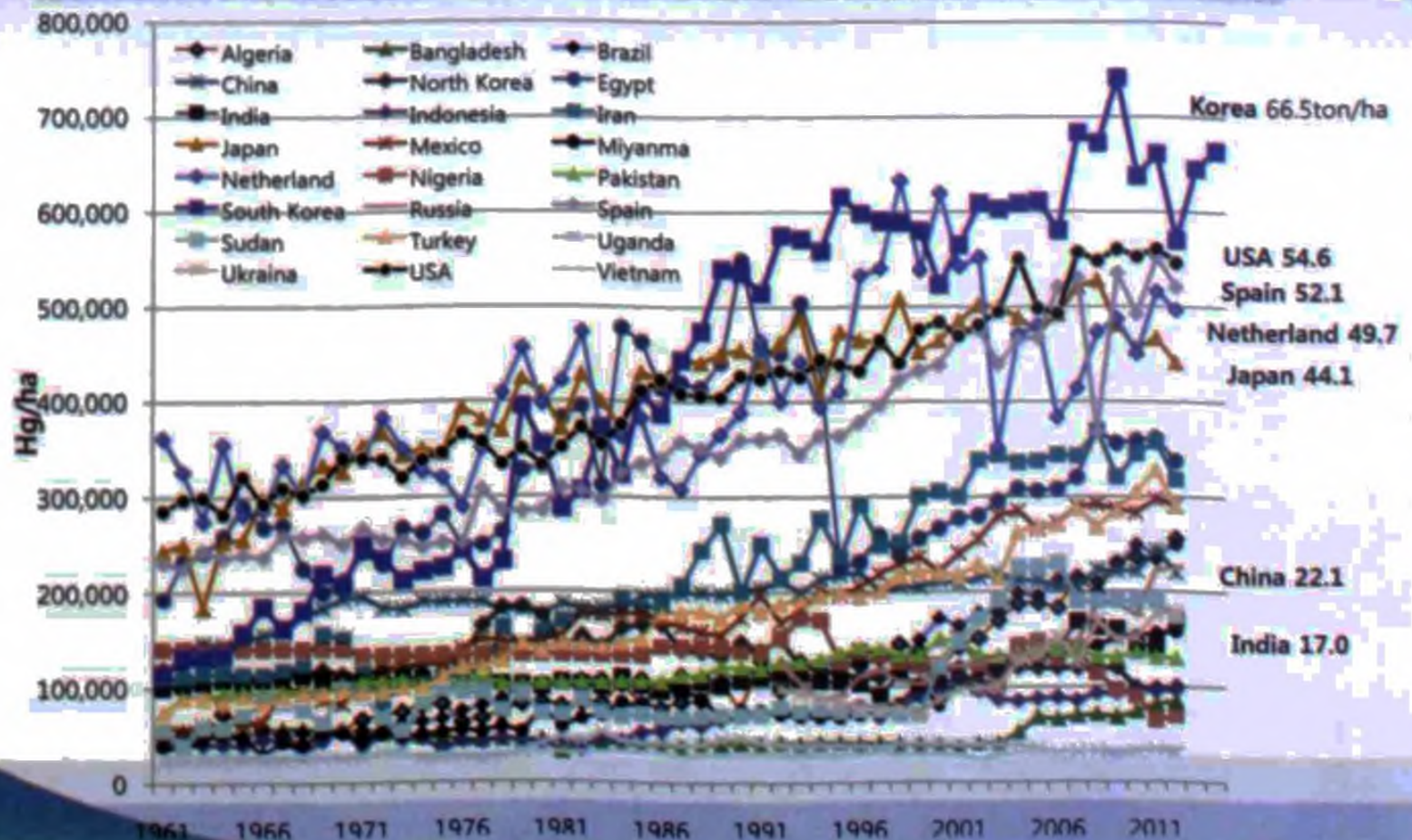


Production outline

In Korea, bulb onion has the fourth biggest area among vegetables, following hot pepper, Chinese cabbage and garlic.

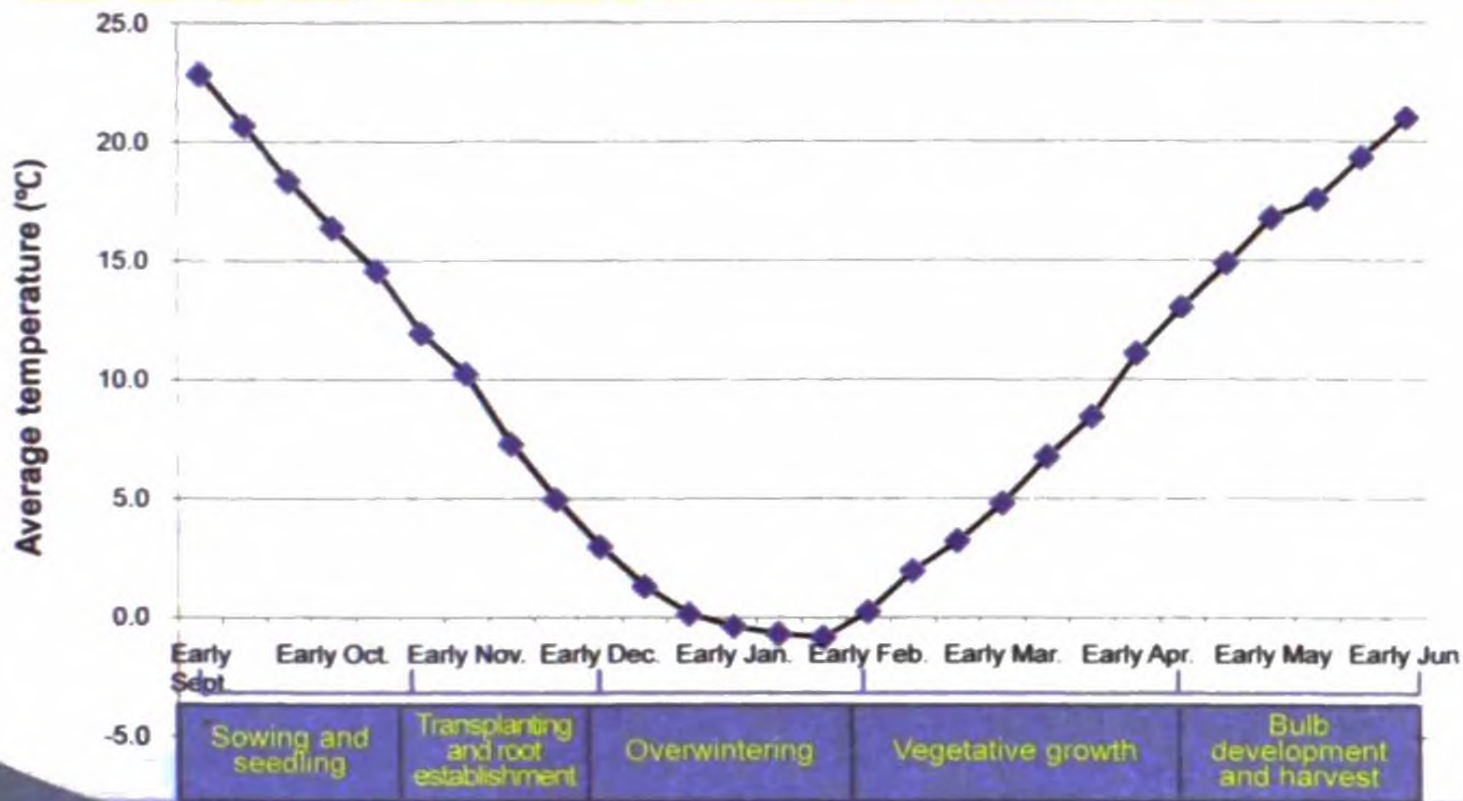
- Cultivation area: 23,911 ha (southern part)
- Production: 1.59 million tons per year
- Average bulb yield: 66.5 ton ha⁻¹
- Cultivars: short-day (7%) to intermediate-day (93%)
- Storage: half of harvested onions, until 4 to 10 months

Korean bulb onion performs the highest yield all over the world, which is due to extremely intensive practices, including plastic mulch, high plant density, and frequent chemical sprays, etc.



Temperature change during onion growth

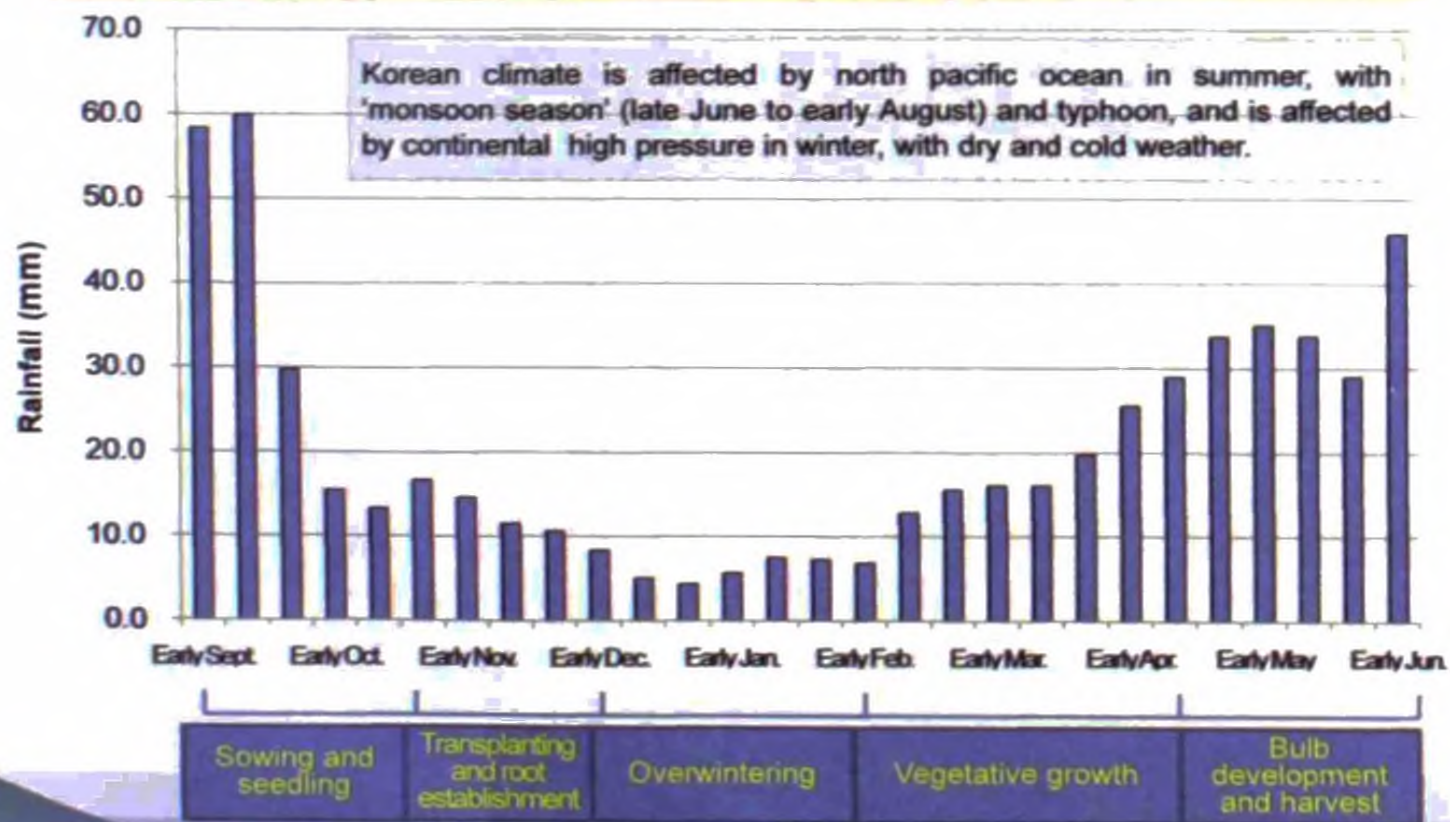
Average temperature : 10.0°C (early Sept. ~ early Jun.), yearly average temp. : 13.0 °C
 Maximum temp. 22.8°C (early September); minimum temp. -0.8°C (late January)



Habcheon county: southeastern part of Korea

Rainfall during onion growth ('72~'03)

Total rainfall : 582mm (early Sept. ~ early Jun.), yearly rainfall : 1,276 mm
 Maximum rainfall 60mm (mid September); minimum rainfall 4.3mm (late December)



Habcheon county: southeastern part of Korea

Onion seedling



Soil solarization of seedling bed (August)



Sowing (Early to mid September)



Seedling management (September to October)



Seedling lifting (Late October to early November)

Transplanting and overwintering in paddy soil



Field preparation and plastic mulching (Late October)



Transplanting (Early November)



Flood ing irrigation (Early November)

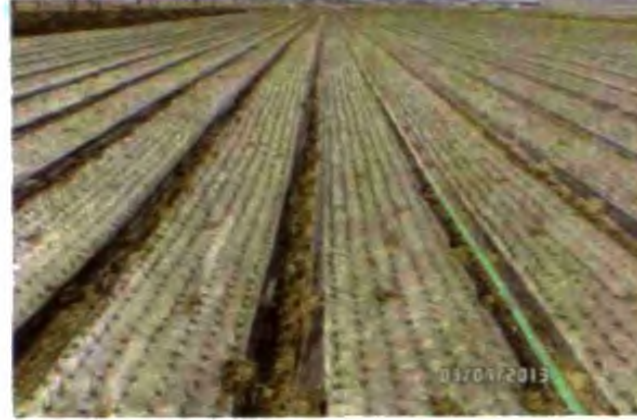


Overwintering (December and January)

Vegetative stage in paddy soil



Initial growth (February)



Initial growth (March)



Leaf enlargement (Early April)



Maximum vegetative stage (Late April)

Bulb development



Initial bulbing stage (Early May)



Mid bulbing stage (Late May)



Tops-down stage (Early June)



Late bulbing stage (Mid June)

Harvest



Leaf cutting and plastic film removal (Mid June)



Bulb lifting (Mid June)



Putting bulbs in 20kg mesh bag (Mid June)



Transporting onion bags

Storage



Short storage(July)



Cold storage at 0°C(August to April)

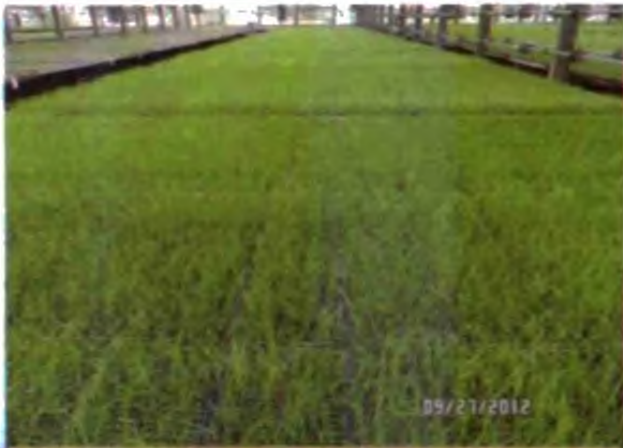
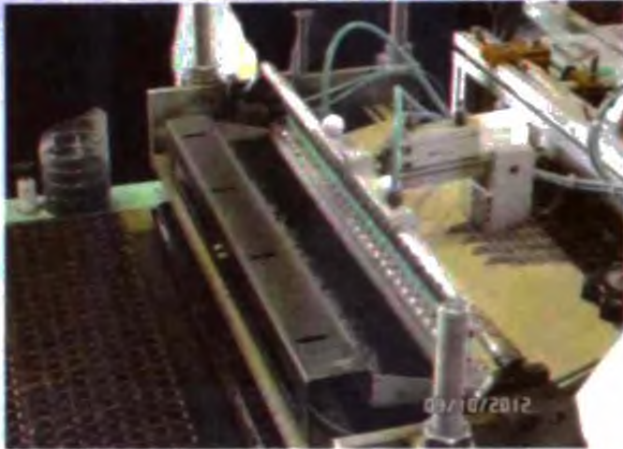


Grading and packaging



Grading and packaging

Mechanization get underway.



Sowing in plug trays in a nursery

Sowing in seedling box

Mechanization get underway.



Sowing in soil bed with a seeder

Direct Sowing

Mechanization get underway.



Transplanter
(Dongyang, Korea company)



Transplanter
(Kubota, Japan company)

Mechanization get underway.



Bulb lifter



Bulb harvester

2

Diseases and pest insects

Fungal foliar diseases

1. Downy mildew

- **Pathogen:** *Peronospora destructor*
- **Symptoms**
 - Pale, elongated patches on leaves forming gray or purple downy hair of sporing bodies
 - Chlorosis and collapse of leaves and flower stalks
- **Infection sources:** plant debris, crop overlap, systemically infected bulbs and sets, infected transplants
- **Conditions for spore production**
 - Temp.: 3-25°C
 - Relative humidity: 100%
 - Spores form at night and release with RH drop in day, 9-16 days latent period between infection and spore production
- **Conditions for infection :** optimum 10-12°C, free water on leaf for 2-4hours (fog, rain or irrigated water)
- **Fungicides:** dithiocarbamates, copper, chlorotharonyl, metalaxyl, etc.(alternate different fungicides to avoid pathogen resistance)
- **Resistance:** cultivar differences, resistance from *A. roylei* being transferred to onion
- **Cultural control:** avoid crop overlap, hygiene, rotation>4 years, to minimize RH round leaves, use wide spacing, orient row parallel to prevailing wind and use moderate N

Fungal foliar diseases

2. *Stemphylium* leaf blight and stalk rot

- **Pathogen:** *Stemphylium vesarium*
- **Symptoms**
 - Small, white to brown watery leaf spots elongating to spindle-shaped patches with dark brown or black centres where conidia form
- **Infection sources:** ascospores from infected debris, conidia from debris in spring and from infected plants as epidemic develops
- **Conditions for spore production**
 - Temp.: 10-21°C, >14 h for ascospores, rainfall and 15-32°C for conidia
- **Conditions for infection:** >8 hours leaf wetness at 10-25°C, more infection with longer wetness and higher temp. (up to 20°C), tissue damage by other pathogens (downy mildew)
- **Fungicides:** dithiocarbamates, iprodione, mancozeb, chlorotharonyl (vary fungicides to avoid resistant pathogens)
- **Cultural control:** rotation > 3 years, hygiene, to minimize leaf wetness by wide spacing, orient row parallel to prevailing wind and use moderate N
- **Special features:** symptoms difficult to distinguish from purple blotch, often occurs with the latter as a disease complex, causes collapse of flower stalks

Fungal foliar diseases

3. Purple blotch

- **Pathogen:** *Altaernaria porri*
- **Symptoms**
 - 2-3mm watery lesions on leaves and flower stalks which elongate and bleach, with purple or brown centres, rot of infected bulbs
- **Infection sources:** debris, infected bulbs
- **Conditions for spore production**
 - Optimum temp.: 25°C, little at < 13°C
 - light and RH > 90%, spore release with RH drop
- **Conditions for infection:** 25°C, free water on leaf for 6 hours, older and damaged leaves more susceptible (e.g. by thrips)
- **Fungicides:** as for *Stemphylium* leaf blight
- **Cultural control:** as for *Stemphylium* leaf blight
- **Special features:** often in disease complex with *Stemphylium* leaf blight

Fungal foliar diseases

4. Leaf fleck, leaf spot, collar rot

- **Pathogen:** *Botrytis cinerea*
- **Symptoms**
 - Small leaf spot, rot round pseudostem with grey mould on it
- **Infection sources:** debris, nearby crops, sclerotia in soil
- **Conditions for spore production**
 - it can occur at low temp. (5°C)
- **Conditions for infection :** plants stressed by cold (collar rot)
- **Fungicides:** dithiocarbamates, benimidazoles
- **Cultural control:** avoid crop overlap, hygiene

Fungal foliar diseases

5. Leaf blight or blast

- **Pathogen:** *Botrytis squamosa*
- **Symptoms**
 - Small, round to ellipsoid white lesions with pale halo, leaf die-back from tip, sporing on dead leaves
- **Infection sources:** sclerotia in debris and soil which form conidia, nearby crops
- **Conditions for spore production**
 - Temp.: 14-20°C
 - Free water for 12 hours, spore release with RH change
- **Conditions for infection**
 - Temp.: 16-28°C
 - Free water on leaf for > 6 hours, old and senescent leaves susceptible
- **Fungicides:** as for leaf fleck
- **Resistance:** cultivar differences, resistance from *A. roylei* being transferred to onion
- **Cultural control:** avoid crop overlap, hygiene, promote air movement and leaf drying by wide spacing, rotation

Fungal diseases infecting from the soil

1. Damping off

- **Pathogen:** *Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp., and *R. solani*
- **Symptoms**
 - Pre-emergence: the fungus kills radicle and plumule of seed before emergence from soil
 - Post-emergence: The pathogen attacks the collar region of seedlings on the surface of soil. The collar portion rots and ultimately the seedlings collapse and die.
- **Conditions for infection**
 - Temp.: wide range (generally, high temp and high humidity)
- **Control:** fumigation, solarization, avoidance by timing, crop rotation, fungicide

Fungal diseases infecting from the soil

2. *Fusarium* basal rot

- **Pathogen:** *Fusarium oxysporum*
- **Symptoms and features**
 - The pathogen can cause disease at all stages of onion growth, from seedling to stored bulb.
 - The fungus can penetrate the base plate of alliums and cause a brown discoloration and rot, so that the shoot easily detaches from base.
 - Infection can be increased by damage from pests.
- **Conditions for infection**
 - Optimum temp.: 27-30°C
 - Temp. range: $\geq 15^{\circ}\text{C}$
- **Control:** resistant cultivars, crop rotation, fumigation, solarization, avoidance by timing

Fungal diseases infecting from the soil

3. White rot

- **Pathogen:** *Sclerotium cepivorum*
- **Symptoms and features**
 - The fungus penetrates the root epidermis and invades the root cortical tissue.
 - Plants infected with white rot may have a cottony white or grey mass of fungal mycelium on the stem base
 - Mycelium can infect adjacent plants and spread of the disease is facilitated by the high plant density. It is easily transferred from infected field to other fields by machines or equipments
 - Field infections can go unnoticed at first, but can reduce yields to uneconomic level in 4 years of successive onion crops
 - Once established, infected land is usually abandoned for onion production because of the persistence of sclerotia in soil
- **Conditions for infection**
 - Optimum temp.: 14-18°C
 - Temp. range: 9-24°C for sclerotial germination; 5-29 °C for mycelial growth
- **Control:** fumigation, solarization, fungicide, avoidance by timing

Fungal diseases infecting from the soil

4. Pink rot

- **Pathogen:** *Pyrenochaeta terrestris*
- **Symptoms and features**
 - Infected plants have characteristic pink-hued roots which become darker red with time.
 - Infected roots ultimately collapse and die
- **Conditions for infection**
 - Optimum temp.: 24-28°C
 - Temp. range: $\geq 16^{\circ}\text{C}$
- **Control:** resistant cultivars, fumigation, solarization, fungicide, avoidance by timing

Fungal diseases infecting from the soil

5. Disease control

- **Prevention of spread**

- All soil-borne diseases can be spread by anything that moves infected soil from place to place.
- The movement of contaminated soil from disease-infested land on boots, implements, etc. must be prevented
- Infected plant debris should be confined and the disease propagules destroyed by high-temperature composting or other means.

- **Cultural control**

- 5 or 6-year gap between *allium* crop: pink root
- 3 or more-year gap: *Fusarium* basal rot

- **Resistant cultivars**

- Pink root or *Fusarium* basal rot resistant cultivars available.

- **Destruction of propagules**

- Crop rotation
- Fumigants: methyl bromide, chloropicrin or dichloropropene (the use of fumigants is becoming increasingly unacceptable on environmental grounds)
- Composting of crop residue: more than 7 days over 50°C for destroying white rot sclerotia

Fungal diseases infecting from the soil

5. Disease control

- **Fungicides**

- It can be effective to apply at seed sowing, set planting or seeding transplanting.
- Broad-spectrum dithiocarbamate protectant fungicide: thiram
- Systemic and curative fungicides: thiobendazole, carboxin, tebuconazole
- However, problems of loss of fungicidal activity through the build-up of resistance and of enhanced degradation in soil is increasing.

- **Biological control**

- Fungal antagonists: *Bacillus subtilis*, *Trichoderma harzanium*, *Sporidesmium sclerotivrum*
- The control efficiency is erratic and unpredictable under field conditions

⇒ **Improved control can be achieved by combination of biological control agents, disease-suppressive composts, fungicidal seed treatment and crop rotation as well.**

Fungal diseases of stored bulbs

1. Neck rot

- **Pathogen:** *Botrytis aclada*, *B. allii*, *B. byssoidea*
- **Symptoms**
 - Bulb decay starting at bulb neck
 - Forming black sclerotia on bulb surface
- **Infection sources:** spores from senescent leaves and from sclerotia, infected seed
- **Conditions for infection**
 - Optimum temp.: 22-23°C
 - Temp. range: 5-25°C
- **Special features**
 - The symptoms usually develop 2-3 months after harvest.
 - The pathogens produce spores on dead leaf tissue and can invade the tip of ageing leaves. It is latent in live green leaves, causing no disease. By sequentially invading successive leaves, the pathogens enters those leaves which swell at the base to form the outer fleshy scales of the bulb.
 - There is no evidence of spread from bulb to bulb in store.
- **Control**
 - Use of uninfected seeds, disinfection of seed by systemic benzimidazole fungicide
 - The pathogens cannot infect dry, senescent leaf tissue, so that in dry climate, onions field-dried with the foliage intact are not at risk.

Fungal diseases of stored bulbs

2. Black mould

- **Pathogen:** *Aspergillus niger*
- **Symptoms**
 - black, sooty mould and between outer bulb scales, particularly along vein
- **Infection sources:** debris in soil, infected seed
- **Conditions for infection**
 - Optimum temp.: 28-34°C (> 80% humidity)
 - Temp. range: 10-40°C
- **Special features**
 - In tropical regions where onions are frequently stored above 30, the fungus commonly blemishes stored bulbs
 - The fungus invades via the neck, often via injured tissue when tops fall or are cut near maturity.
- **Control**
 - Use of uninfected seeds
 - Good curing after harvest, careful bulb handling and storage of unwounded bulbs

Fungal diseases of stored bulbs

3. Blue mould

- **Pathogen:** *Penicillium* spp.
- **Symptoms**
 - Soft, watery lesions later covered with blue mould
- **Infection sources:** debris in soil
- **Conditions for infection**
 - Optimum temp.: 21-25°C (> 80% humidity)
 - Temp. range: 15-32°C
- **Special features**
 - Invasion of bulbs is usually through tissue damaged by bruises, wounds, sunscald or freezing
- **Control**
 - Good curing after harvest, careful bulb handling and storage of unwounded bulbs

Bacterial diseases

1. Bacterial streak or bulb rot

- **Pathogen:** *Pseudomonas viridiflava*
- **Symptoms**
 - Dark, water-soaked streak on leaves spreading to leaf base and into bulb
 - Causing total foliar collapse in severe cases
 - Milder infections causing pale yellow turning to red-brown rotten centre bulb scales after harvest
- **Special features**
 - It survives as surface dweller on many weeds
 - It can be very destructive to nitrogen-rich succulent onions

Bacterial diseases

2. Bacterial soft rot

- **Pathogen:** *Erwinia* sp.
- **Symptoms**
 - Soft yellow to brown rot starting in bulb centre releasing foetid-smelling, viscous, watery fluid
- **Special features**
 - It is short-lived in soil but persists in rhizosphere.
 - It survives in intestine of onion fly larvae and adults.

Bacterial diseases

3. Sour skin or bacterial canker

- **Pathogen:** *Burkholderia cepacia*
- **Symptoms**
 - Macerated, sour-smelling, mushy bulb scales
 - Grainy yellow ooze under infected scales
 - Spread within scales, rather than between
- **Special features**
 - It can persist in soil.

Bacterial diseases

4. Slippery skin or other soft rots

- **Pathogen:** *Burkholderia gladioli* pv. *alliiicola*
- **Symptoms**
 - Rotten inner scales spreading to the whole bulb
 - The infected core can slip out of the top of the onion bulb when squeezed
- **Special features**
 - It infects via wet neck wounds when onion topped at harvest.
 - Bulb rot is promoted by high-temperature drying (30°C).
 - It can be spread by planting infected onion sets.

Bacterial diseases

5. Centre rot

- **Pathogen:** *Pantoea ananatis*
- **Symptoms**
 - Water-soaked, white-bleached centre leaves surrounded by brown tissue
 - Macerated, foul-smelling bulb interior
 - Also infects seed stalks
- **Special features**
 - It survives as surface dweller on many weeds.
 - it is transmitted by thrips and seed-borne.

Bacterial diseases

6. General characteristics of bacterial diseases

- **Symptoms and infection**

- Infected tissue becomes macerated and water-soaked through the destruction of plant cell wall
- Wounds necessary for infection (wind, pest, hail, cultivation operations, topping at harvest etc.)

- **Control measures**

- Ensure seed and sets are pathogen free.
- Maintaining good crop hygiene by removing or burying diseased debris.
- Utilizing crop rotations of non-host crops with a minimum of 1 year between *Allium* crops
- Separating vulnerable crops both in time and space so that there is not a continuous 'infection cycle' from one *Allium* crop to another.
- Avoiding excessive nitrogen fertilizer, which can result in luxuriant foliage that is easily damaged by wind and cultivation traffic and which tends to maintain a wet microclimate in the crops
- Minimizing damage to plants from cultivation and by having good pest control

Pest insects

1. Onion thrips

- **Symptoms and infection**

- Most severe in the warmer onion production areas.
- Pierce leaf cells and feed on the sap released, between the young leaf blades at the top of the neck.
- Damage is most severe when plants are water-stressed in hot, dry weather.
- Thrips-vectored iris yellow spot virus(IYSV) is a potentially devastating disease of onion bulb and seed crops.

- **Control**

- Insecticides: when more than 50% plant sampled contained thrips, to avoid insecticide resistant problem
- Sprinkler irrigation can directly wash many thrips off onion leaves.

Pest insects

2. Onion fly or maggot

- **Symptoms and infection**

- The most severe damage is caused by the maggots burrowing into the base of seedlings, causing wilting and collapse.
- When seedling die, the maggots migrate to neighboring plants and may destroy successive plants in a row
- In many onion-growing regions there are three generations per year of the onion fly
- Maggots of the second and third generations burrow into the bases of large plants and developing bulbs and thereby predispose them to rotting by secondary infections of fungi and bacteria.

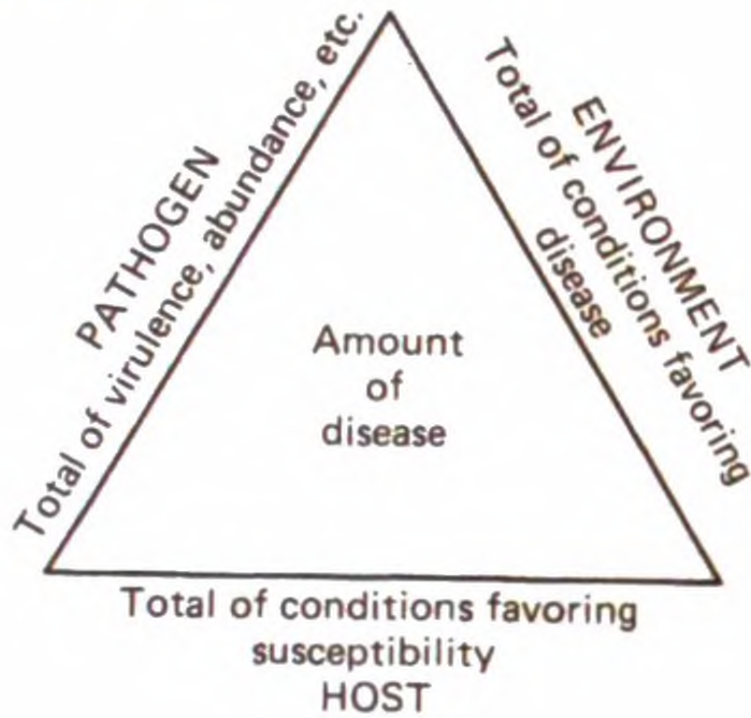
- **Control**

- Use of good decomposed compost
- Removal of onion plant debris or previous crop residue

3

Integrated pest management strategies in Korea

Disease incidence

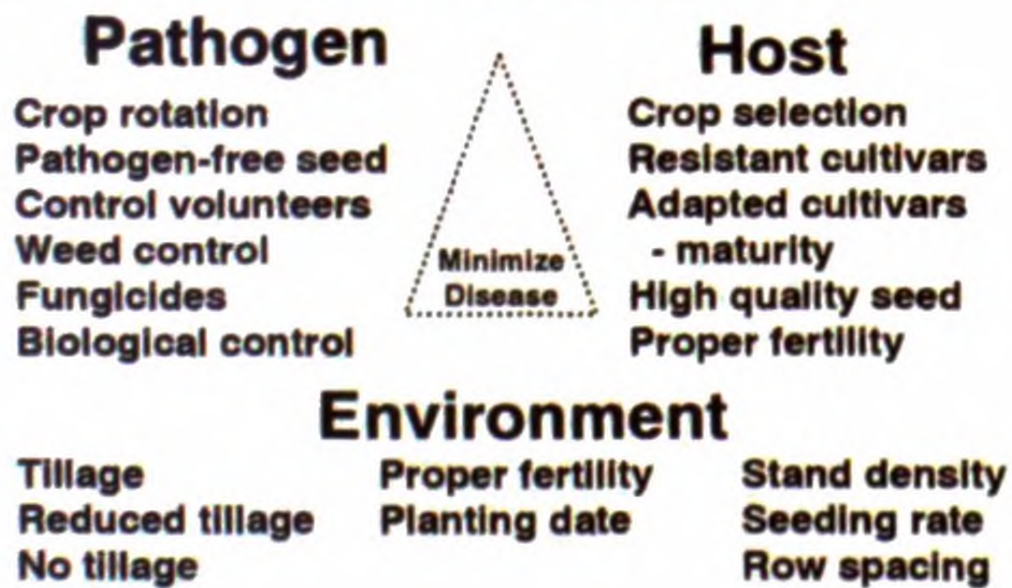


- **Pathogen**
 - Presence of pathogen
 - Pathogenicity
 - Adaptability
 - Dispersal efficiency
 - Survival efficiency
 - Reproductive fitness
- **Host**
 - Susceptibility
 - Growth stage and form
 - Population density and structure
 - General health
- **Environment**
 - Temperature
 - Rainfall and dew
 - Leaf wetness period
 - Soil properties
 - Wind
 - Herbicide damage

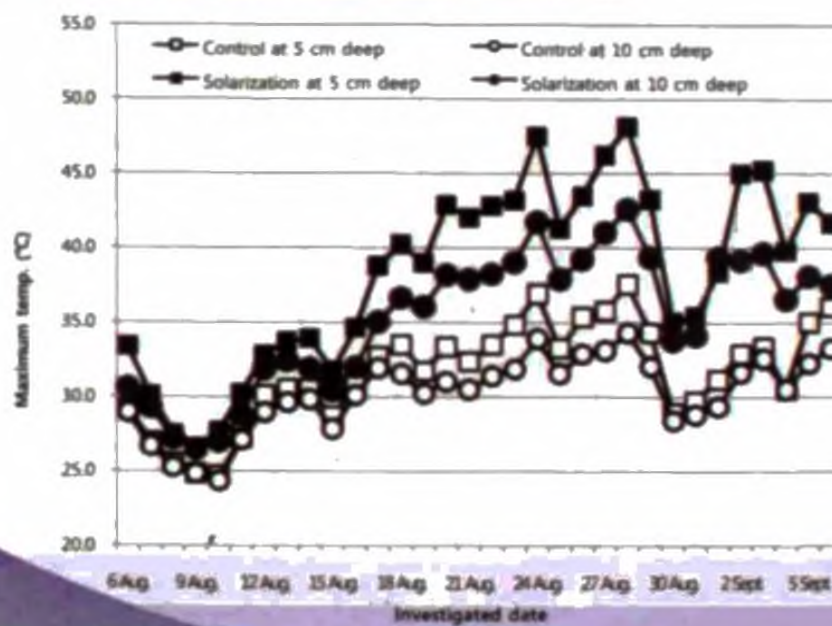
Integrated management practices

Integrated Management Practices

Basic support: Knowledge of crop diseases and host range, field scouting, and record keeping



Solarization in seeding bed



• Methods

- Covering material: transparent plastic film
- 20 to 40 days before sowing
- Before mulching, compost at 30 ton/ha plus lime 2 ton/ha are applied and bed preparation performed.
- Intact seal of plastic film

• Effects

- Reduction in disease incidence
Damping off 93.5%, pink root 98.0%
- Reduction in weed incidence : 88%
- No incidence of maggots

Onion production followed by rice harvest



• Methods

- Flooding during summer season

• Effects

- No soil borne disease incidences
- Reduction in foliar diseases
- Reduction in weed incidence

High ridge and deep furrow



- **Methods**

- Approximately 20 cm deep at ridge preparation
- 2~ 3 times furrow cultivation in spring

- **Effects**

- Good drainage
- Decrease in field humidity
- No excessive soil moisture stress
- Good root growth
- Decrease in fungal and bacterial diseases

Narrow ridge and wide distance between rows



- **Methods**

- Ridge width 100-110 cm and furrow width 30-40 cm
- 16-20 cm between rows and 13 cm plant distance

- **Effects**

- Good aeration
- Good drainage
- Decrease in field humidity
- No excessive soil moisture stress
- Good root growth
- Decrease in fungal and bacterial diseases



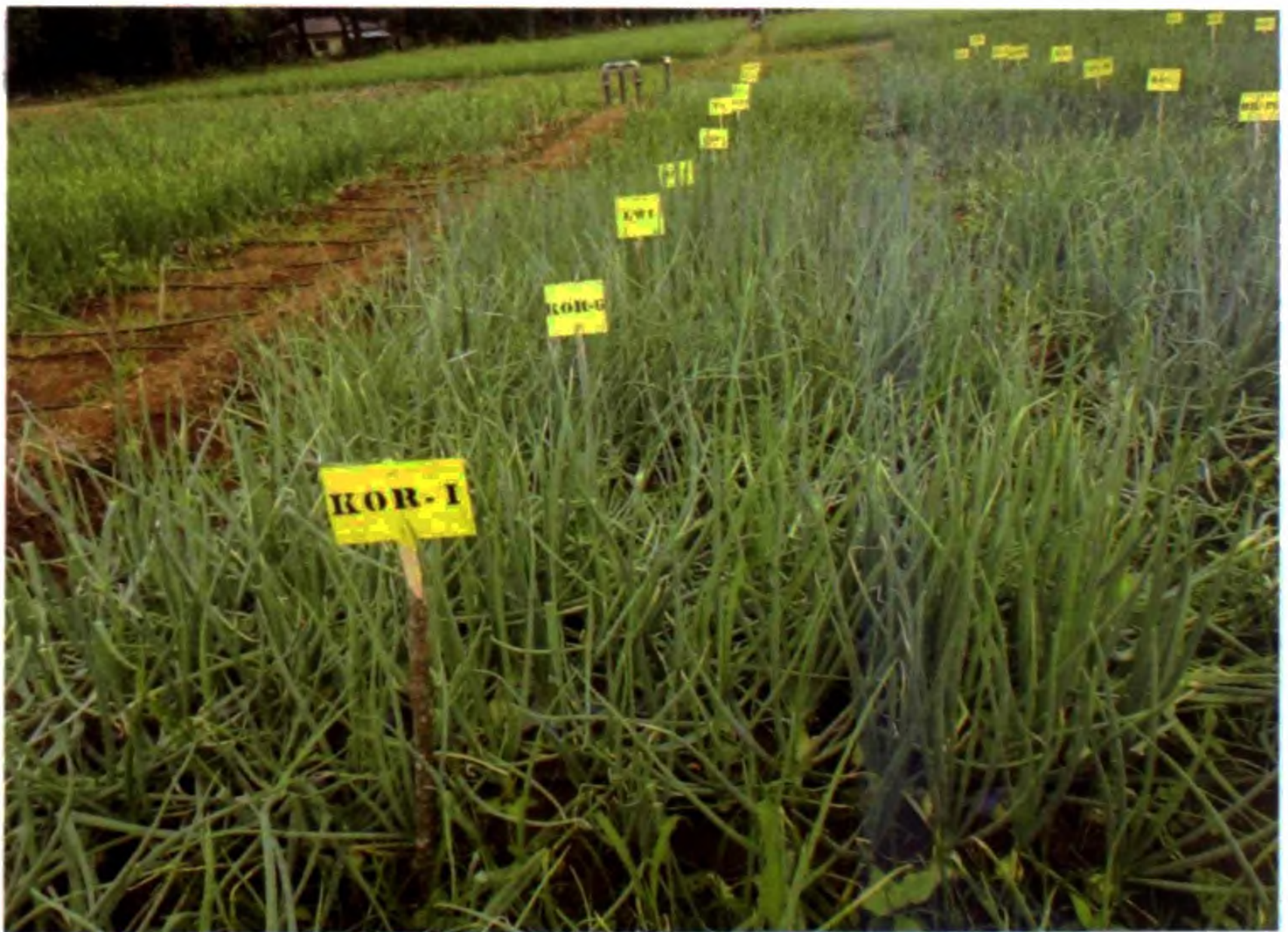
Thank you
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KOPIA ACTIVITIES ON ONION IN SRI LANKA



Multiplication of onion bulbs at Field Crops Research and Development Institute, Mahalluppallama under the KOPIA program



Identification of elite lines received through KOPIA and other programs



Production of breeder seeds at the Field Crop Research and Development Institute, Mahalluppallama



Evaluation of breeding line at the Field Crop Research and Development Institute, Mahalluppallama



Bulb multiplication in farmers fields

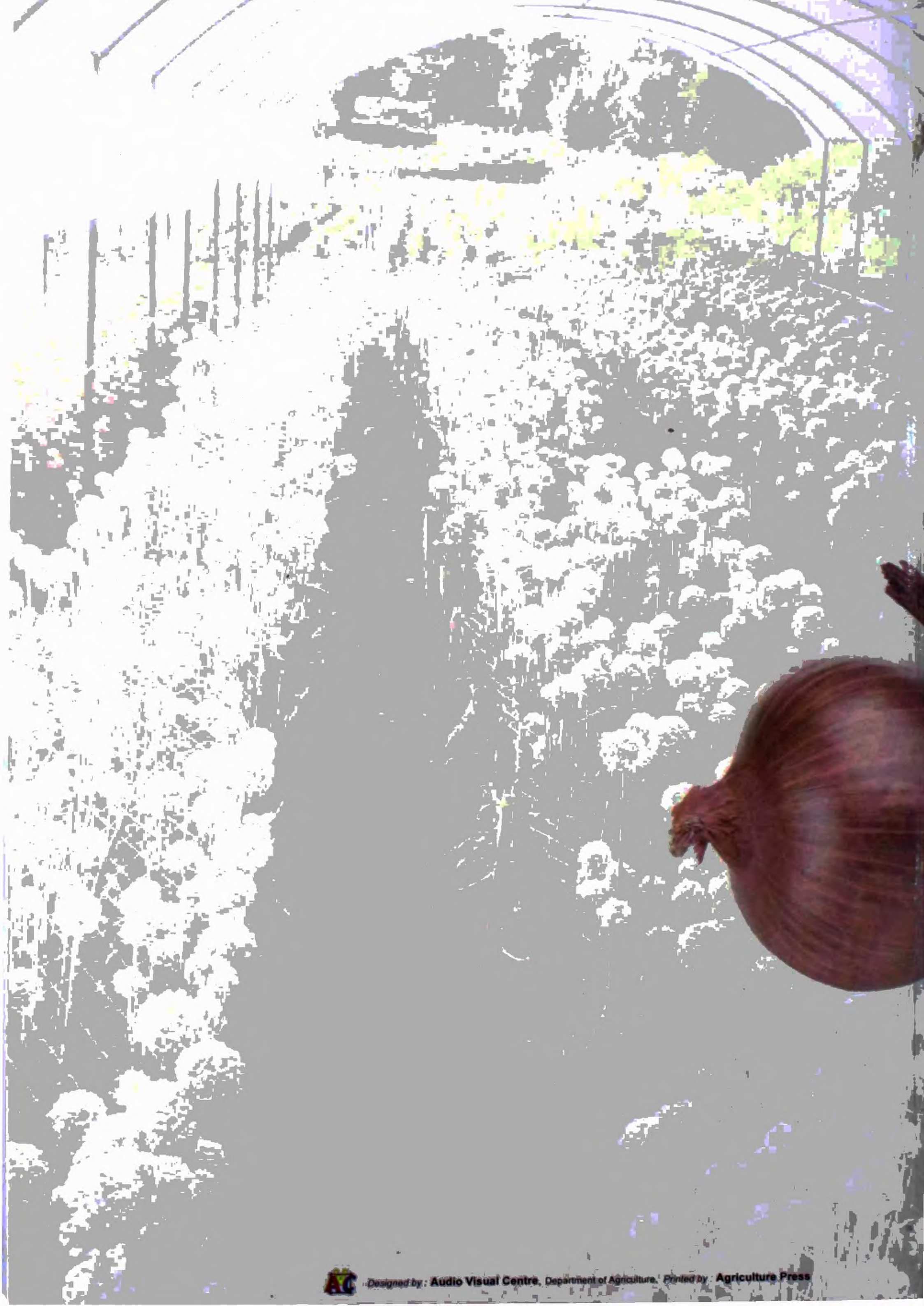


Storage of onion bulbs for distribution among farmers

KOPIA activities on onion in Sri Lanka



Seed production units in farmer's fields



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