Propagação das Plantas:
Princípios e Práticas

Propagação de Plantas e Conservação da Biodiversidade Vegetal

(Cód. 214051)

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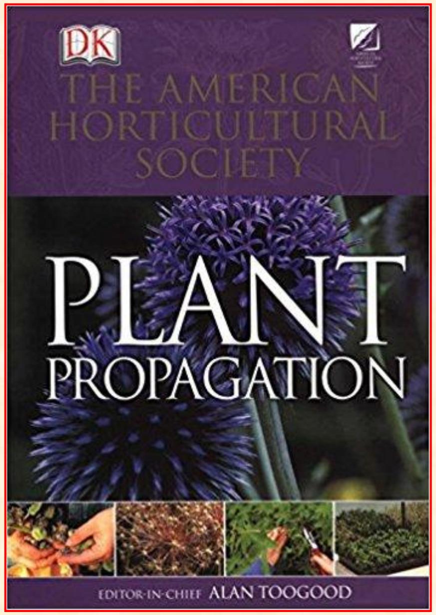

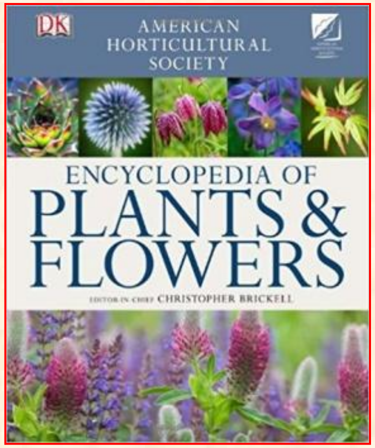

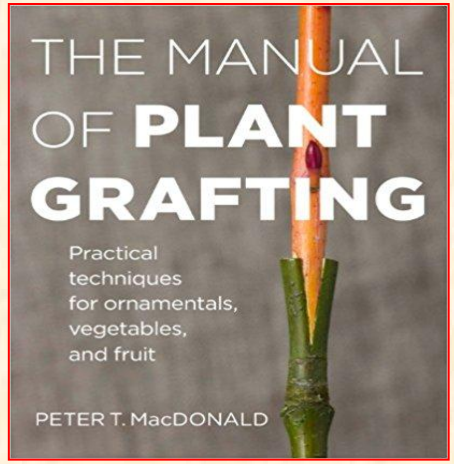

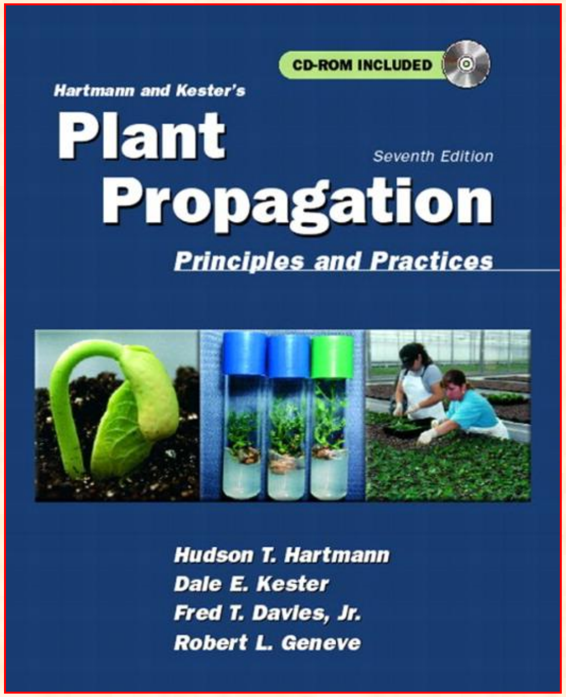

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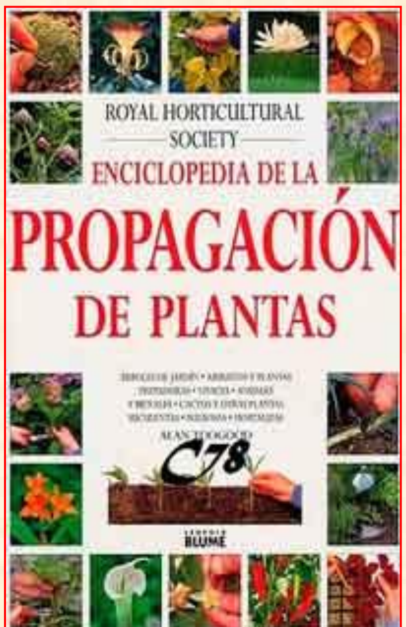
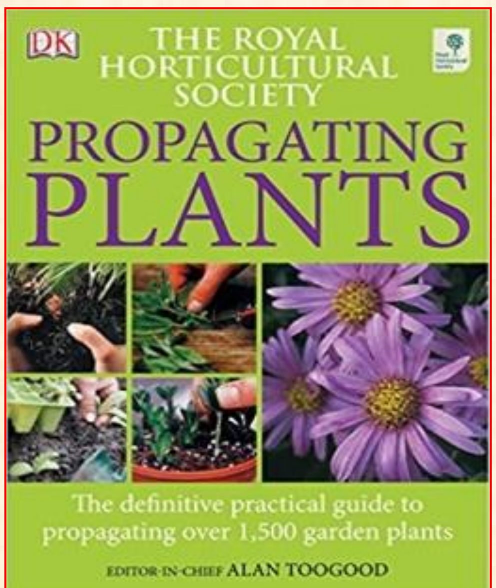
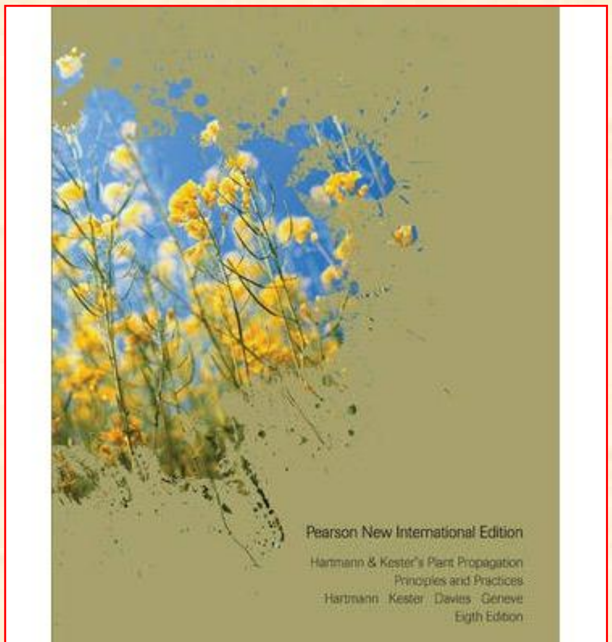






Introdução:

- Propagação:
  - multiplicação métodos sexuais e assexuais
    - conhecimento x experiência prática
    - 10.000 anos: seleção de espécies de interesse e propagação em larga escala
    - feijão, tomate, cevada, arroz $\Rightarrow$ seleção
    - milho, trigo, fumo, morango $\Rightarrow$ hibridação (alterações cromossômicas)
- Melhoramento genético: Mendel (1890), produção de sementes em larga escala
- Propagação vegetativa: indutores químicos, sistemas de névoa úmida, sombreamentos, indutores químicos

Principais métodos de propagação:

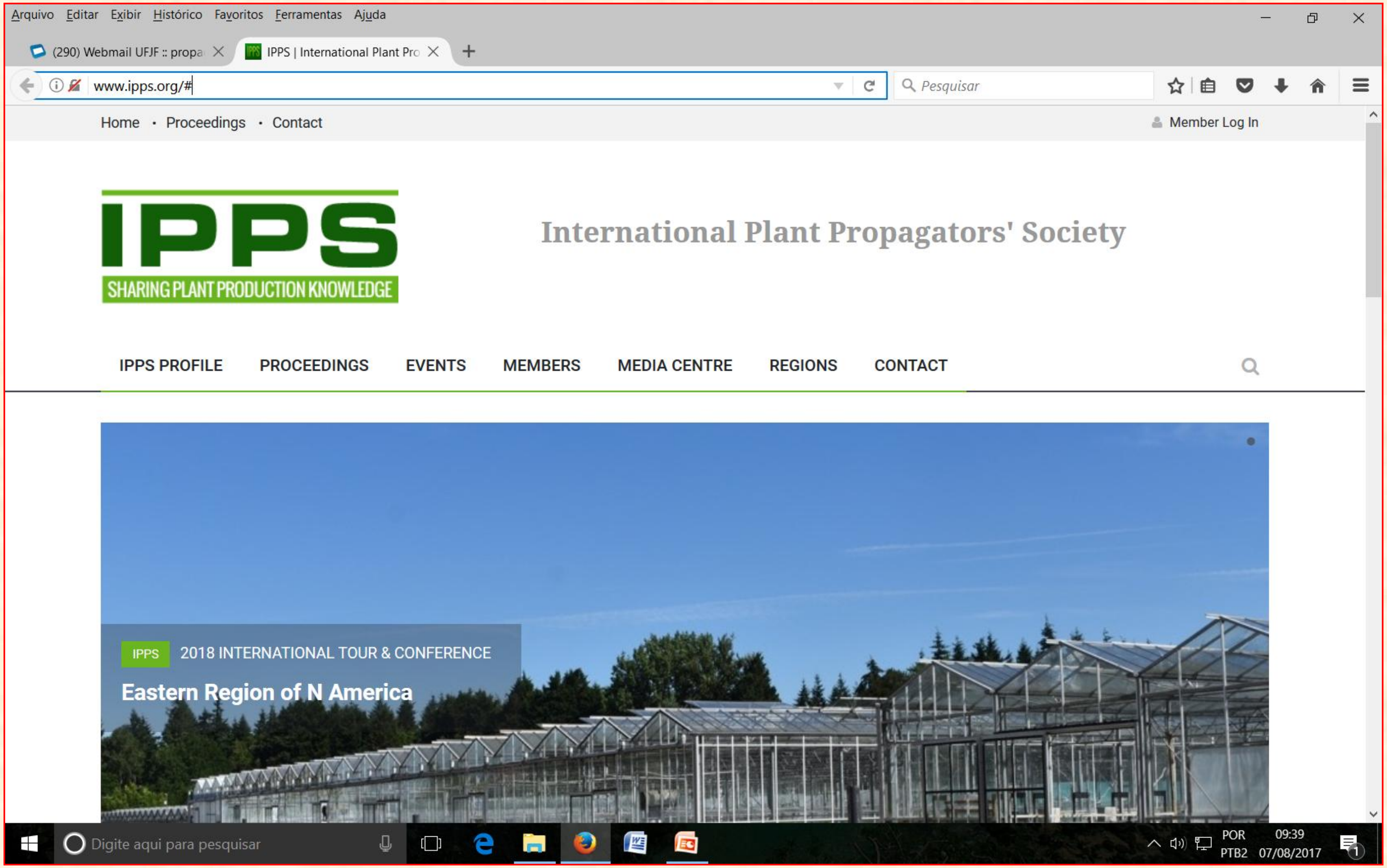
- Sementes: sexual, cultivos de pólen, óvulos, embriogênese somática, sementes e esporos
- Apomixia (assexual): embriões nucelares e adventícios
- Vegetativa: estacas (caules, folhas, gemas, raízes)
- Enxertias:
- Mergulhias:
- Estruturas especiais: Estolhos, bulbos, cormos, rizomas, tubérculos, raízes tuberosas, xilopódios
- Cultivo *in vitro* :

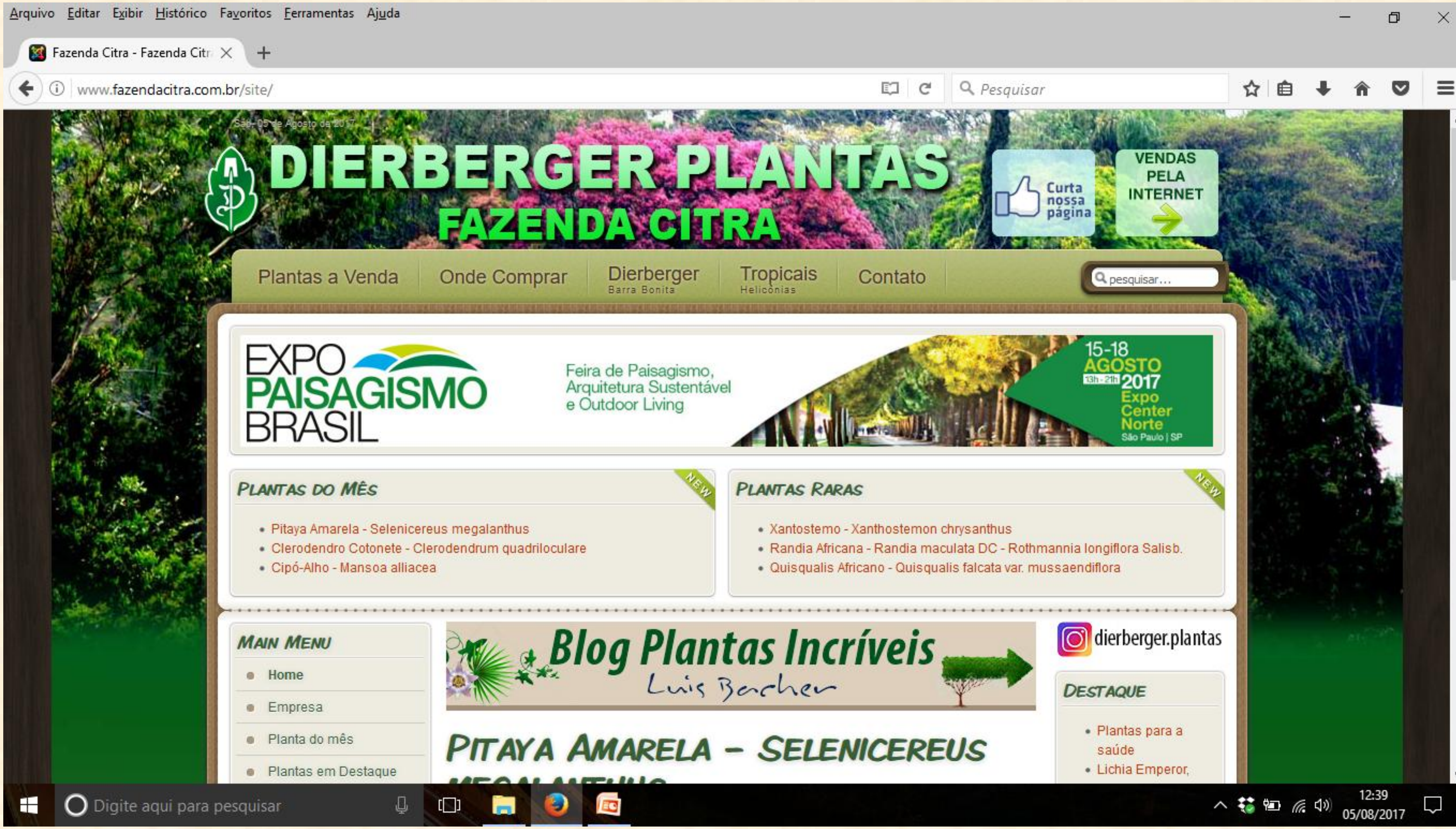
Termos e nomenclaturas:

- Calos: divisões mitóticas, células de parênquima, organização precária e sem diferenciação
- Raízes e brotações adventícias: não provenientes do eixo embrionário
- Espécies: unidade taxonômica fundamental designa grupo de plantas com características distintas ou específicas.
- Variedade botânica: subgrupos morfologicamente distintos da mesma espécie (por isolamento geográfico)
- Cultivar: grupos representam um tipo único com características específicas reproduzidas durante a propagação; são denominadas cultivares (*var*iedade *culti*vada”

- Poliembrionia: mais de um embrião em uma única semente
- Apomixia: reprodução de um zigoto por via não usual (sem meiose ou fertilização)
- **Associações**:
  - Associação Americana de Viveiristas (1875):
    - AmericanHort (2014): (http://americanhort.org/)
  - American Horticultural Society (1922):
    - http://ahsgardening.org/
  - American Society for Horticulturae Science (1903):
    - http://www.ashs.org/
  - Associação Internacional de Propagadores de Plantas (1951):
    - http://www.ipps.org/#
  - Associação Brasileira de Horticultura (1961):
    - http://www.abhorticultura.com.br/index.php
  - Associação Brasileira de Cultura de Tecidos de Plantas (1983):
    - http://www.abctp.org.br/inicio
  - Dierberg (Fazenda Citra Ltda - www.fazendacitra.com.br)
  - Holambra (www.holambra.com.br)

http://www.ipps.org/#

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PLANTAS DO MÊS
Pitaya Amarela - Selenicereus megalanthus
Clerodendro Cotonete - Clerodendrum quadriloculare
Cipó-Alho - Mansoa alliacea
PLANTAS RARAS
Xantostemo - Xanthostemon chrysanthus
Randia Africana - Randia maculata DC - Rothmannia longiflora Salisb.
Quisqualis Africano - Quisqualis falcata var. mussaendiflora
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dierberger.plantas
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Plantas para a saúde
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Tipos de sementes:

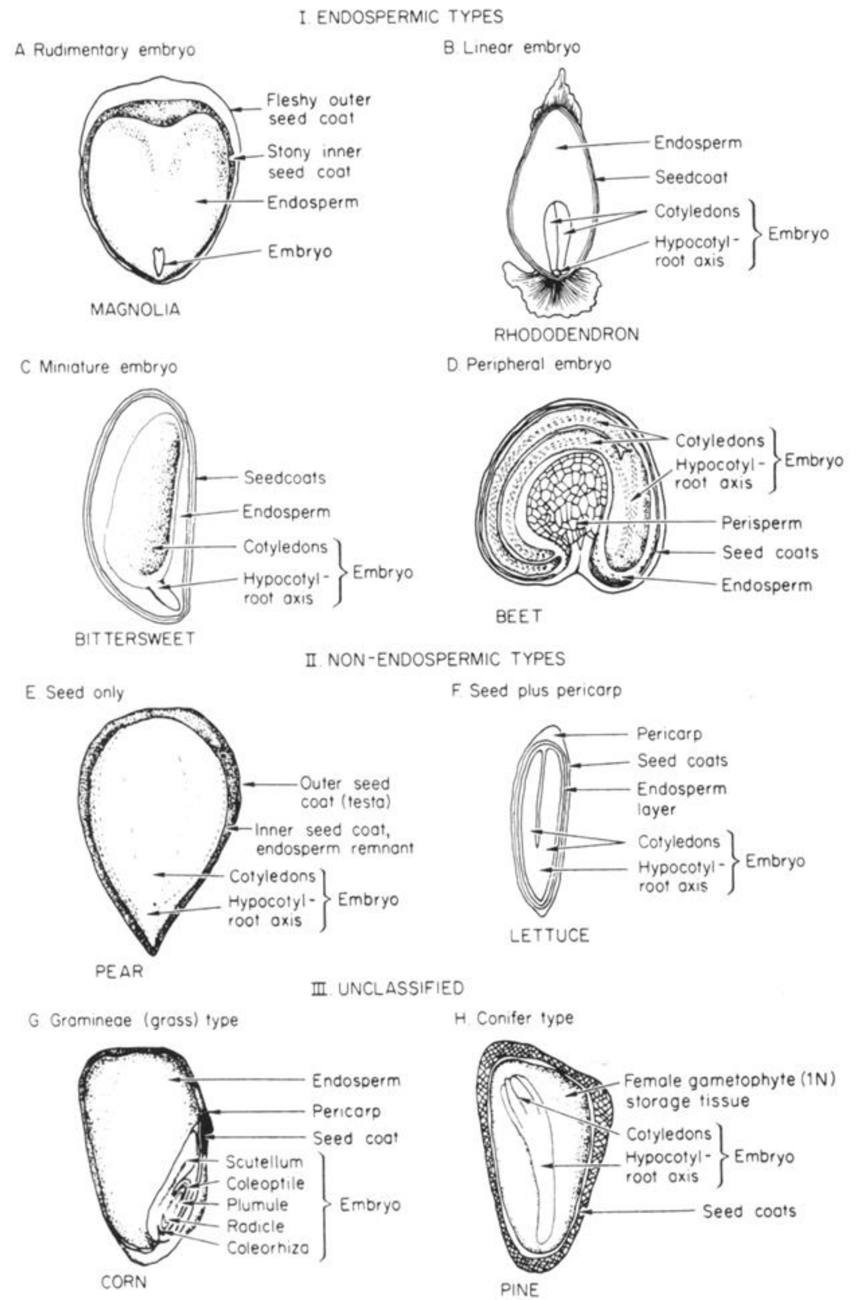


FIGURE 3–9 Morphological types of seeds as described in the text. (*Rhododendron* and bittersweet redrawn from (*53*).)

Poliembrionia:

Figure 26
Polyembryony in trifoliate orange (*Poncirus trifoliata*) seeds as shown by the several seedlings arising from each seed. One seedling, usually the weakest, may be sexual; the others arise apomictically from cells in the nucellus and are diploid copies of the mother plant.

Embriões nucelares:

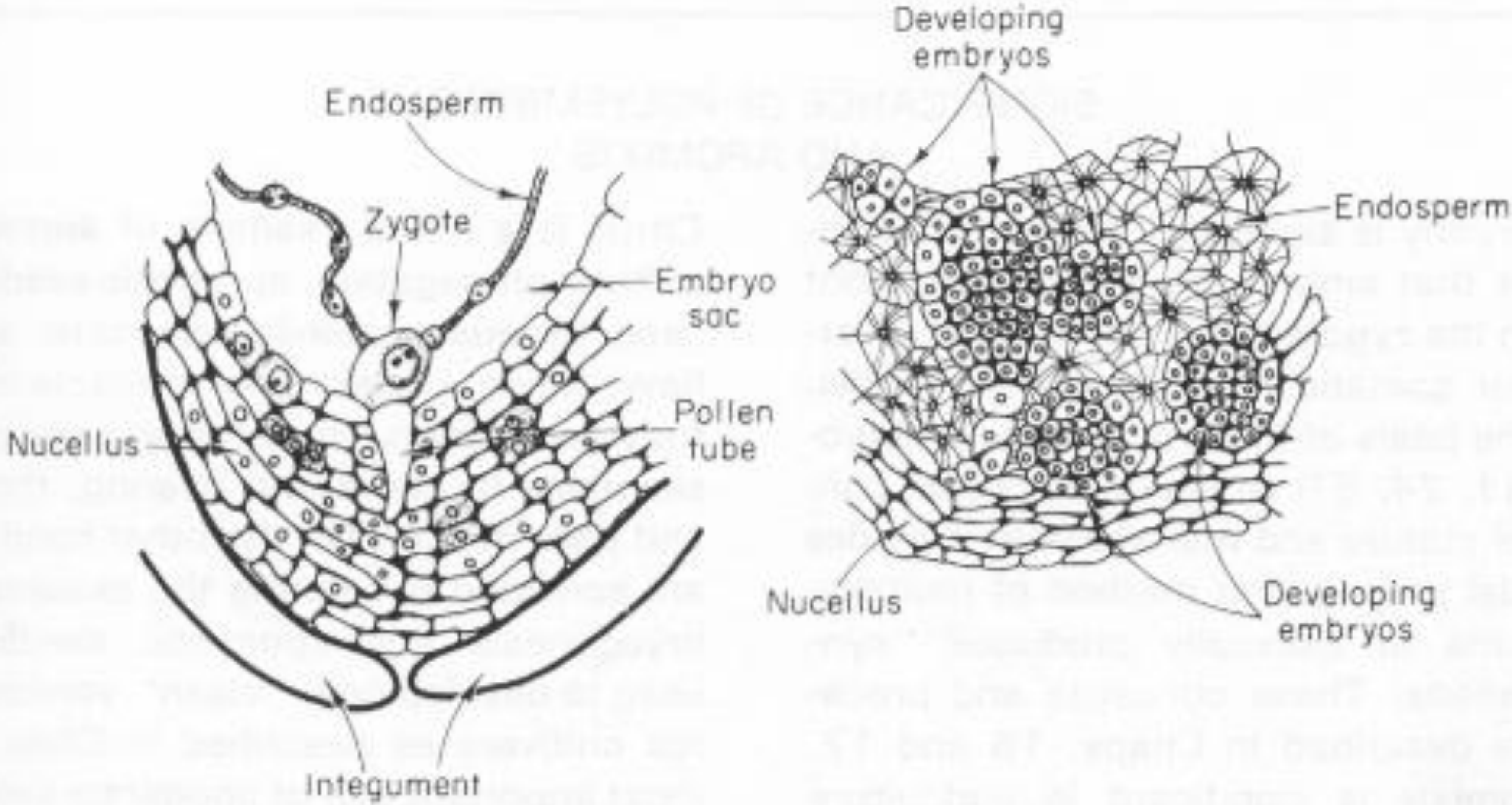


FIGURE 3–11 The development of nucellar embryos in *Citrus*. *Left:* Stage of development just after fertilization showing zygote and remains of pollen tube. Note individual active cells (shaded) of the nucellus, which are in the initial stages of nucellar embryony. *Right:* A later stage showing developing nucellar embryos. The large one may be the sexual embryo. (Redrawn from Gustafsson (*32*).)

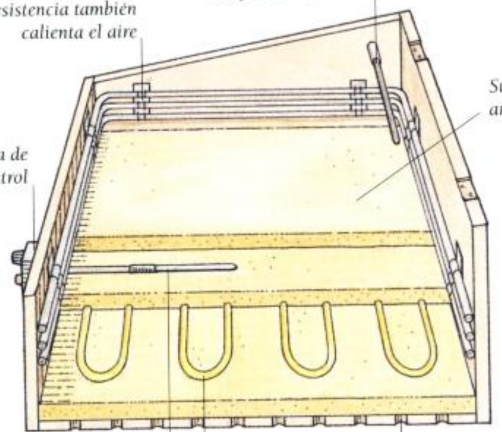
Estrutura operacional e cuidados especiais:

- Luz, água, controle de temperatura, nutrientes, gases:
  - “camas quentes”
  - “invervaderos”
  - “casas de vegetação”
    - filmes de polietileno - PVC
    - sombrites
    - telados
  - Casas de vegetação “Van der Hoeven”
  - aquecimento:
    - serpentinas, combustíveis ou solar

LAS «CAMAS CALIENTES»
Los jardineros de la época victoriana con frecuencia utilizaban «camas calientes» como ésta de Cornualles, Inglaterra, para la propagación y obtención de hortalizas o frutas delicadas en invierno.

"Camas quentes modernas:

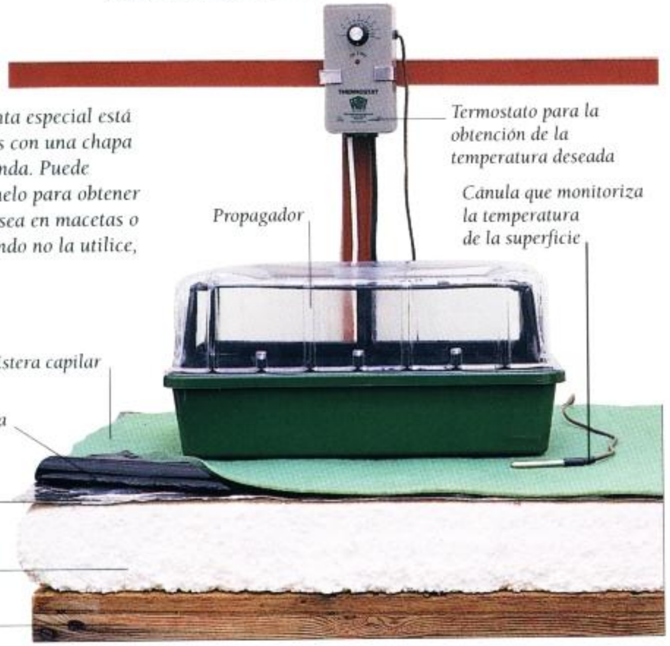
CÓMO PROPORCIONAR CALOR DE FONDO



EFECTOS DEL CALOR DE FONDO *Si la temperatura del medio de enraizamiento es más cálida que la del aire, los esquejes normalmente enraizan con mayor fuerza y rapidez. Las semillas también tendrán más posibilidades de germinar.*

RESISTENCIA DE CALENTAMIENTO DEL SUELO *Coloque el cable, que aquí se utiliza en una caja de propagación, en una serie de curvas en forma de «S» sobre la arena húmeda a una profundidad de 5-8 cm, procurando que las lazadas no se toquen. Las resistencias también pueden utilizarse para calentar aire en espacios cerrados, como en este caso.*

MANTA DE PROPAGACIÓN *Esta manta especial está hecha de alambres eléctricos cubiertos con una chapa de aluminio para que el calor se expanda. Puede utilizarse sobre un banco o sobre el suelo para obtener un área temporal de propagación, ya sea en macetas o en propagadores sin calefacción. Cuando no la utilice, enróllela y guárdela.*



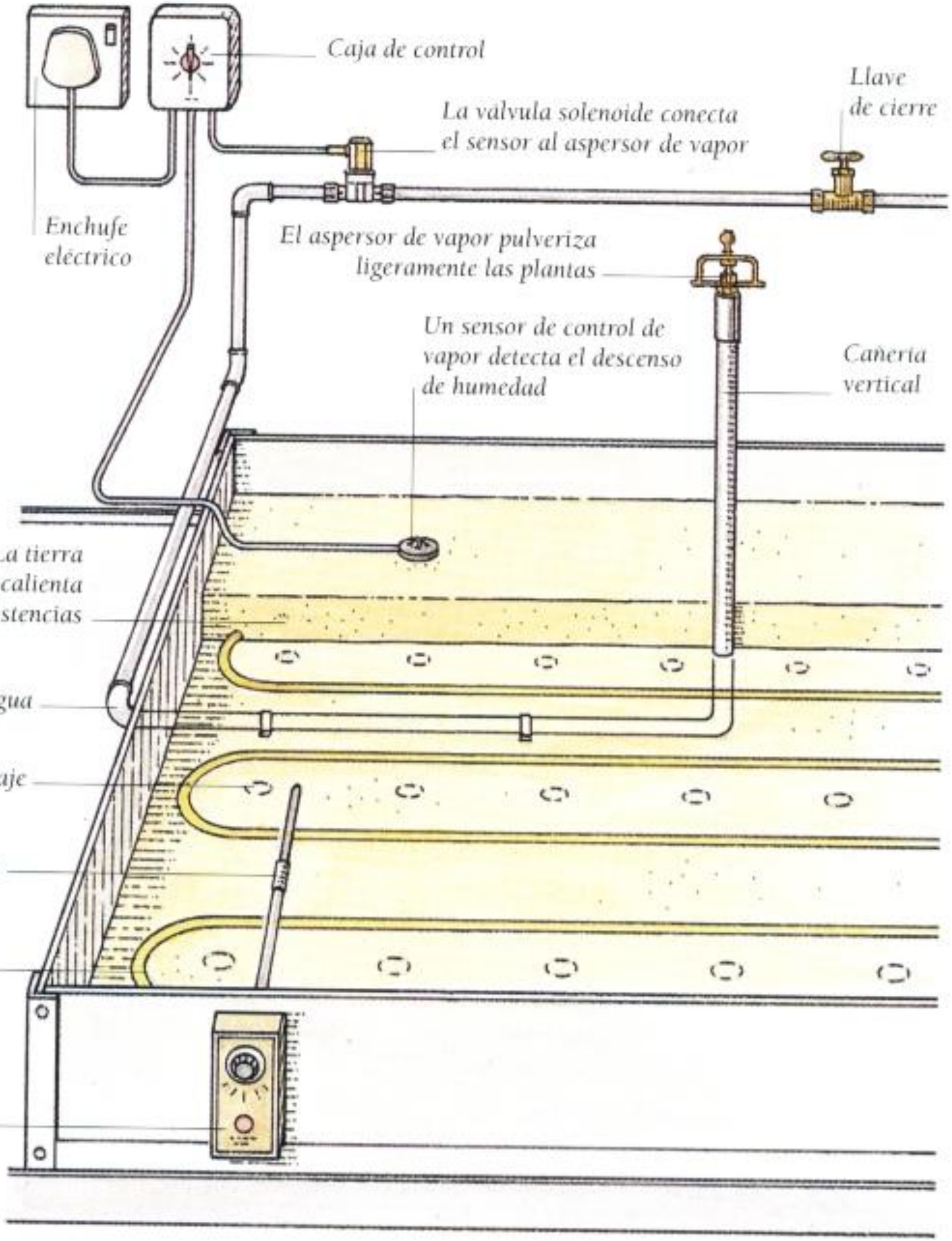
ELABORACIÓN DE UNA CAMA CALIENTE

1 *Ahorquille el suelo en un extremo del invernadero y cúbralo con una capa de 23 cm de estiércol de caballo y paja, y 5 cm de tierra. Pulverice con cal para neutralizar la acidez.*

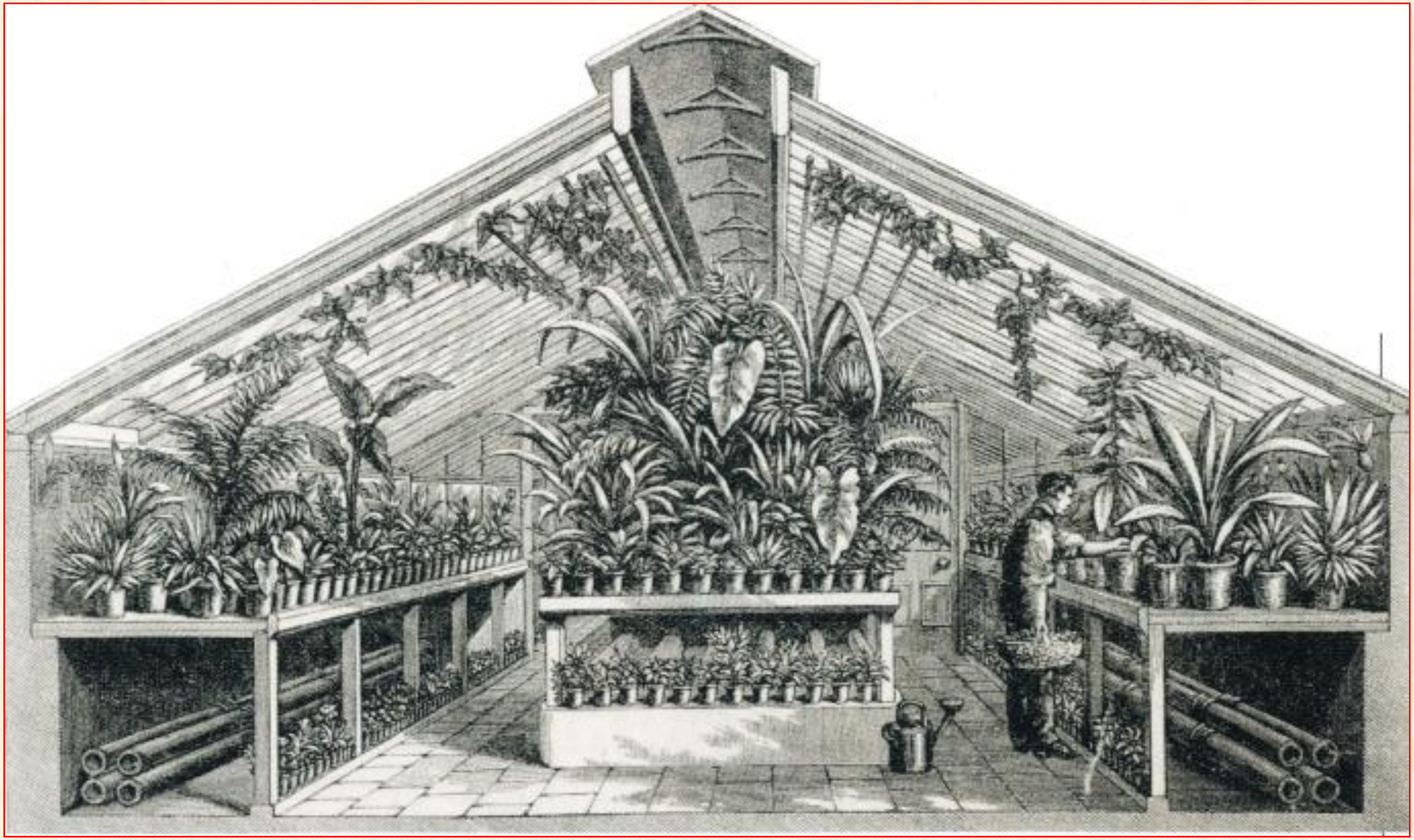
2 *Construya el macizo con dos capas más de abono, tierra estándar y tierra caliza, terminando con una capa fina y nivelada de tierra. Déjelo durante uno o dos días para que el macizo se caliente antes de utilizarlo.*

Sistema de propagación a través de vapor

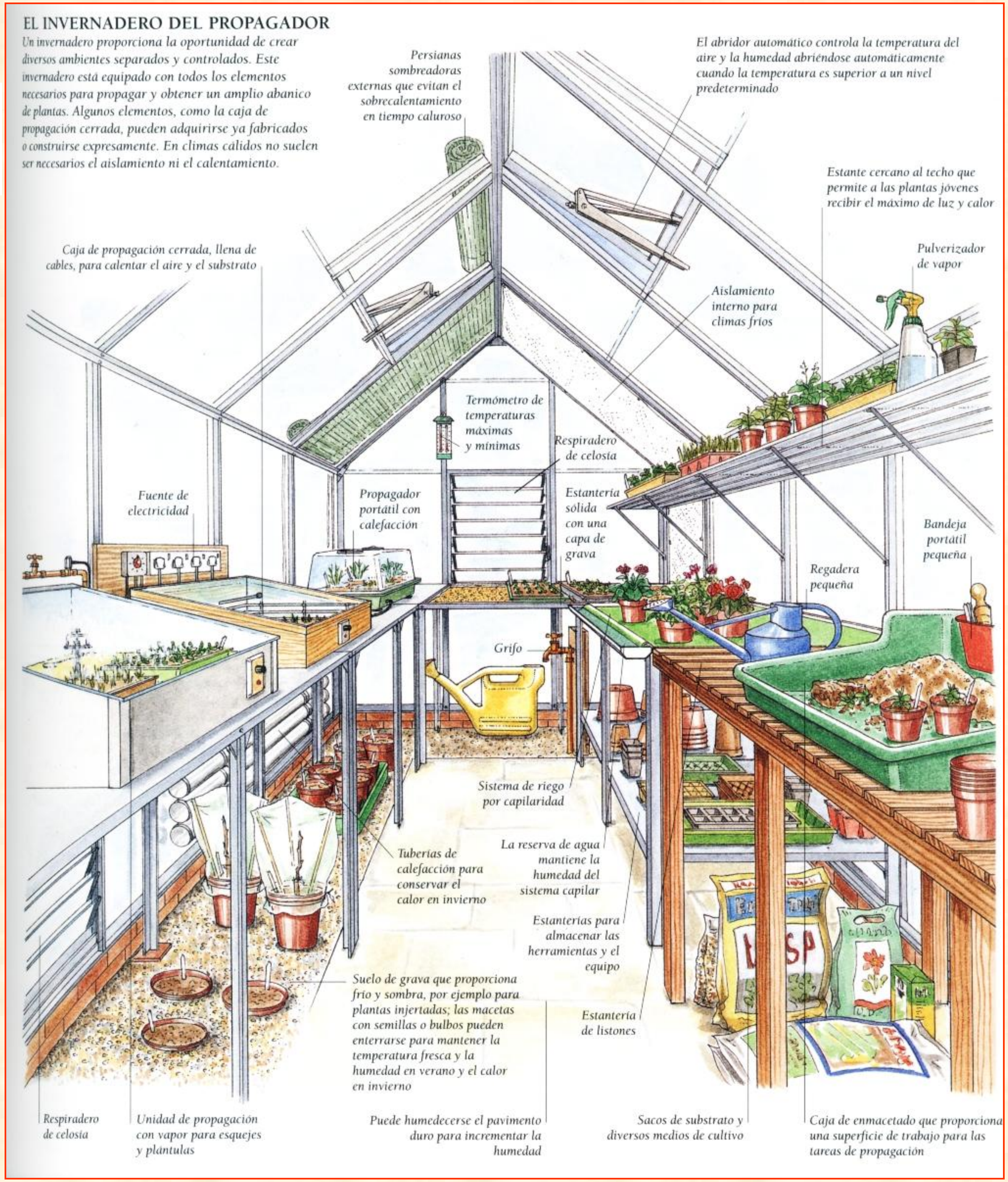
Esta unidad controlada termostáticamente posee un sistema de autoalimentación, pudiéndose cubrir y aislar por la base y los laterales. Proporciona calor de fondo a través de un lecho de tierra o substrato calentado eléctricamente. La continua aspersión de finas gotitas de agua mantiene una película constante de líquido para evitar que los esquejes se sequen.



Antigos “invernaderos”:



Esquema geral de uma casa de vegetação:

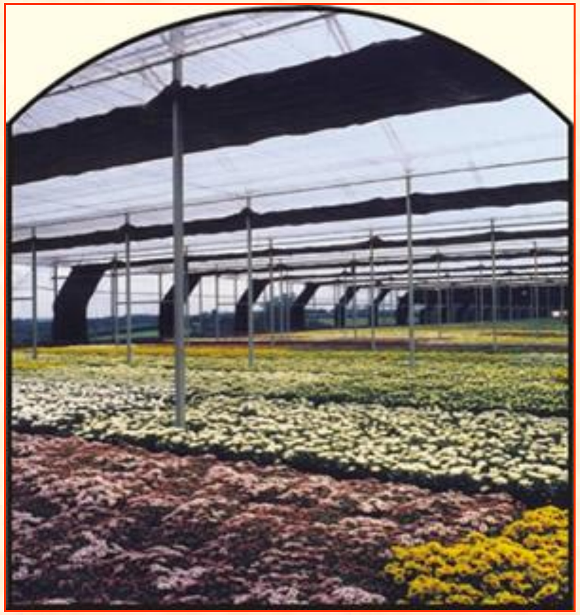


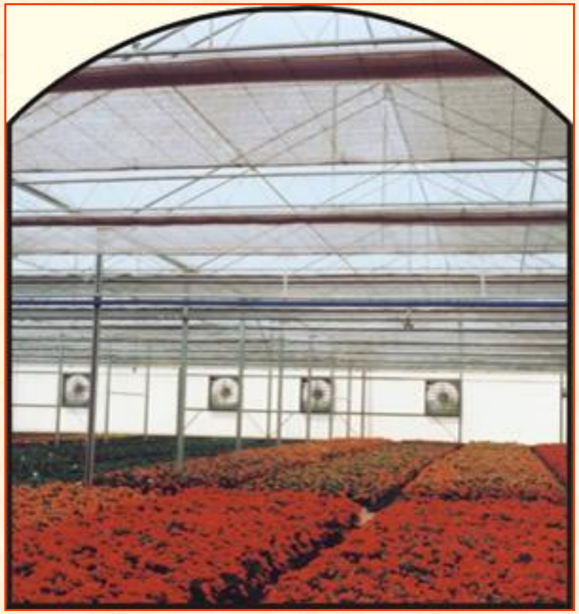
MALLA FLEXIBLE *La malla de plástico, que puede cortarse al tamaño deseado, se utiliza para el sombreado interno o externo. La cantidad de sombra depende del tipo de malla.*

PINTURA SOMBREADORA *Las pinturas proporcionan una sombra muy efectiva porque reducen el calor del sol de forma significativa, al tiempo que dejan penetrar la suficiente luz para un buen desarrollo de las plantas. Aplique la pintura externamente.*

TÚNELES PROTECTORES *Cuando el sol es muy fuerte, es posible disponer de campanas blancas en forma de túnel sujetas sobre aros de alambre a la longitud deseada. Filtran la potente luz solar sin reducir excesivamente el calor.*

Casas de vegetação Van der Hoeven:





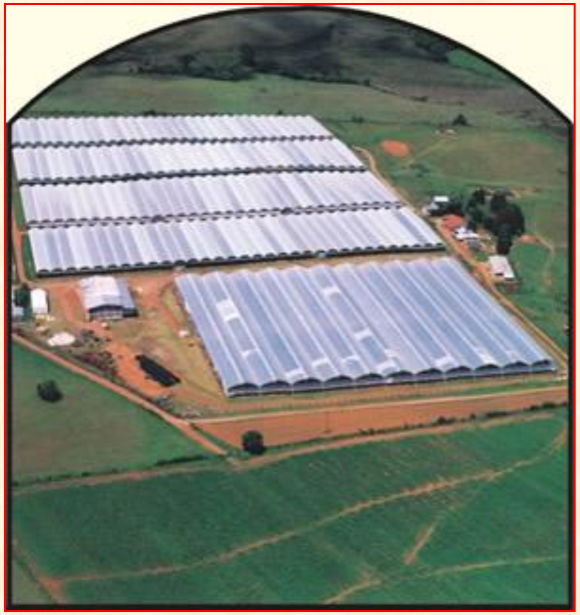


Figure 2
Propagation house heating systems. (a) Gas-fired infrared or vacuum-operated radiant heaters (arrow). (b) Forced hot air heating system. (c) Greenhouse, hot water boilers. (d) Heating below the bench for better control of root zone temperature.

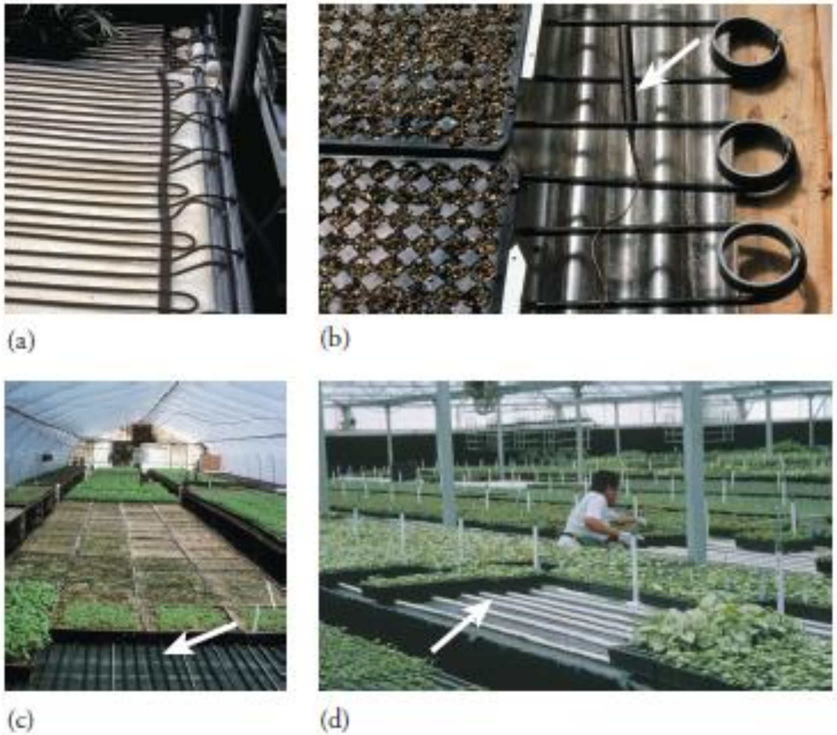
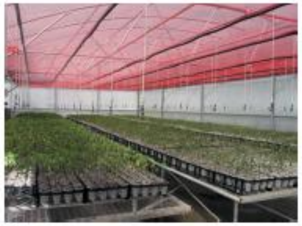


Figure 9
Hot water, root zone heating of propagation flats. (a) Biotherm tubing heating root zone of the plug tray. (b) Notice the probe (arrow) for regulating temperature. (c) The flexible hot water tubing is hooked into larger PVC pipes at set distances to assure more uniform heating. (d) Cuttings in propagation flats placed over white PVC hot water tubing; in milder climates, the ground hot water tubing may be all that is used to control root zone temperature and the air temperature of the propagation house.

Figure 10

(a) Prop house with thermal and shade curtains (arrow) to reduce winter heating costs and reduce light irradiance and greenhouse cooling expenses during summer months. (b) Thermal screen for energy conservation, made of woven aluminized polyester fabric, covering for propagation house with 46 percent light transmission; (c and d) the fabric is placed on top of polyethylene propagation house the covered house.

(a)



(b)

(c)

Figure 11
(a and b) Propagation houses covered with red shade cloth for enhanced root initiation and development. The red netting increases the red, while reducing the blue and green spectra. (c) Shading seed propagation flats to reduce light irradiance and heat load.

pad and fan system
A system commonly used in greenhouse cooling to reduce the air temperature by raising the relative humidity and circulating air.

shown in Figure 12. The **"pad and fan" system,** in which a wet pad of material, such as special honeycombed cellulose, aluminum mesh, or plastic fiber, is installed at one side (or end) of a greenhouse with large exhaust fans at the other, has proved to be the best method of cooling greenhouses, especially in low-humidity climates (6). Fog can be used to cool greenhouses, but is more expensive than conventional pad and fan systems, and is inefficient in climates with high relative humidity (e.g., the Texas Gulf Coast).

(a)

(b)

Figure 12
Fully automated polycarbonate-covered greenhouse. (a) Air is pulled by exhaust fans (black arrows) to vent and cool. Components of both heating and cooling systems are electronically controlled via a weather monitoring station (white arrow) that feeds environmental inputs to computerized controls. (b) Cool cells (wettable pads) through which cooler, moist air is pulled across the propagation house by exhaust fans.

Tipos de Solos e Substratos:

- Meio:
  - firme e denso, capacidade reter água, poroso, livre de invasoras e patógenos, nutrientes:
    - Turfa (acumula 15 vezes o seu peso em água)
    - Musgo *Sphagnum* (10-20 vezes/peso)
    - Vermiculita: formada por hidratação de certos minerais basálticos [$(MgFe,Al)_3(Al,Si)_4O_{10}(OH)_2.4H_2O$]; espande quando lhe é aplicado calor; possui alta capacidade de troca catiônica CTC)
    - Perlita: perlita expandida é resultado do aquecimento do mineral vulcânico, onde ocorre uma expansão de quatro a vinte vezes seu volume original; a superfície da perlita é formada de pequenas cavidades onde a água fica retida e disponível para as raízes das plantas
    - Fibras minerais, flocos de poliestireno, húmus, restos de cultura
    - Plantmax®; Carolina®; Bioplant®, etc.

PRINCIPALES INGREDIENTES DEL SUBSTRATO

MARGA *Suelo de jardín esterilizado, de calidad elevada, con una buena fuente de nutrientes, drenaje, aireación y retención de la humedad. Para substratos sustanciosos.*

ARENISCA *Oscila entre la muy fina, de 2-3 mm, o la fina, de 5 mm, y la gruesa, de 7-12 mm. Mejora el drenaje, en especial en el substrato para especies alpinas y cactos.*

TURBA *Estable, duradera, con buena aireación y retención de humedad, pero de bajo contenido en nutrientes. Una vez seca, es difícil devolverle la humedad.*

PERLITA *Gránulos expandidos de roca volcánica. Estéril, inerte y ligera, retiene la humedad pero drena libremente. El tamaño medio/grueso añade aireación y un buen drenaje.*

CORTEZA FINA *Fragmentos finos de corteza de pino que se utilizan como sustituto de la turba, o para substratos ácidos o muy bien drenados, para orquídeas o palmeras.*

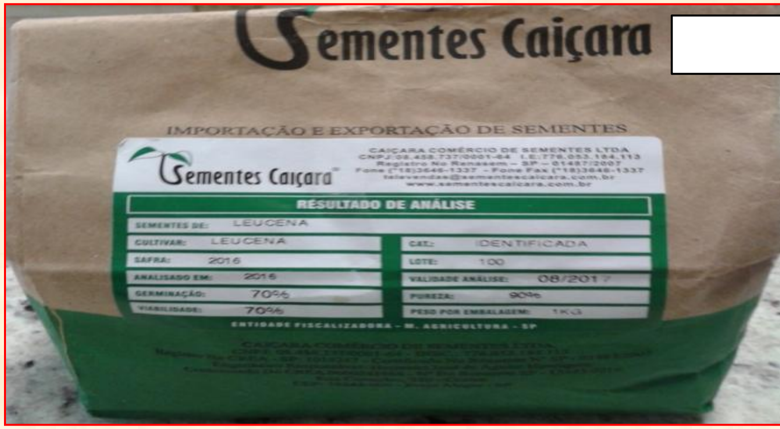
VERMICULITA *Mica expandida e hinchada que actúa de forma similar a la perlita, pero retiene más agua y menos aire. El tamaño fino añade drenaje y aireación.*

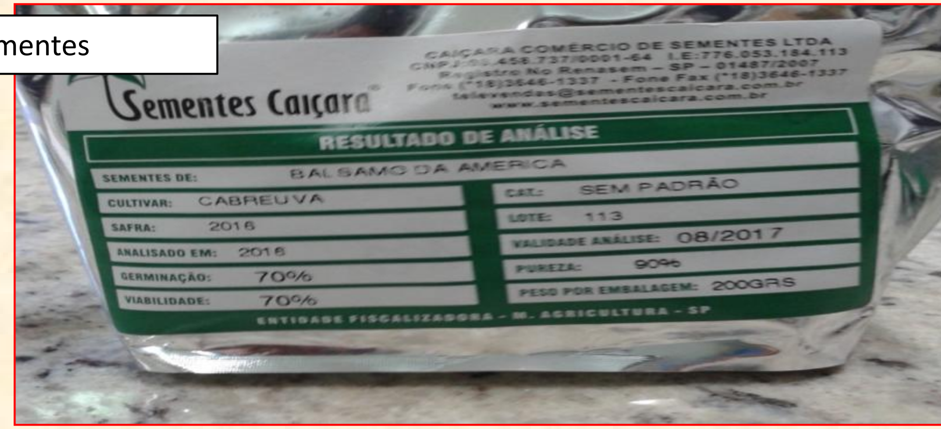
FIBRA DE CORTEZA DE COCO *Se utiliza como sustituto de la turba. No se seca tan rápidamente, pero requiere más fertilizantes. Una buena base para substratos limpios.*

ARENA *La arena fina, plateada, favorece el drenaje y la aireación en substrato para semillas; la arena gruesa proporciona una textura más abierta al substrato para esquejes.*

HUMUS DE HOJAS *Hojas descompuestas que sustituyen a la turba. Puede albergar plagas o enfermedades. La textura gruesa es mejor para el substrato de esquejes.*





Materiais utilizados para a produção das plantas a partir de sementes e das mudas, com destaque para os substratos, os vasos de cultivo e para o corretor de acidez.

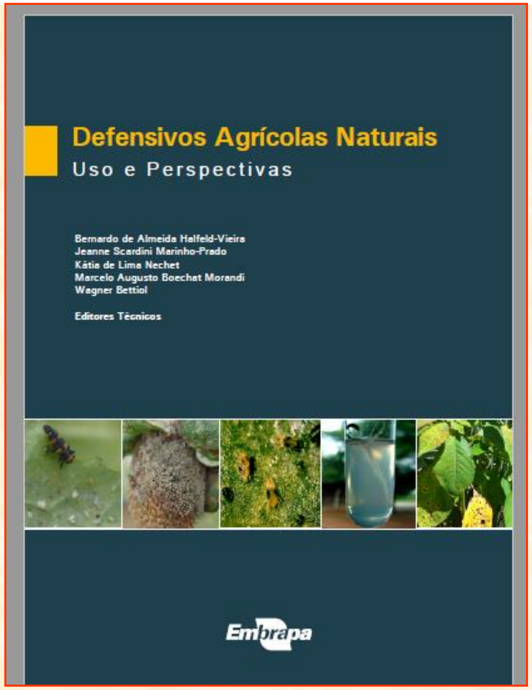

MURIPI

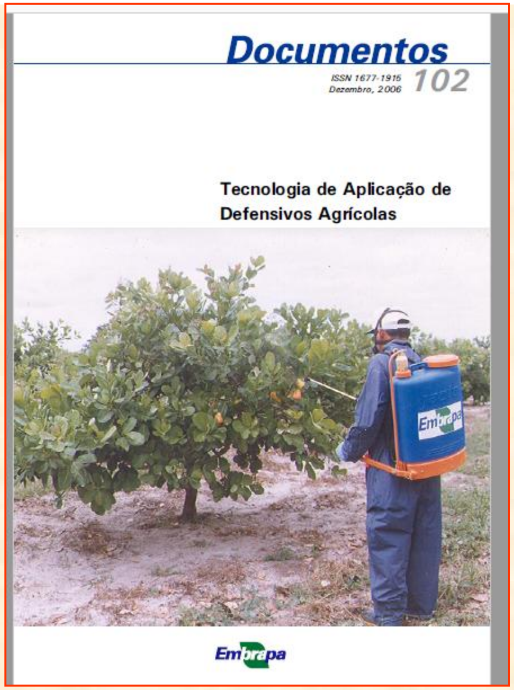

MURIPI
CSM

- Patógenos: pasteurização, autoclavagem, microondas
  - *Pythium* - Captan (Orthocide)
  - *Phytophythora* - Benomyl (Benlate) + Captan
  - *Rizoctonia* - Benomyl (Sistêmico)
  - *Fusarium* - Benomyl
  - *Verticilium* – Benomyl
    - *Benomyl foi banido em vários países*
- Desinfestação: material, ferramentas,utensílios e ambiente
  - 1 Parte de água sanitária (2-2,5%) : 9 partes de água
- Seleção do material vegetal:
- Desinfestação da base de estacas:
  - hipoclorito sódio (30 mg L^{-1}) + Captan + Benlate (Benomyl)

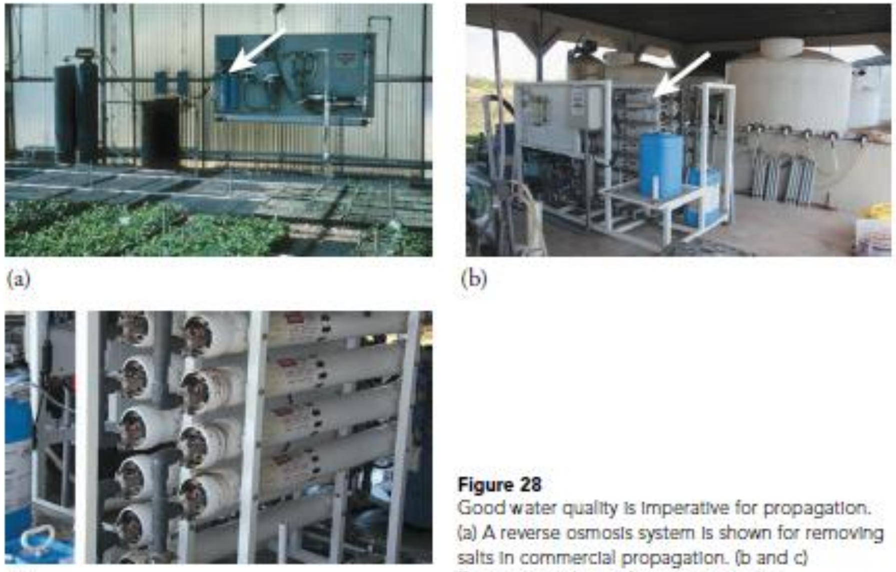
Agrotóxicos (Defensivos agrícolas) - Produtos químicos usados na lavoura, na pecuária e mesmo no ambiente doméstico, com a finalidade de exterminar pragas ou doenças. Inclui inseticidas, fungicidas, acaricidas, nematicidas, etc. Os agrotóxicos são classificados, de acordo com seu potencial toxicológico, em:

- *(i) Classe I: extremamente tóxicos (faixa vermelha);*
- *(ii) Classe II: altamente tóxicos (faixa amarela);*
- *(iii) Classe III: medianamente tóxicos (faixa azul);*
- *(iv) Classe IV: pouco ou muito pouco tóxicos (faixa verde);*





Qualidade da água:



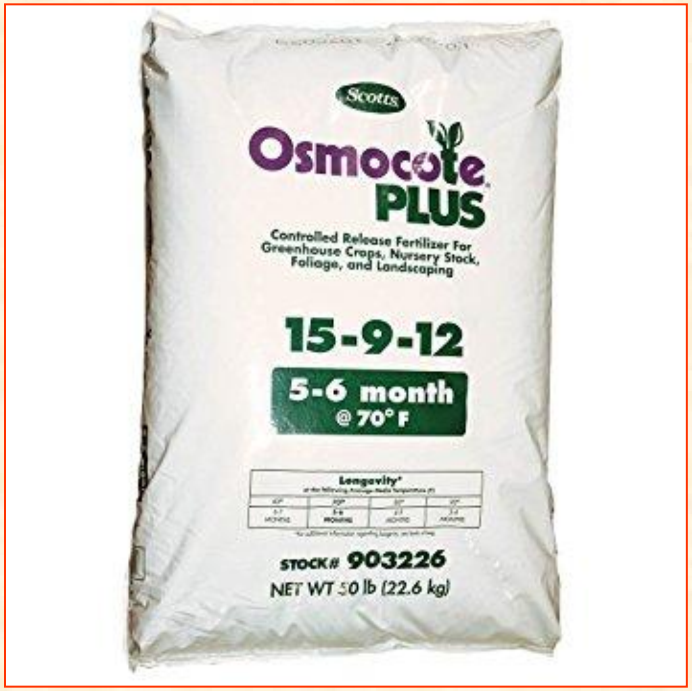
(a) (b) (c)

Figure 28
Good water quality is imperative for propagation. (a) A reverse osmosis system is shown for removing salts in commercial propagation. (b and c) Deionizing columns for removing salts.

When the water source is a pond, well, lake, or river, contamination by weed seeds, mosses, or algae can be a problem. Chemical contamination from drainage into the water source from herbicides applied to adjoining fields or from excess fertilizers on crop fields can also damage nursery plants. Recycled water, which is discussed in the section "Best Management Practices (BMP)," is used in nursery and greenhouse production, and is being evaluated for general propagation in some nurseries.

The pH of Irrigation Water and Substrate Media The pH is a measure of the concentration of hydrogen ions and can affect the rooting of cuttings, germination of

- Soluções nutritivas:
- Fertilizantes de liberação lenta:
  - *pellets* solúveis em água (Osmocote)
  - material inorgânico de liberação lenta
  - materiais orgânicos com quebra biológica
- pH 5,5 - 7,0:
- Iluminação:
  - RFA, fluorescentes, alógenas ou vapor de sódio, LEDs
- Enriquecimento com CO_2:
- Tipos de recipientes:
  - material dobrável baixa espessura
  - tubetes PVC
  - bandejas poliestireno expandido, bandejas de fibra
  - vasos de barro
  - jacás


Scotts
Osmocote
PLUS
Controlled Release Fertilizer For Greenhouse Crops, Nursery Stock, Foliage, and Landscaping
15-9-12
5-6 month
@ 70° F
Longevity
STOCK# 903226
NET WT 50 lb (22.6 kg)

Scotts
70°
3 4 5 6 8 9 12 14 16
MONTH RELEASE
Osmocote
CLASSIC
Fertilizante de liberación Controlada
18-6-12
The Foundation of Plant Nutrition™
Los Cimientos en Nutricion de Plantas™
NET WT.: 50 lb (22.6 kg)
90555

Controlled Release Fertilizer
Osmocote
Classic
14-14-14
3-4
For best results use with Micromax
Net WT 50 lb (22.6 kg)
everris.
E90550

Scotts
Osmocote
CLASSIC
19-6-12
lo·start
inicio bajo

BANDEJAS MODULARES

Las bandejas modulares se han fabricado durante años y se encuentran disponibles en una gran variedad de formas y tamaños. Los módulos permiten a las plántulas y esquejes desarrollar sistemas radiculares antes de ser plantados y manejarlos sin dañar las raíces o los tallos. Llene una bandeja con substrato para semillas y siembre una en cada celda. Cuando asomen las raíces por la base, deje que se sequen ligeramente y empújelas hacia afuera con la ayuda de un lapicero.

BANDEJA MODULAR DE 13 MM *Es el tamaño de módulo más pequeño. Utilícelo para 576 plántulas pequeñas de crecimiento rápido.*

BANDEJA MODULAR DE 20 MM *Esta bandeja permite cultivar 273 plántulas con varios pares de hojas.*

BANDEJA MODULAR DE 30 MM *Hasta 135 plántulas pueden desarrollarse en esta bandeja. Entierre los módulos en recipientes de 6 cm.*

BANDEJA MODULAR DE 37 MM *Las bandejas más grandes sostienen hasta 70 plántulas o esquejes herbáceos pequeños.*

BANDEJAS DE FIBRA MINERAL DE 40 MM *Cuando las utilice, alimente las plántulas o esquejes con un fertilizante líquido diluido una vez hayan desarrollado verdaderas hojas.*

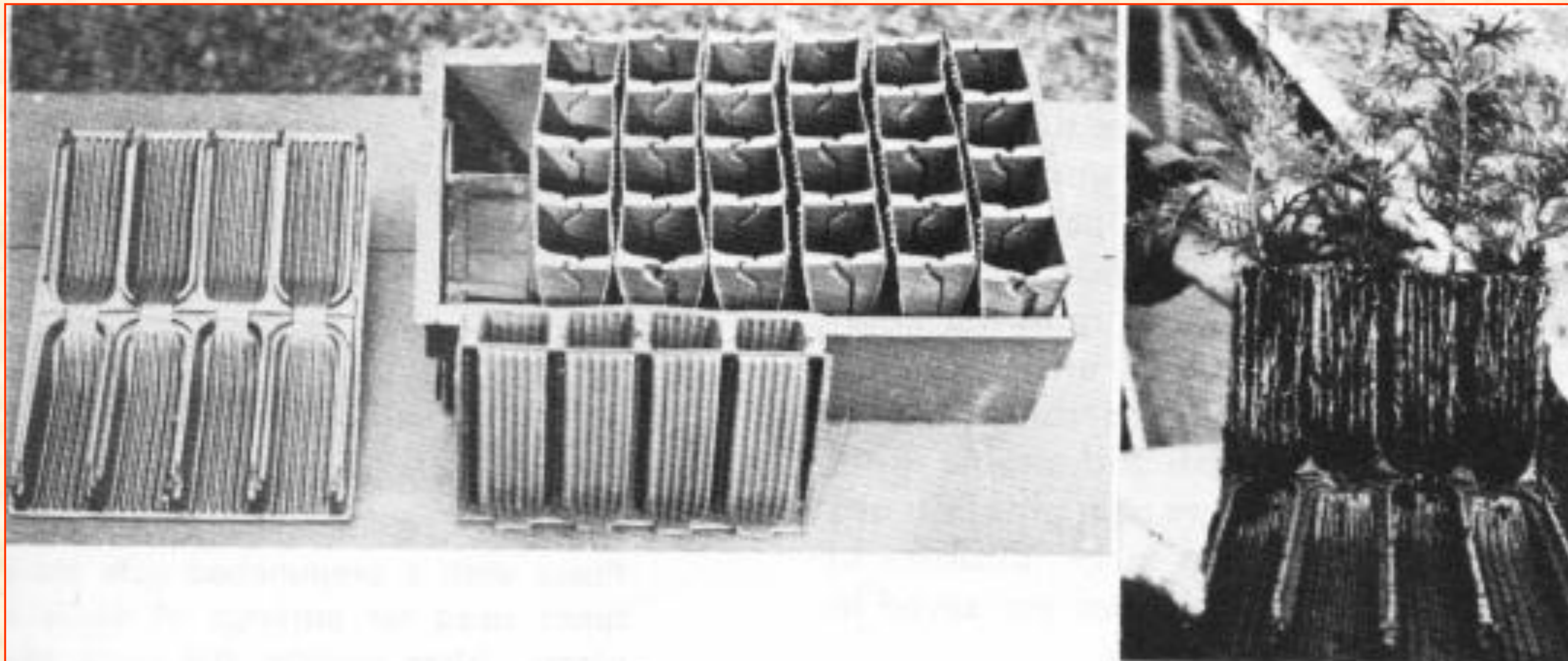


FIGURE 2–15 Plastic containers (Rootrainers) made of preformed, hinged plastic sheets (*left*). These fold together and lock to form a set of four containers that fits into a special plastic tray. The vertical grooves on the sides of the containers reduce the likelihood of undesirable root spiralling. The containers can be opened to permit inspection of the roots or removal of the plants. This type of container is widely used in reforestation for propagating and growing seedlings.

Manuseio e produção de sementes:

- Maturação das sementes:
  - máximo em peso seco
  - colheita precoce x colheita tardia
- Tipos de frutos x coleta das sementes:
  - sementes e frutos secos - frutos indeiscentes
    - milho, feijão, espécies arbóreas
  - sementes e frutos secos - deiscentes
    - folículos, vagens, cápsulas, síliquas
  - sementes no interior de frutos com polpa
    - extração da polpa, fermentação
- Secagem:
  - ortodoxas x recalcitrantes
  - lenta
  - umidade de segurança: 8-15%

- Sementes recalcitrantes:
  - vida-curta, germinação imediata
- Sementes ortodoxas:
  - maior viabilidade e longevidade
- Condições de armazenamento:
  - Ideal: taxa respiratória e metabólica reduzidas
  - umidade:
    - principal fator
    - Equilíbrio com UR do ar
    - sementes ortodoxas: genes *LEA*
    - sementes recalcitrantes
      - Clima tropical (UR e temperatura elevadas)
      - Clima temperado (UR elevada e baixa temperatura)
- Temperatura:
  - redução aumenta tempo de armazenagem
  - criopreservação: -196°C (nitrogênio líquido)

- Recipientes:
  - aberto
  - herméticos e impermeáveis
  - agentes dessecantes (sílica-gel: 1 parte sílica / 10 partes sementes)
  - armazenamento condicionado - desumidificadores
- Etapas da germinação:
  - embebição
  - estacionária
  - germinativa
- Testes de germinação:
  - percentagem, taxa, velocidade
  - tetrazólio
  - longevidade
  - vigor

- Taxa de germinação:
  - número de dias para alcançar percentual de germinação
  - Média de dias = MD
    - MD = $N_1T_1+N_2T_2+ ...+N_xT_x$ / número total sementes germinadas
    - Recíproco da fórmula - coeficiente de velocidade
  - valor de germinação (inclui taxa e percentagem final): VG
    - curva obtida a partir da emergência radícula ou plúmula
    - T: ponto de redução da taxa de germinação
    - G: percentual final de germinação
    - VP: pico de germinação
    - VP $\rightarrow$ percentual em T (*P*) / número de dias (*B*)
    - Média de germinação diária (MGD):
      - percentagem germ final *G* (*Y*) / número de dias para alcançar o % final de germ *G* (*X*)

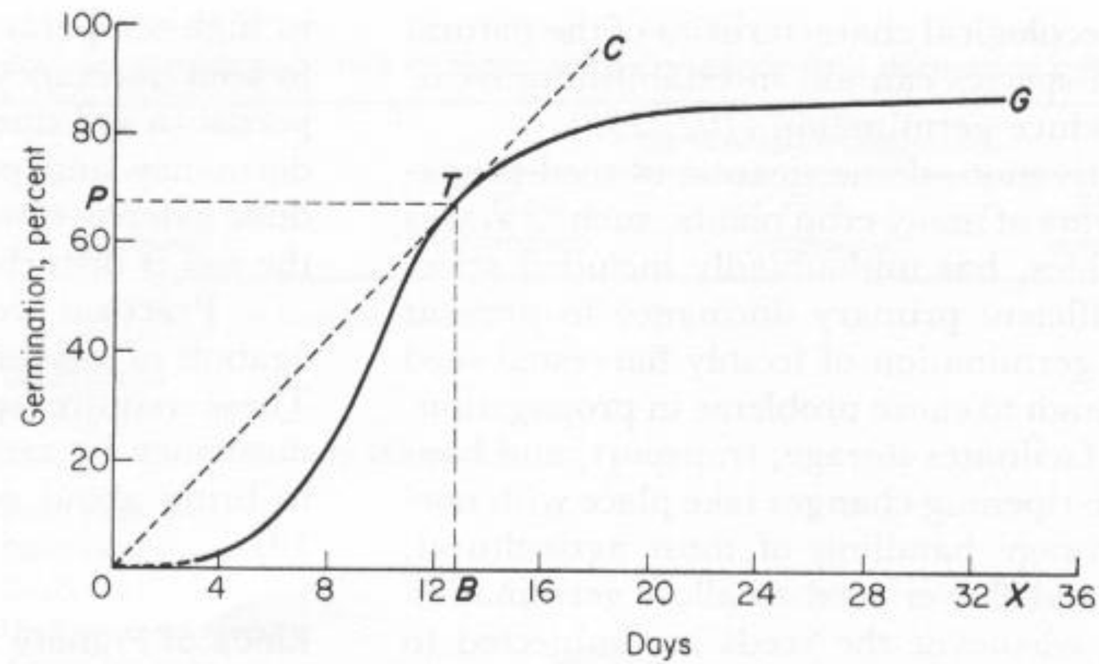


FIGURE 6–4 Typical germination curve of a sample of germinating seeds. After an initial delay, the number of seeds germinating increases, then decreases. Such a curve can be used to measure germination value. (Redrawn from Czabator (*38*).)

T: ponto de redução da taxa de germinação

G: percentual final de germinação

VP: pico de germinação

VP → percentual em T (*P*) / número de dias (*B*)

VG = VP x MGD

VG = (68/13) x (85/34)

VG = 5,2 x 2,5

VG = 13

Figure 24
Precocious or viviparous germination occurs when the seed prematurely germinates in the fruit. This is the result of the developing seed not completing the third stage of development—maturation drying. The cause of precocious germination is usually the inability of the embryo to produce or perceive abscisic acid (ABA). ABA is a potent germination inhibitor and one of its roles during seed development is to prevent precocious germination. The tomato illustrated here is most likely an ABA production mutant.

BOX 6 **GETTING MORE IN DEPTH ON THE SUBJECT**

PRECOCIOUS GERMINATION OR VIVIPARY

Precocious germination or vivipary is the phenomenon in which seeds precociously germinate without maturation drying. These seeds germinate in the fruit while still attached to the plant (Fig. 24). Precocious germination occurs naturally in some species like mangrove (*Rhizophora mangle*). In mangrove, precocious germination is an adaptation to growing in a wet (swampy) environment. Embryos germinate directly on the tree to produce seedlings with a long, javelin-shaped root (Fig. 25). The seedling eventually falls and becomes embedded in the mud below (65).

vivipary Germination of a seed while it is still attached to the mother plant.

For most plant species, however, precocious germination is undesirable. Premature seed sprouting occurs in many species including cereal grains (wheat and corn), fleshy fruits (citrus and tomato), and nuts (pecan). Precocious germination is considered a genetic mutation, but occurrence of precocious germination can be modified by the environment (71). Expect increased precocious germination in susceptible species during periods of wet weather (7).

The genetics of viviparous mutants in corn has been most extensively studied (50). Up to nine genes have been associated with precocious germination in corn. The common feature in viviparous mutants is reduced production, or insensitivity to abscisic acid (ABA). This supports the role for ABA in maintaining the embryo in the developmental mode through maturation drying.

Figure 25
Precocious (viviparous) germination in mangrove (*Rhizophora mangle*). (a and b) Note the protrusion of the radicle from the fruit while it is still attached to the plant. (c) After sufficient radicle growth the fruit will fall from the plant and embed in the soft marshy soil around the mother plant.

Tipos de dormência:

- Dormência primária:
  - suspensão temporária do crescimento meristemático
  - incapacidade de germinação
- Pós-amadurecimento:
  - processos internos que levam à superação da dormência primária
- Dormência secundária:
  - mecanismo de sobrevivência (mesmo com embebição)
- Quiescência:
- Terminologias alternativas:
  - ecodormência ≈ quiescência
  - paradormência - sinais físicos ou bioquímicos de origem externa
  - endodormência - fatores fisiológicos no interior da semente

Quadro 1. Principais categorias e terminologias relacionadas à dormência em sementes

		Terminologia geral		
Tipo de dormência da semente	Descrição	Ecodormência	Paradormência	Endodormência
	I. Não dormência:			
Nenhuma	Quiescência	X		
	II. Dormência primária:			
Física	Casca		X	
Mecânica	Casca		X	
Inibidor	Casca		X	
Morfológica	Embrião não desenvolvido		X	X
Fisiológica	Relacionado às membranas		X	
- Termodormência	Relacionado às membranas	X	X	
- Fotodormência	Relacionado às membranas	X	X	
Intermediária	Combinação		X	X
Embrião	Interna		X	X
- Epicótilo	Interna		X	X
Dupla	Combinações		X	X
	III. Dormência secundária:			
Diversas		X	X	X

Fatores relacionados à dormência primária:

- Casca-dura ou impermeável:
  - macroesclereídeos, ceras, substâncias cuticulares
    - Leguminosae, Malvaceae, Chenopodiaceae, Convolvulaceae
- Substâncias químicas:
  - fenóis, cumarinas, ácido abscísico
  - “pluviômetros químicos”
  - inibição do desenvolvimento do embrião:
    - dormência morfológica (embriões rudimentares)
      - camada mucilaginosa interna
        - » mostarda, lavendula
- Embrião incompleto:
  - pró-embrião: ranúnculo, papoula, ginseng
  - torpedos: cenoura, azaléa
  - espécies monocotiledôneas tropicais:
  - palma, *Actinida*, *Annona squamosa*

- Dormência fisiológica:
  - pós-colheita, transitória, desaparece com desidratação
  - relacionada ao embrião → semi-permeabilidade de revestimentos
- Dormência embrionária:
  - principalmente relacionada ao resfriamento
  - embrião: desenvolvimento cotilédones e hipocótilo, engrossamento radícula,
  - estratificação: areia + temperaturas baixas
    - temperatura utilizada: característica da região
    - temperaturas altas: plantas anãs
- Dormência secundária:
  - alface na luz - germina
  - alface no escuro (2 d) - excisão do embrião - germina
  - alface no escuro (8 d) - excisão do embrião - não germ.

- Indutores de germinação de natureza hormonal:
  - fitormônios ou fitorreguladores
  - reguladores de crescimento
    - giberelinas (GA_3)
      - síntese *de novo* de enzimas
      - mobilização de reservas
    - ácido abscísico:
      - prevenção à germinação precoce (previne viviparidade)
        - » cascas sementes nozes, pêssego, maçã, rosa, ameixa
    - citocininas:
      - baixa atividade nas sementes
      - reverte efeitos ABA
      - efeitos “permissivos” para a ação das GA’s
    - etileno:
      - promoção em trevo, amendoim
    - KNO_3: ?
    - Tiouréia: atividade citocinínica

- Embebição:
  - $\Psi w < -100$ MPa $\Rightarrow \tau$ elevado, π menor contribuição
  - embebição prévia ou lavagem:
    - acelera emergência
    - embebição excessiva é prejudicial (metab. fermentativo)
- Condicionamento osmótico:
  - solução externa com π elevada (PEG, NaCl, KNO_3)
    - atividades metabólicas mantidas
    - atraso na emergência da radícula
- Temperatura:
  - dormência x germinação $\rightarrow$ adaptação climática
  - temp. constante $\rightarrow$ algumas sementes não germinam
    - bancos de sementes profundas
- Gases:
  - O_2: fundamental, exceto para aquáticas
  - CO_2: afeta a dormência

- Luz:
  - promoção:
    - fitocromo - reversão V / VL
    - criptocromo - sem reversão
  - inibição: maxixe, *Nigelia*, *Allium*, *Amaranthus*
  - baixas temperaturas ou alternância eliminam exigência por luz
  - frutos verdes: transmissão de infra-vermelho
  - lâmpadas fluorescentes x incandescentes x Leds
  - luz solar: 2:1 (V : VL)
  - VL: maior penetração no solo
  - pode causar dormência secundária
- Sensibilidade:
  - Membranas cascas e, ou, endosperma

- Testes:
  - amostragem
  - pureza
  - teor de umidade
  - tetrazólio
  - vigor
  - envelhecimento precoce
- Escarificação:
  - permeabilidade à água e aos gases
  - quebra, arranhadura, alteração/amolecimento da casca
    - lixas, água quente, trato digestivo, ácidos
    - germinação após incêndios:
      - *Pinnus radiata*: fusão de resinas
- Estratificação:
  - frio

Produção e Beneficiamento de Sementes

(a)

(b)

(c)

Figure 16
F_1 hybrid cultivars of many vegetable and flowering annuals are created following large-scale hand pollination in a controlled environment. (a) Removing male parts in snapdragon prior to hand pollination. (b) Hand pollination. (c) Pepper fruit prior to harvest for seed extraction.

seed orchard
A planting used in forestry or in fruit tree nurseries to maintain seed sources as seedling populations of selected seed families or of a clone (fruit and nut trees) or collections of clones (forestry).

from which off-type plants are removed should be established around the area.

Seed Orchards **Seed orchards** are established to produce tree seeds of a particular origin or source. For example, fruit tree nurseries maintain seed orchards to produce seeds of specific rootstock cultivars under conditions that will prevent cross-pollination and the spread of pollen-borne viruses. A clonal cultivar such as 'Nemaguard' peach is budded to a rootstock, planted in isolation to avoid chance cross-pollination by virus-infected commercial cultivars, and grown specifically for rootstock seed production as part of the nursery operations.

Figure 4
Corn seed is actually a fruit (caryopsis) and is an example of a crop with dry non-dehiscent fruits. (a) Corn seed is harvested with a picker, leaving the kernels attached to the cob. Although corn used for grain is combined (harvested and shelled in one operation), corn for seed is usually not shelled until it is allowed to dry further to prevent mechanical injury. (b) Corn dehusker. (c) Dehusked corn cobs. (d) Shelled kernels (seeds) ready for storage.

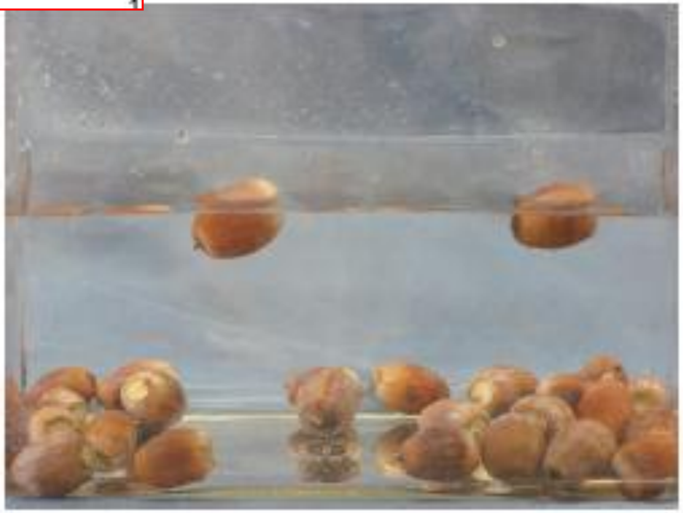


Figure 5
Non-viable oak nuts (acorns) float in water, while viable seeds are more dense and sink.

(a) (b) (c)

Figure 7
Seeds with non-dehiscent and dehiscent fruits often require additional drying after harvest. (a) Portable field drying wagons alongside a permanent bin dryer used for drying prairie wildflower seeds. (b) Open wire screen racks used for air drying woody plant seeds. (c) Forced-air dryer.

(a) (b) (c) (d) (e)

Figure 9
Sandersonia seed removal from a dry dehiscent capsule. (a) Hand-cut fruiting stems are cut and windrowed under protective cover for additional drying. (b) Pods are passed through a threshing machine to remove seeds. (c) The threshing cylinder with a rasp-bar is the most common thresher. (d and e) Proper threshing captures up to 90 percent of the available seeds, but additional conditioning is usually needed to remove fruit debris.

(a) (b) (c)

Figure 10
Seed conditioning based on seed size and shape. (a) Hand screens manually sift seeds from plant debris; (b) Mechanical cleaner and seed sizing units use aspiration (air movement) combined with screens of various shapes and sizes to remove seed debris and separate seeds into various size classes. (c) Close up of screens in a scalper unit that separates good seed from plant debris and other unwanted material.

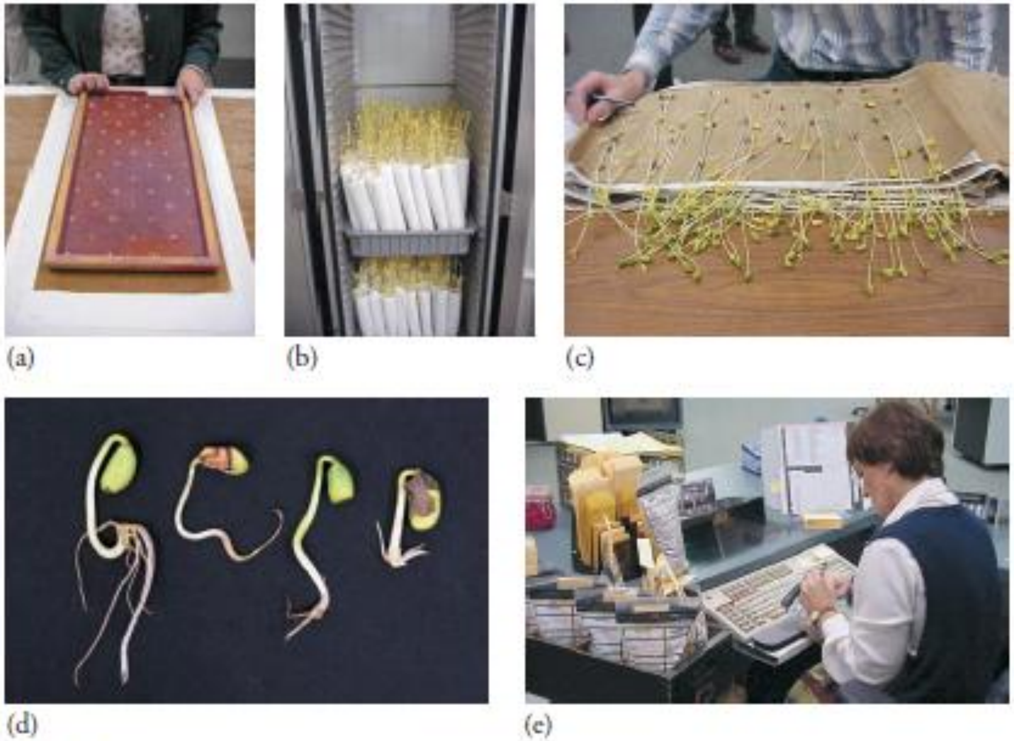
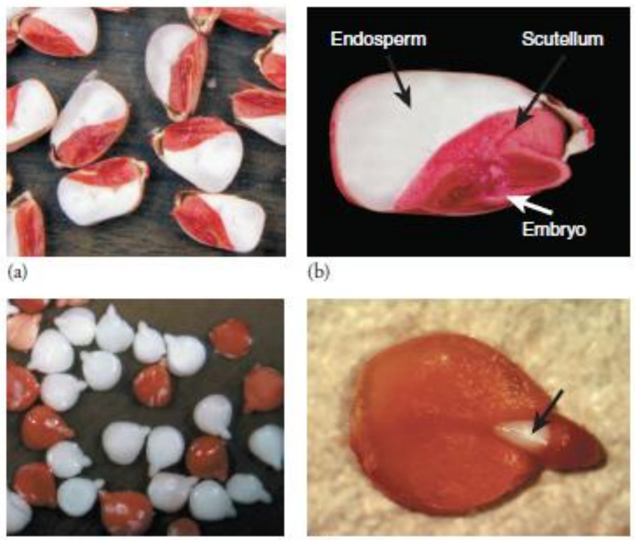


Figure 21
Commercial seed labs process a large number of seed samples. They must keep accurate records of each seed lot and must be efficient to process samples in a timely manner while maintaining high reproducibility from seed lot to seed lot. (a) A seed analyst uses a template board to place a standard number of seeds in precise locations on the germination paper for the rolled towel or Petri dish tests. (b) Rolled towels are held upright in the growth chamber. (c) After the number of days indicated in the testing rules, the seed analyst counts the number of normal seedlings. (d) The seed analyst must determine if a seedling is normal and can be counted as germinated. These seedlings are "abnormal" because either the shoot or root has not developed normally after the final count for this seed test. (e) Results are recorded in a computer database.

Figure 22
The excised-embryo test is a quick evaluation method used for dormant seed. Eastern redbud (Cercis) seeds require at least four months of moist chilling to satisfy dormancy and another 2 weeks for a standard germination test. In comparison, isolated embryos removed from the seed coverings will germinate in 5 days.

X-ray Analysis X-ray analysis of seeds (80) can be used as a rapid test for seed soundness (2). X-ray photographs do not normally measure seed viability but provide an examination of the inner structure for mechanical disturbance, absence of vital tissues, such as embryo or endosperm, insect infestation, cracked or broken seed coats, and shrinkage of interior tissues (Fig. 24).

Standard X-ray equipment is used to assess seeds. Dry seeds are exposed for 1/2 to 3 minutes at 15- to 20-kilovolt tube potential. Seed with dimensions less than 2 mm are too small to show details. Since X-rays do not injure the seed, further tests for viability can be conducted on the same batch (2). Prototype machines that provide fast, automatic, online sorting have been proposed (140). These procedures have the potential to remove nonviable seeds as well as seeds with morphological characteristics that are linked to poor vigor.



(a) (b) (c) (d)

Figure 23
Tetrazolium chloride (TZ) is used to test seed viability. Portions of the embryo will stain red (an indication of respiration) if they are viable. The seed analyst must determine if vital portions of the embryo are living, which would indicate positive germination potential. (a and b) A positive TZ corn seed test showing that the embryo and scutellum are viable while the white endosperm is non-living at maturity. (c and d) A poor TZ test in gasplant (Dictamnus). White embryos are non-viable and the embryo (d) although generally red-stained would probably be abnormal because the shoot area (arrow) did not stain.

(a) (b)

Figure 24
Examples of the X-ray tests for the 1999 (a) and 2005 (b) harvests of *Gaura biennis* capsules. Note the number of filled and empty (aborted) seeds in the capsules. Courtesy of the Ornamental Plant Germplasm Center, The Ohio State University.

BOX 4 GETTING MORE IN DEPTH ON THE SUBJECT
SEED VIGOR TESTS

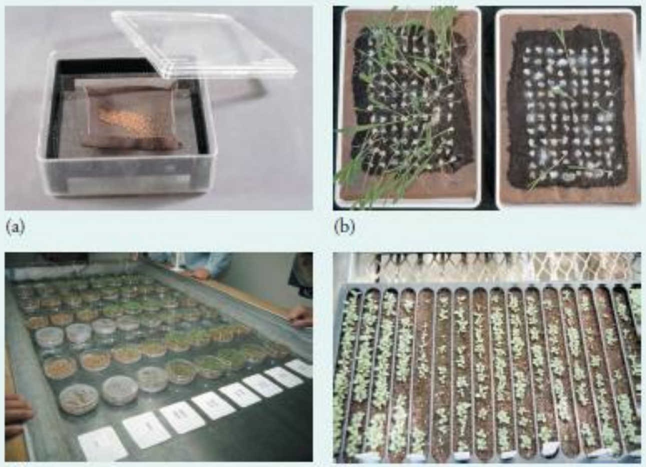
Details for procedures used to conduct vigor tests are found in the Association of Official Seed Analysts' handbook on seed vigor testing (7). The more commonly conducted vigor tests include (Fig. 28).

Aging Tests Controlled deterioration and accelerated aging (AA) are established vigor tests for agronomic, horticultural, and forestry species. Both tests are based on the premise that vigor is a measure of **seed deterioration.** Hampton and Coolbear (60) concluded that aging tests were the most promising vigor tests for most agronomic species. Both methods are described in detail in the AOSA vigor testing methods (59).

seed deterioration The loss of vigor and viability in a seed during storage.

Controlled deterioration (92) exposes seeds to high temperature (40 or 45°C) for a short duration (24 or 48 hours) after the moisture content has been raised to approximately 20 percent. Seed moisture is raised prior to exposure to high temperature and maintained by keeping seeds in sealed watertight packages. Germination is usually assessed as radicle emergence, but normal germination improves results in some cases.

Accelerated aging is similar to controlled deterioration but differs in the way seed moisture is increased and, therefore, modifies the duration of the test (133). It is a test commonly used for agronomic and vegetable seeds. Prior to a standard germination test, seeds are subjected to high temperatures (40 to 45°C) and high relative humidity (near 100 percent) for 2 to 5 days. This is done by suspending seeds on a stiff nylon frame suspended above water in specially designed boxes (Fig. 28a). This partially hydrates the seed without permitting radicle emergence. Higher-vigor seeds tolerate this stress better than



(a) (b) (c) (d)

Figure 28
Various seed vigor tests. (a) Impatiens seeds in accelerated aging boxes. The frame inside the box keeps seeds suspended above water or a solution of saturated salts. (b) Sweet corn seeds sprouting in the cold test. Seeds are placed on moist towels or Kimpack and covered with field soil. It is easy to see that the seed lot on the *left* has higher vigor (seedling emergence) compared with the seed lot on the *right*. (c) A thermal gradient table provides numerous temperatures to simultaneously test germination of a single seed lot, which is useful for determining seed vigor by evaluating germination at minimal and maximal temperatures. Breeders also use thermal gradient tables to evaluate a genotype's tendency for producing seed susceptible to thermodormancy (like lettuce). (d) For many horticultural crops, standard germination and seedling vigor is evaluated in a seedling grow-out test. The environment for this test is standard greenhouse conditions where the crop will be commercially grown.

(Continued)

low-vigor seeds, as shown by higher normal germination percentages in the standard germination test conducted after the aging treatment. For smaller-seeded species, like flower seeds, lower relative humidity is used to reduce rapid seed hydration. This variation is called the saturated salt accelerated aging test, because it uses saturated salts rather than water to control humidity in the accelerated aging boxes (150).

Cold Test (59) This is the preferred vigor test for corn seed (Fig. 28b). Seeds are planted in boxes, trays, or rolled towels that contain field soil and held at 10°C for 7 days before being moved to 25°C. The number of normal seedlings that emerge are counted after 4 days.

Cool Test This is a vigor test that uses procedures identical to the standard germination test, except the temperature is lowered to 18°C. A similar tool being used to evaluate vegetable and flower seed vigor is the thermal gradient table (Fig. 28c). This provides a range of temperatures by circulating warm and cold water to the table. This determines the range of germination for a seed lot. Higher vigor seeds germinate better at the extreme temperatures on the table.

Electrolyte Leakage Seeds tend to "leak" electrolytes when imbibed, and the amount of electrolyte leakage usually increases as seeds deteriorate. Electrical conductivity can be measured by using a conductivity meter. Conductivity measurements have been correlated with field emergence, especially in large-seeded crops like peas and corn (94).

Seedling Growth Seedling grow-out tests can be conducted under greenhouse or growth-chamber conditions, and vigor calculated based on seedling emergence and uniformity (Fig. 28d). An alternative to plug and flat germination includes evaluations like the slant-board test that uses similar conditions as the standard germination test for percentage germination. After a period of time at a controlled temperature (this varies between species), shoot and root length or seedling weight is determined (Fig. 29a). This permits a determination of strong versus weak seedlings in a seed lot. Measuring individual seedlings can be tedious, but advances in computer-aided image analysis offer an alternative to hand measurements (Fig. 29b) (71, 105). Ball Seeds Inc. (West Chicago, IL) has introduced the Ball Vigor Index that employs computer analysis of video images of seedlings in plug trays after a predetermined number of days. The index is suggestive of seedling greenhouse performance.

(a) (b)

Figure 29
(a) A slant-board test for lettuce. Seedling must be grown in an upright orientation to get straight seedlings. Radicle length is then measured by hand. (b) Computer-aided measurements of digital images of petunia from Petri dish germination.

(a) (b) (c)

Figure 34
Germplasm storage.
(a) Movable storage cabinets for seed storage. (b and c) Seed storage in liquid-nitrogen–filled dewers.

Figure 35
Various seed storage methods.
(a) Small, high value seeds in plastic containers. (b) Vegetable seeds stored in sealed cans. (c) Large-seeded vegetables in bulk storage in waxed boxes. (d) Conditioned storage for crop seeds. (e) Refrigerator storage for flower seeds.

1. **Open storage** without humidity or temperature control
2. Storage in **sealed containers** with or without temperature control
3. **Conditioned storage** with humidity and temperature control

Open Storage without Humidity or Temperature Control Many kinds of orthodox seeds need to be stored only from harvest until the next planting season. Under these conditions, seed longevity depends on the relative humidity and temperature of the storage atmosphere, the kind of seed, and its condition at the beginning

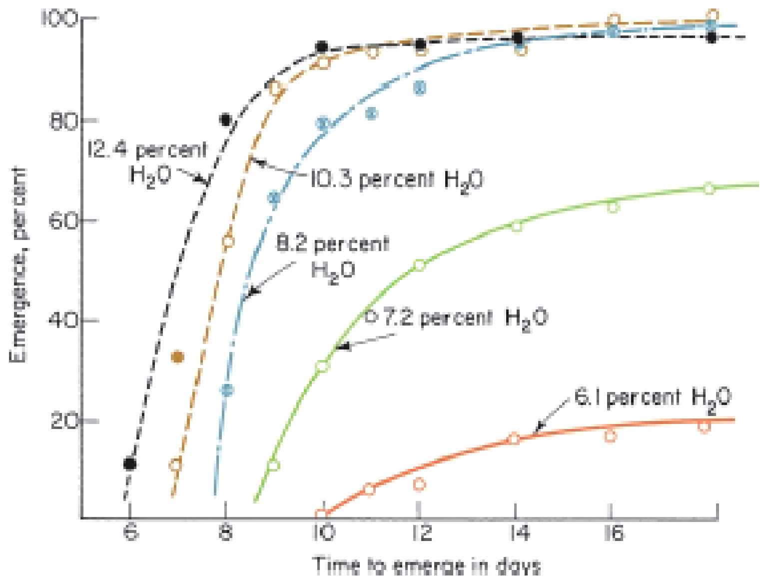


Figure 19
Effect of different amounts of available soil moisture on the germination (emergence) of 'Sweet Spanish' onion seed in Pachappa fine sandy loam. From Ayars, 1952.

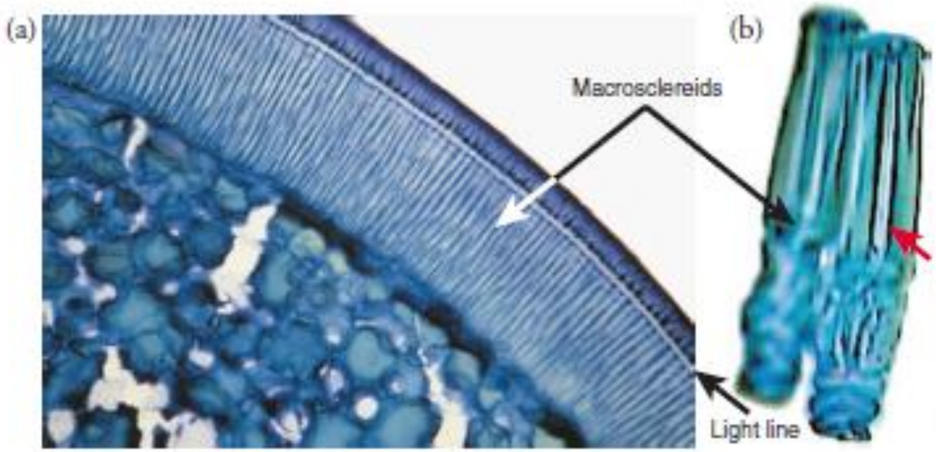


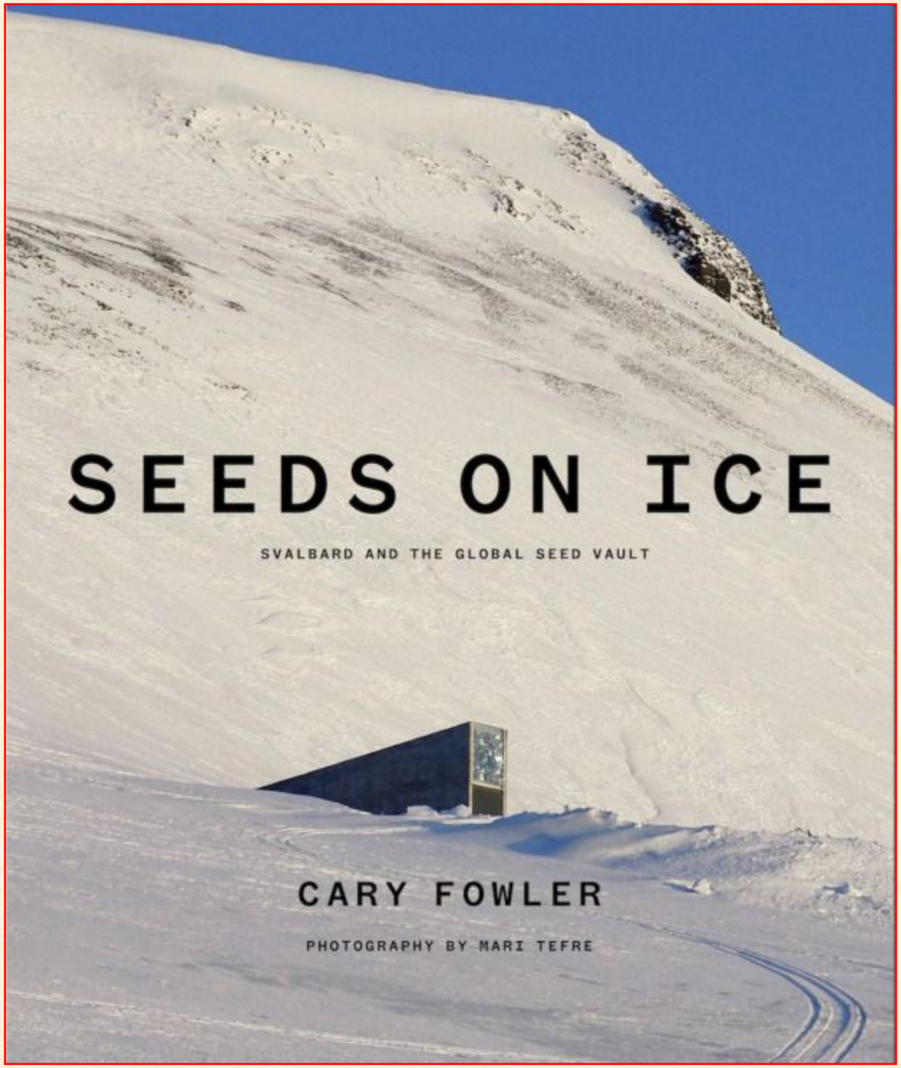
Figure 25
(a) Cross-section of a redbud (*Cercis canadensis*) seed showing the typical macrosclereid layer in the seed coat. Notice the light line that is the top half of each macrosclereid cell.
(b) Individual macrosclereid cells from a chemically digested seed coat. These cells show the interior lumen (red arrow) surrounded by the non-living thickened cell walls.

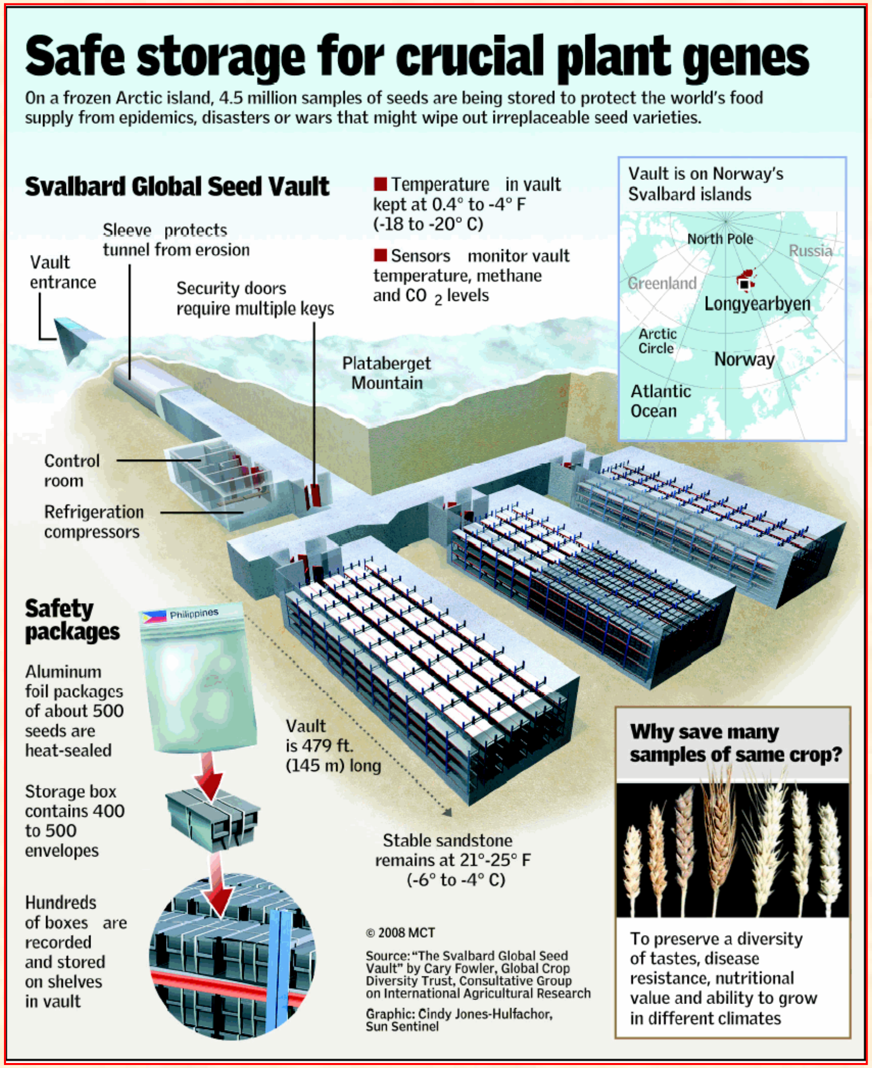
(a) (b)

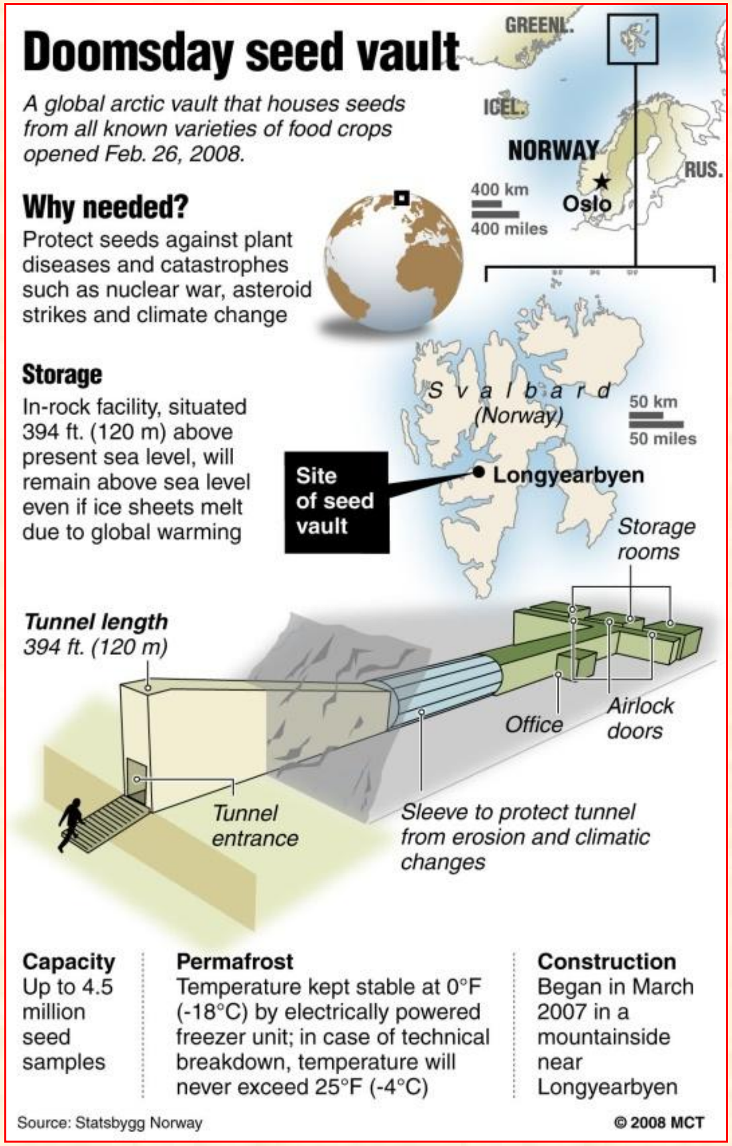
Figure 4
The inside of a vacuum seeder showing the rotating plate that picks up and delivers single seeds. This plate is for sowing spinach.

Svalbard Global Seed Vault - Noruega

(Silo Global de Sementes de Svalbard)






Doomsday seed vault
A global arctic vault that houses seeds from all known varieties of food crops opened Feb. 26, 2008.
GREENL.
ICEL.
NORWAY
RUS.
Oslo
400 km
400 miles
Why needed?
Protect seeds against plant diseases and catastrophes such as nuclear war, asteroid strikes and climate change
Storage
In-rock facility, situated 394 ft. (120 m) above present sea level, will remain above sea level even if ice sheets melt due to global warming
Svalbard (Norway)
50 km
50 miles
Site of seed vault
Longyearbyen
Storage rooms
Tunnel length 394 ft. (120 m)
Office
Airlock doors
Tunnel entrance
Sleeve to protect tunnel from erosion and climatic changes
Capacity
Up to 4.5 million seed samples
Permafrost
Temperature kept stable at 0°F (-18°C) by electrically powered freezer unit; in case of technical breakdown, temperature will never exceed 25°F (-4°C)
Construction
Began in March 2007 in a mountainside near Longyearbyen
Source: Statsbygg Norway
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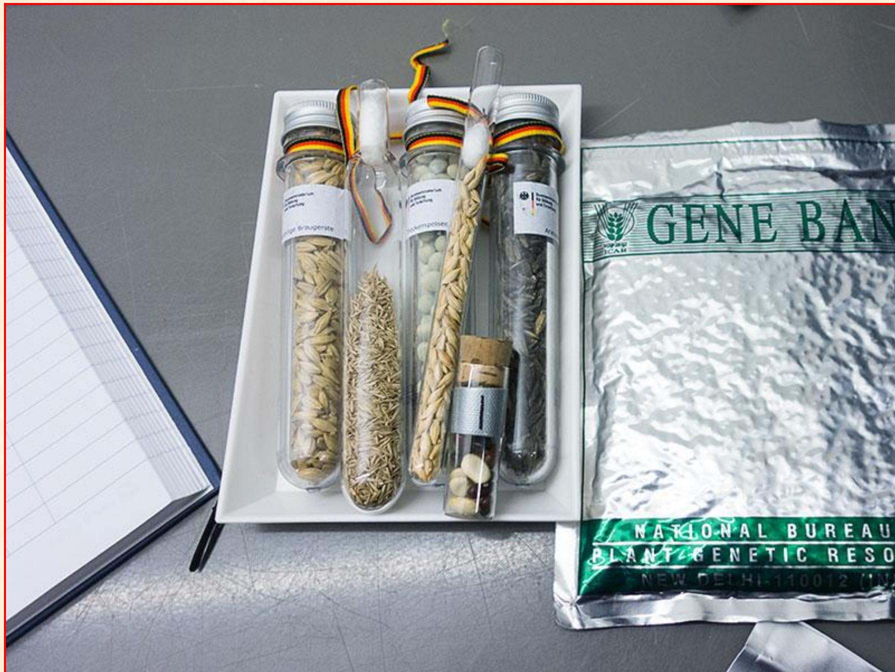
GENE BAN
NATIONAL BUREAU
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GENETIC RESOURCES
POTATO
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Rede nacional de recursos genéticos vegetais: parceria e modernização em prol da segurança alimentar no Brasil

Macroprograma 1: Grandes Desafios Nacionais
Projetos componentes:

- Rede nacional de recursos genéticos vegetais: parceria e modernização em prol da segurança alimentar no Brasil
- Bancos ativos de germoplasma de forrageiras
- Bancos Ativos de Germoplasma de Cereais
- Bancos Ativos de Germoplasma de Espécies Frutíferas
- Banco ativo de germoplasma de hortaliças e condimentares
- Embrapa investe na diversificação dos métodos de conservação de espécies industriais para garantir a integridade do material genético conservado
- Bancos Ativos de Germoplasma de espécies leguminosas, oleaginosas e fibrosas
- Bancos Ativos de Germoplasma de Espécies Florestais e Palmeiras