

# CULTIVATION OF CONTAINERIZED PLANTING STOCK



- **A technology known and used for centuries**
- **The technology has many advantages, but also many shortcomings**
- **The technology differs significantly from conventional technologies**
- **If the nursery is not adequately equipped:**
  - **Bad planting stock quality**
  - **High proportion of manual labour - high plant price**

# BASIC CLASSIFICATION OF CONTAINERIZED PLANTING STOCK

- According to the technology used to create the root ball

- Clod

- Packaged

- Containerized

- Seedlings

- Plants

- Large-size plants



- According to the container material



- Solid (not allowing the roots to penetrate)

- Allowing the roots to penetrate



- According to the handling method

- Single wrapper / pot (placed onto palettes)



- Container (can be placed onto palettes)





# CULTIVATION TECHNOLOGY FOR CONTAINERIZED SEEDLINGS

**SOWING IN A CONTAINER –  
AN ARTIFICIAL COVER  
(MAX. 1 YEAR)**

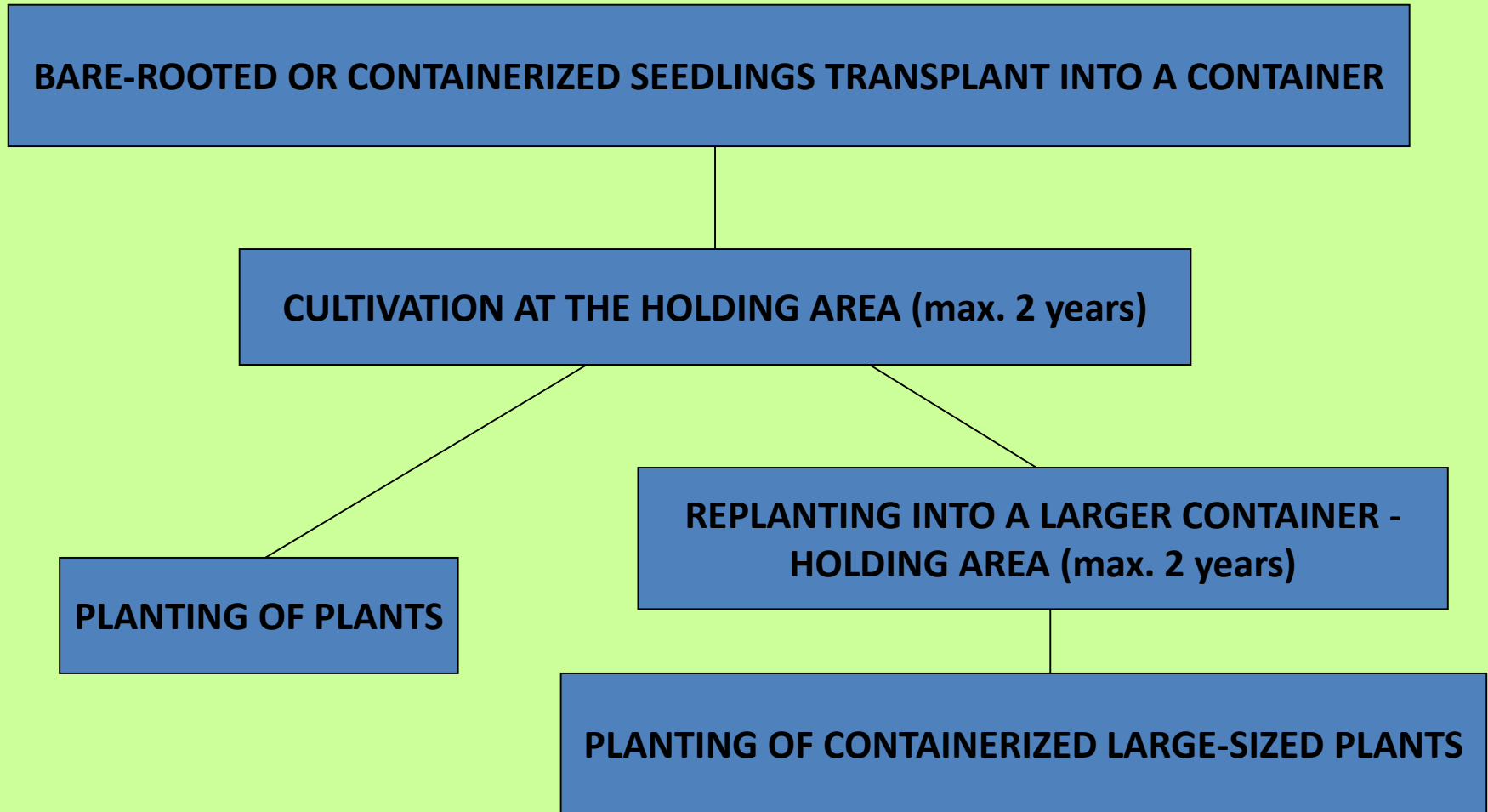
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graph LR; A[SOWING IN A CONTAINER – AN ARTIFICIAL COVER (MAX. 1 YEAR)] --> B["(HARDENING OFF)  
– HOLDING AREA (foil removal)  
– PLANTING OF SEEDLINGS"]; A --> C[TRANSPLATING INTO A SOIL  
– PLANTING OF BARE-ROOTED PLANTS]; A --> D["REPLANTING INTO A CONTAINER  
– HOLDING AREA  
– PLANTING OF CONTAINERIZED PLANTS"];
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**(HARDENING OFF)  
– HOLDING AREA (foil removal)  
– PLANTING OF SEEDLINGS**

**TRANSPLATING INTO A SOIL  
– PLANTING OF BARE-ROOTED PLANTS**

**REPLANTING INTO A CONTAINER  
– HOLDING AREA  
– PLANTING OF CONTAINERIZED PLANTS**

# CULTIVATION TECHNOLOGY FOR CONTAINERIZED PLANTS



# **REQUIREMENTS FOR NURSERY OPERATION**

- **Special sowing place**
- **Holding area**
- **The preparation of substrates**
- **Equipment for the filling and sowing of containers**
- **Equipment for planting into containers**
- **Production hall**

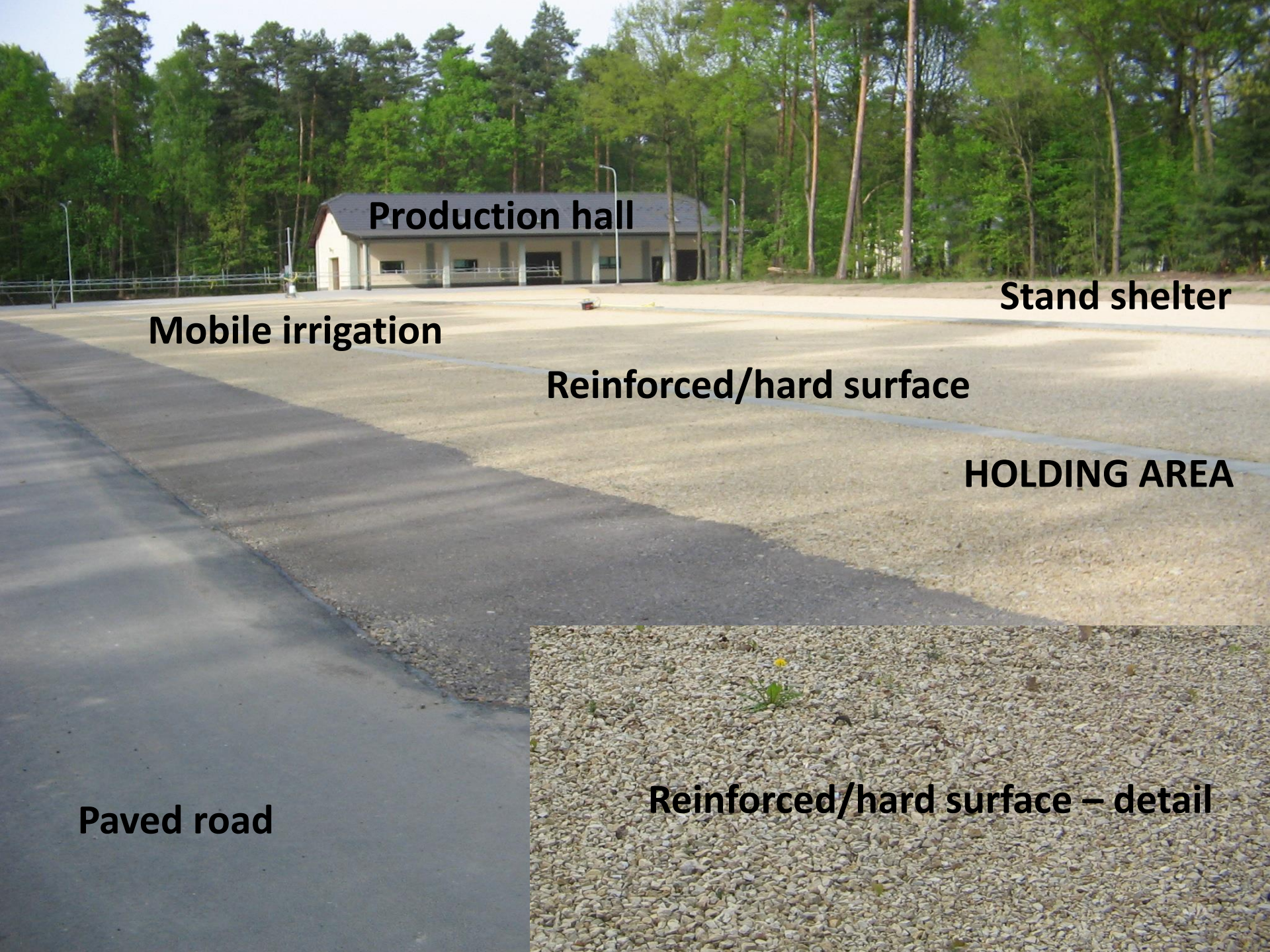
# **SPECIAL SOWING PLACE**

- **Containerized seedlings**
  - **Usually artificial covers**
- **Containerized plants**
  - **Bare-rooted or containerized seedlings are necessary**
  - **Can be bought**

# **HOLDING AREA**

- **Function**
  - **Seedling hardening-off**
  - **Cultivation of plants and large-sized plants**
- **As close to the production hall as possible**
- **Surface reinforcement (hard surface)**
  - **Broadcast - asphalt, concrete, debris**
  - **Paved roads + special foil**
- **Accessible even by heavy trucks**
- **Water must not stagnate, without weeds**
- **Protected against drying winds (barriers)**
- **Irrigation for the entire area**





**Production hall**

**Stand shelter**

**Mobile irrigation**

**Reinforced/hard surface**

**HOLDING AREA**

**Paved road**



**Reinforced/hard surface – detail**





**GREEN HOUSES**

**HOLDING AREA**





**IRRIGATION**

The image shows a long, curved hydroponic greenhouse with a white translucent covering. Inside, rows of green leafy plants are growing in a dark, gravel-filled bed. A silver metal irrigation system with multiple nozzles is positioned above the plants, spraying a fine mist of water. The system is supported by a series of vertical metal stakes. The background shows a line of trees under a cloudy sky.



**Holding area**



**Holding area surface – special foil**



**Drain**

**A sloped holding area surface**



**Holding area with mobile irrigation**





Holding area



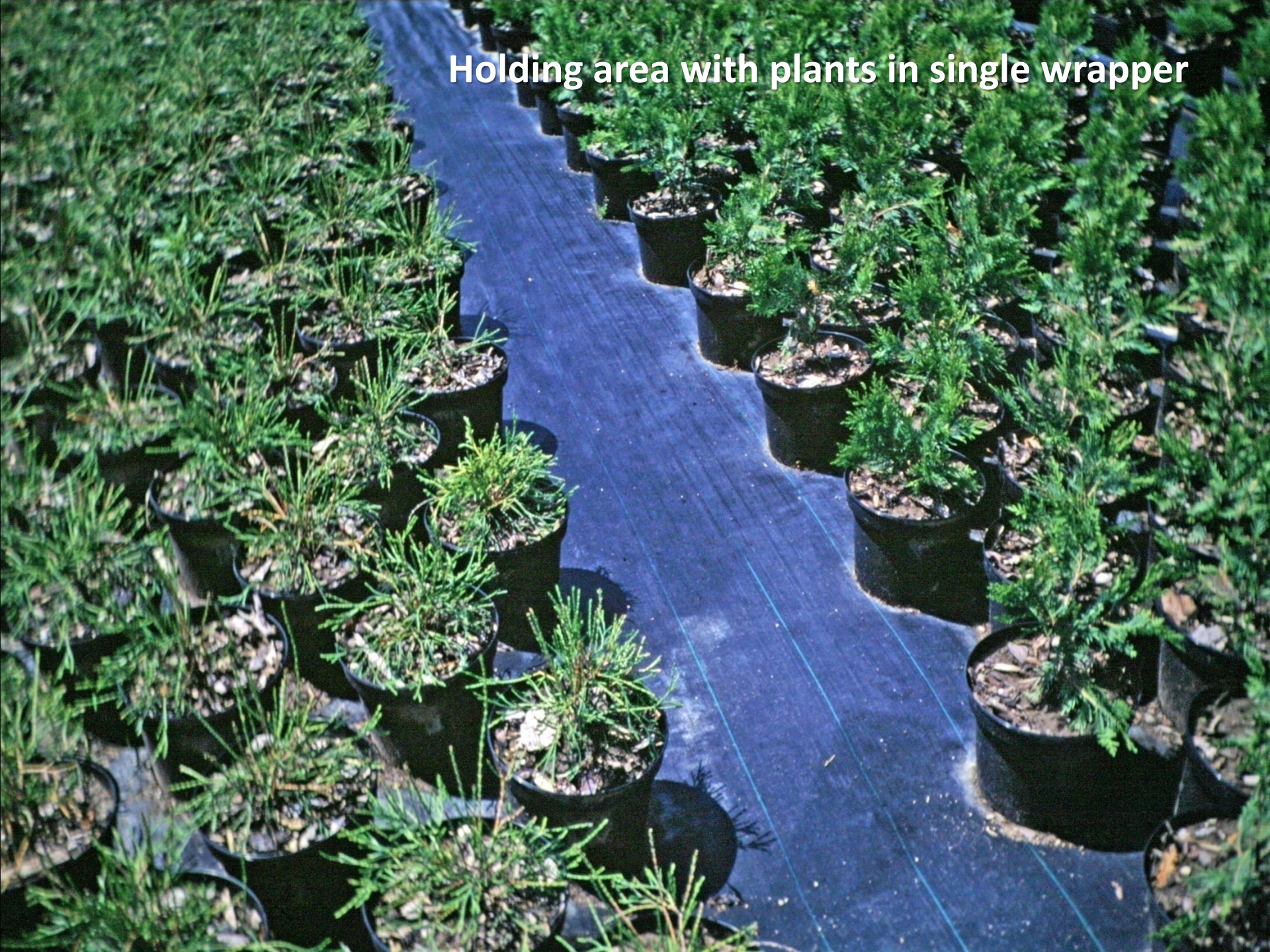


**A holding area with fixed irrigation**





Holding area with plants in single wrapper



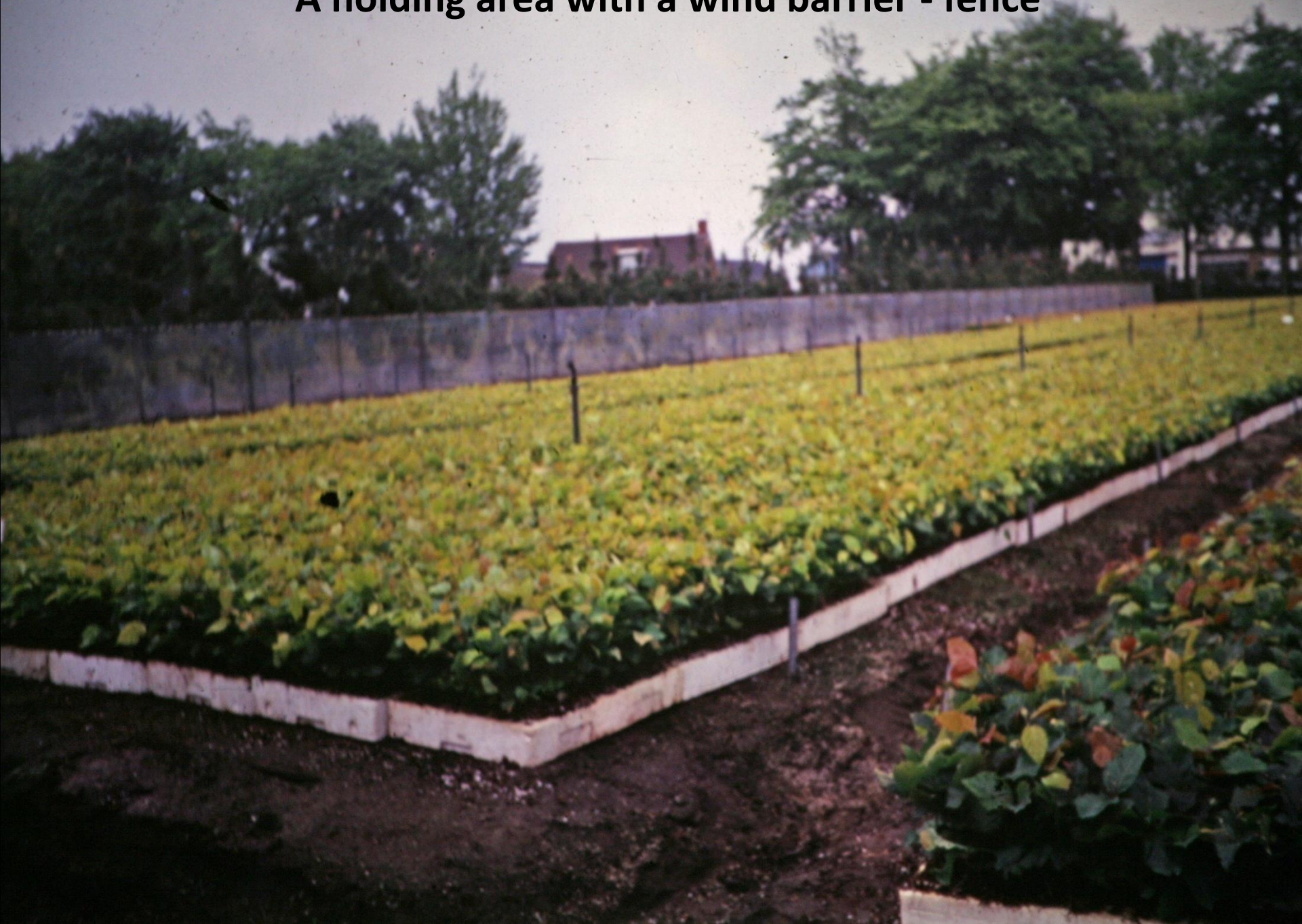


Holding area with plants in single wrapper in special boxes



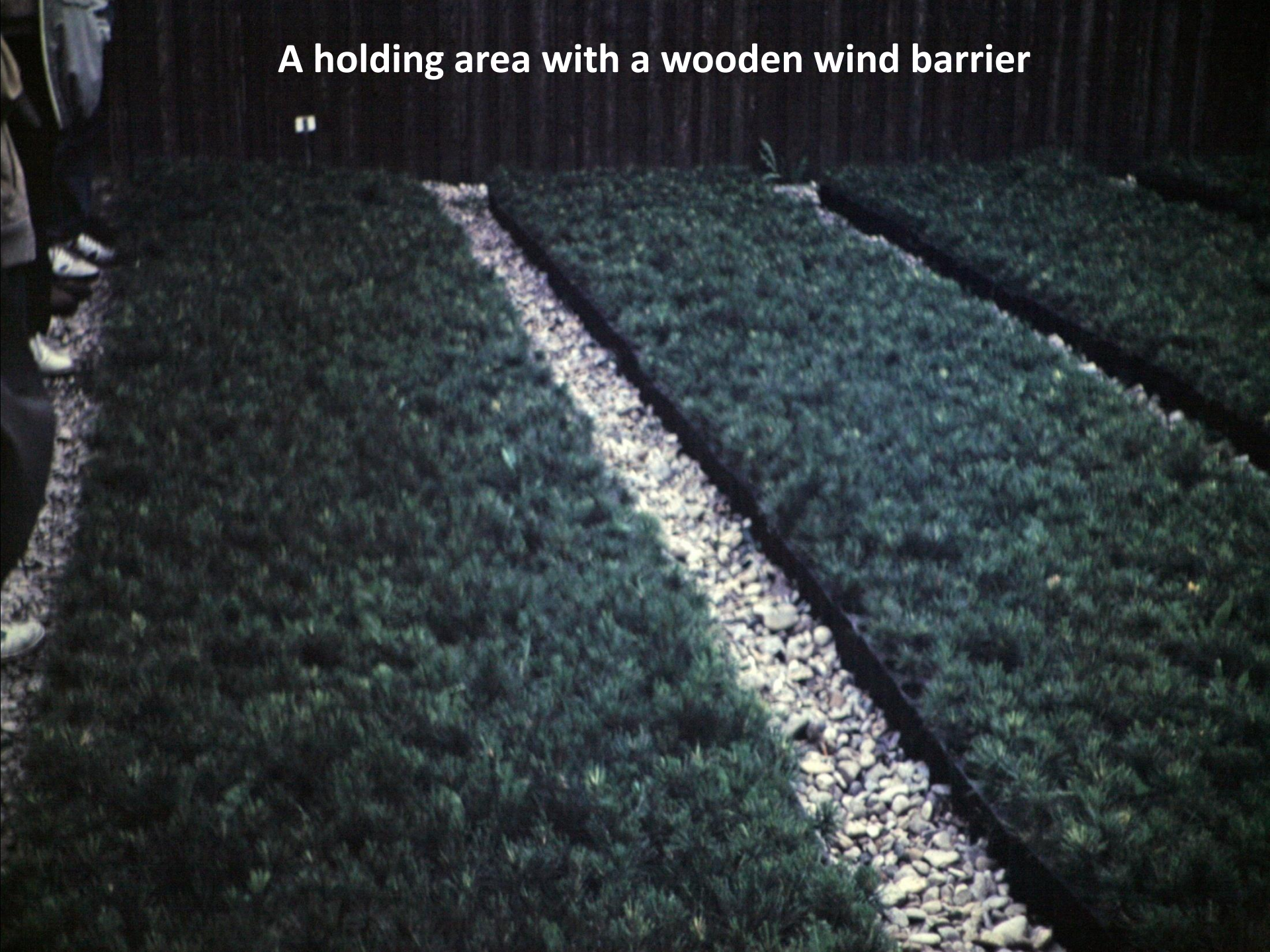


**A holding area with a wind barrier - fence**





**A holding area with a wooden wind barrier**





**A sloped holding area with fixed irrigation**





A holding area with stagnate water







**A paved path between two holding areas  
with the surface covered by a special foil**



An aerial view of a large nursery holding area. The ground is covered with a dark, sloped surface material, likely a special foil. Rows of young evergreen trees are planted in neat, parallel lines across the field. In the background, a paved road and some nursery equipment are visible.

A sloped holding area with the surface covered by a special foil



# HOLDING AREA

**Greenhouse**

**Mobile irrigation**





**A holding area covered by a forest stand,  
suitable for shade-loving firs**





# THE PREPARATION OF SUBSTRATES

- The purchase of finished substrates – not necessary (warehouses)
- The mixing of substrates
  - A reinforced place
  - Mixing equipment
- The production of substrates – composting place necessary
- As close to the production hall as possible
- Rational transport – conveyors

## Gramoflor substrate producer (Germany)





# LAFLORA (Latvia)



# REKYVA (Luthuania)







agro  
profi

agro  
profi

www.agroprofi.cz

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**KEKKILÄ**  
PROFESSIONAL

SUBSTRATE

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**Substrate mixed in a nursery**

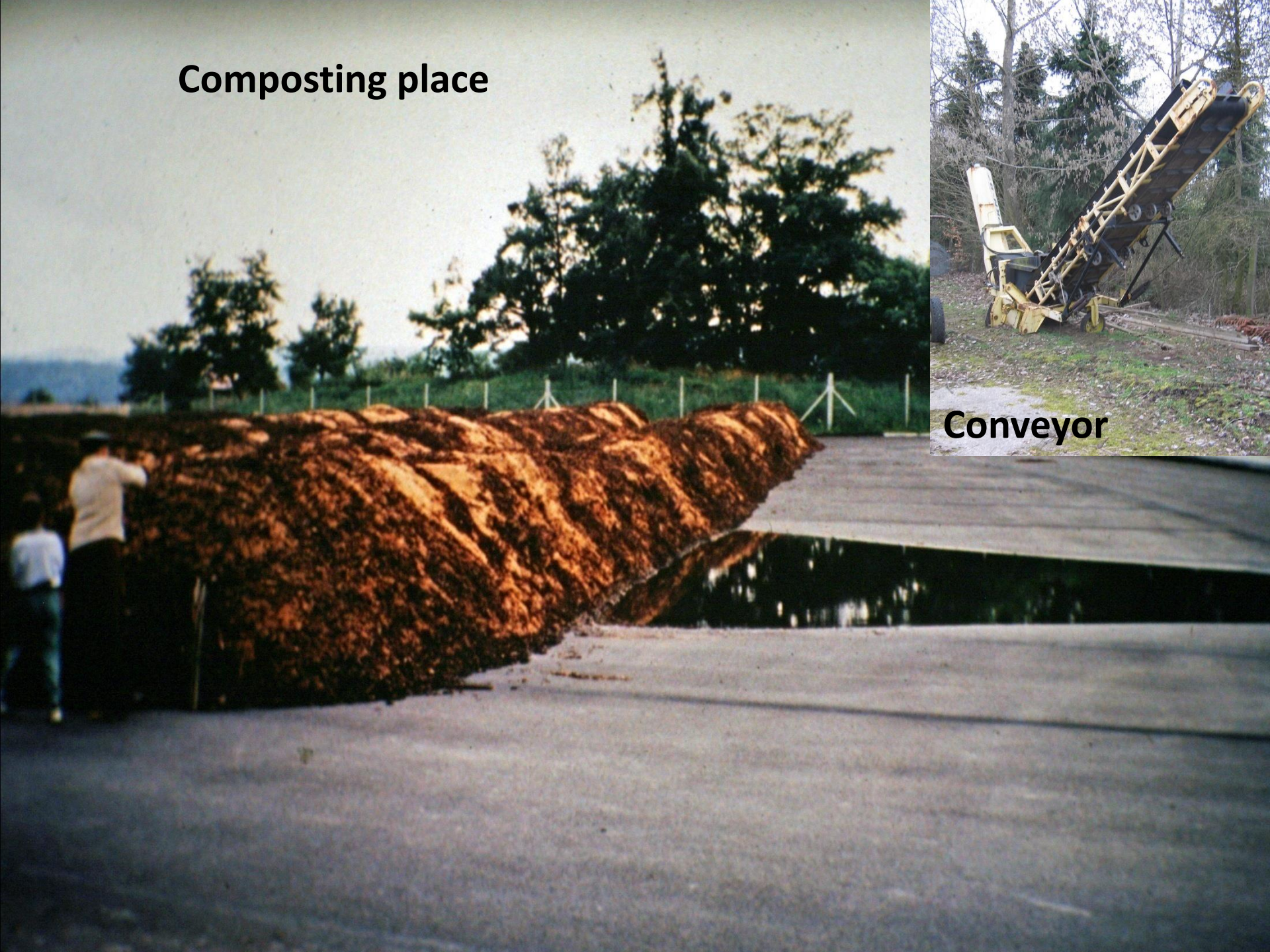


Substrates mixer





**Composting place**



**Conveyor**



**Band conveyor**











Plant the Planet

**Batch mixer**



# The filling of containers with a substrate

By machine



By hand





# **PRODUCTION HALL**



**Production hall**



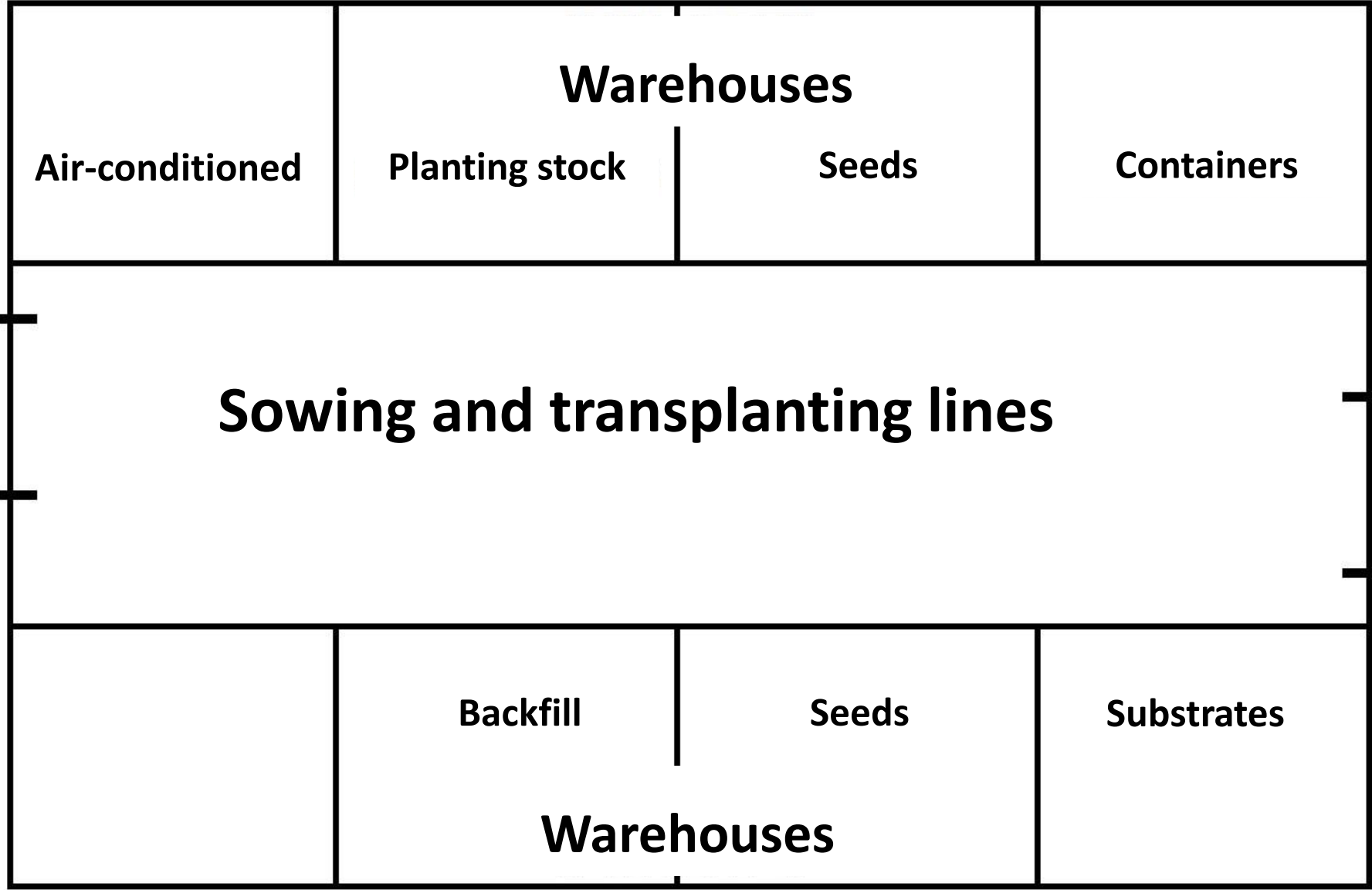




**Production hall**



# PRODUCTION HALL





# BIOLOGICAL PRECONDITIONS FOR CULTIVATION

- air temperature
  - optimum is 15-25°C, conifers up to 20°C
  - most sensitive Douglas-fir to needle formation
  - zero photosynthesis at 40°C and 0°C
- ground (substrate) temperature
  - optimum is 17-25°C
  - root growth from 5 to 30°C



# BIOLOGICAL PRECONDITIONS FOR CULTIVATION

- relative air humidity
  - optimum is 70-90%
  - photosynthesis stops below 50%
- CO<sub>2</sub> concentration
  - low in the atmosphere (330 ppm)
  - optimum is several times higher (spruce 5x, ash 10x)
  - but high illumination and CO<sub>2</sub> regulation is necessary (by irrigation, ventilation, heating, lightening, dimming, CO<sub>2</sub> supply)



## BIOLOGICAL PRECONDITIONS FOR CULTIVATION

- light intensity affects the weight and morphological structure of plants
  - low = tall plants
  - correct = strong plants with branches – optimum is 25-35 kilolux, but 10 is still enough
  - most of species in Central Europe – intensity a little lower than on a sunny day
- photoperiod duration – conifers grow continuously only during long days (spruce, larch, Douglas-fir – continuously; pine – cyclic growth)
  - lightening when sowing in winter
  - further growth is induced by prolonging the photoperiod, interrupting darkness
- spectral composition of light = 2 optimums 440 and 620 nm



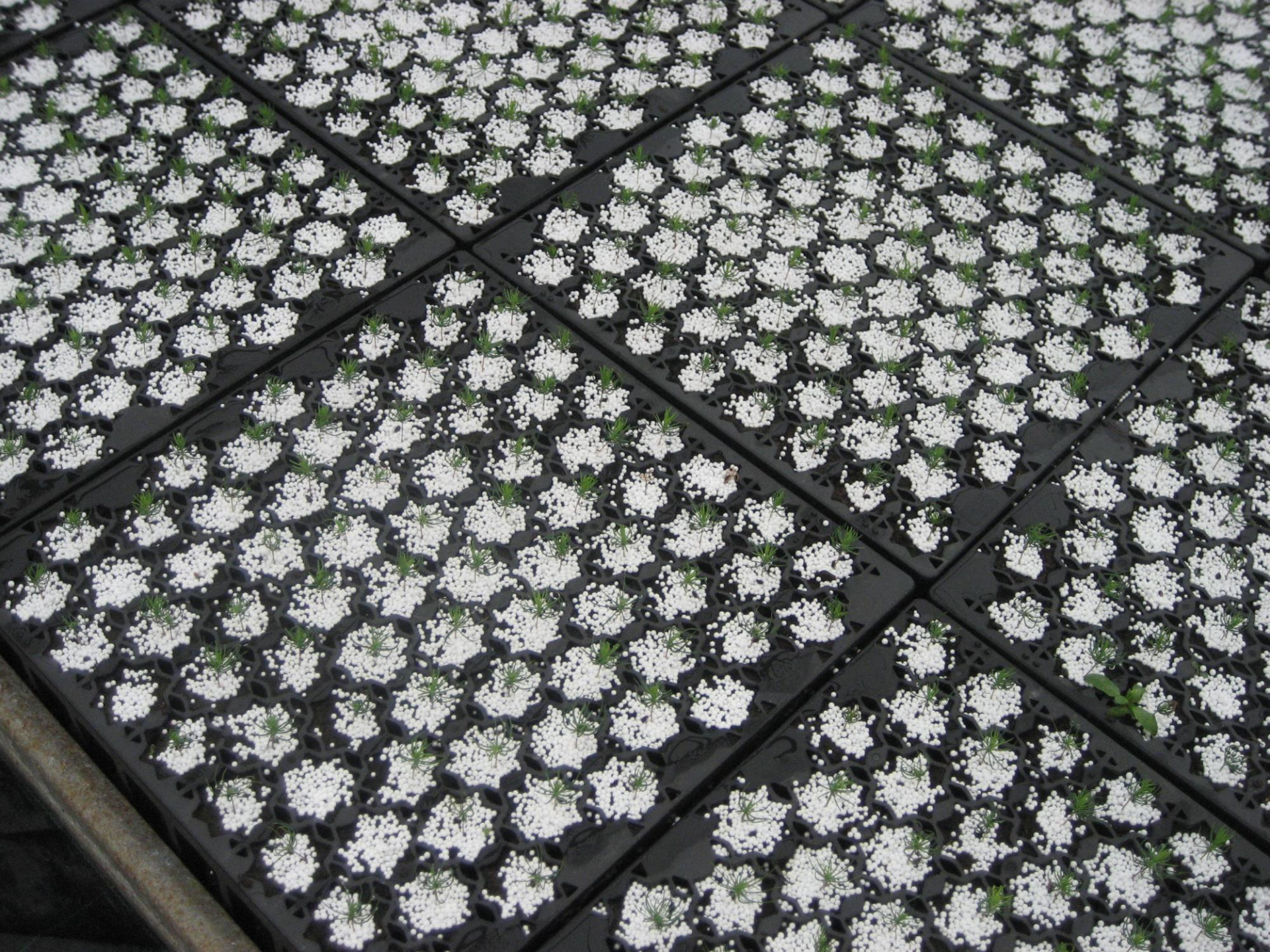
# **CULTIVATION OF CONTAINERIZED SEEDLINGS**

- **Sowing in winter**
  - **Heated plastic greenhouses**
  - **Air-conditioned warehouse**
- **Sowing during the vegetation period**
  - **Plastic greenhouse and air-conditioned warehouse**
- **100% germination capacity, 100% purity**
  - **Sowing of 1 seed**
  - **Sowing of multiple seeds – a need to single seedlings**
  - **At least 95% of the sown containers in a holding area**
  - **Backfill – sand, perlite**



- **Small seeds not germinated – mechanized sowing**
- **Large seeds germinated – manual sowing, no backfill**
- **Substrate compaction**
  - **Not using any vibration, if possible**
  - **Substrate volume = up to 130% of the container volume**
- **Seed in the centre of the cell – no deformation of the root system**
- **Sowing lines**
  - **Automatic and manual**















































# Sowing into containers

**By hand**



**By a mechanical precision seeder**





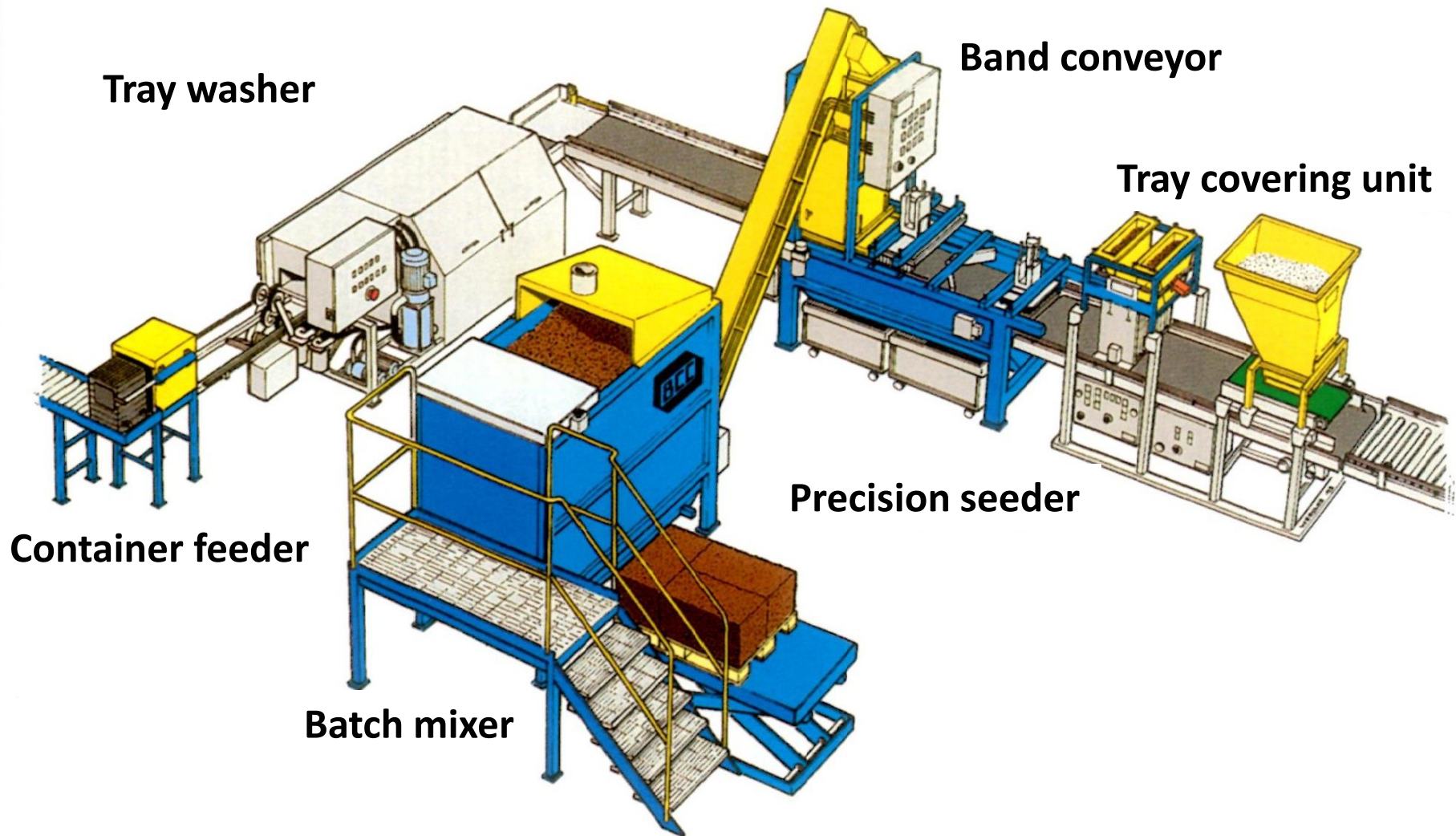
# Covering seeds



**A tray covering unit**

























# TREATMENT

- no loosening, no weeding (only germinating weeds), the application of herbicides
- the entire treatment is focused on maintaining the hydrothermal regime of air and soil
- regulation of all factors required (air 15-22.5°C, soil 17-25°C, RH over 70%, substrate humidity over 60%)
- ventilation = door opening (short greenhouses only), foil stripping, cover opening, ventilator
- beware of bird damage (a net)
- irrigation
  - additional 40-50 m<sup>3</sup>/ha/day
  - purposeful +30% (against frosts, pesticide and fertilizer application)
  - seedlings 60-80%
- intensity 2, 3 mm/h
- interval as needed



# MOVING SEEDLINGS TO A HOLDING AREA (FOIL REMOVAL) - HARDENING-OFF

- the effect of the foil changes during the vegetation period
  - positive until the end of May
  - indifferent until mid-August
  - harmful after mid-August (change of physiological processes)
- late hardening-off = mortality in culture
- gradual transition = after opening cover, under rainy and windless conditions
- when = sum of temperatures (3 times a day) = 1000°C
- after removal, the foil must be cleaned and dried



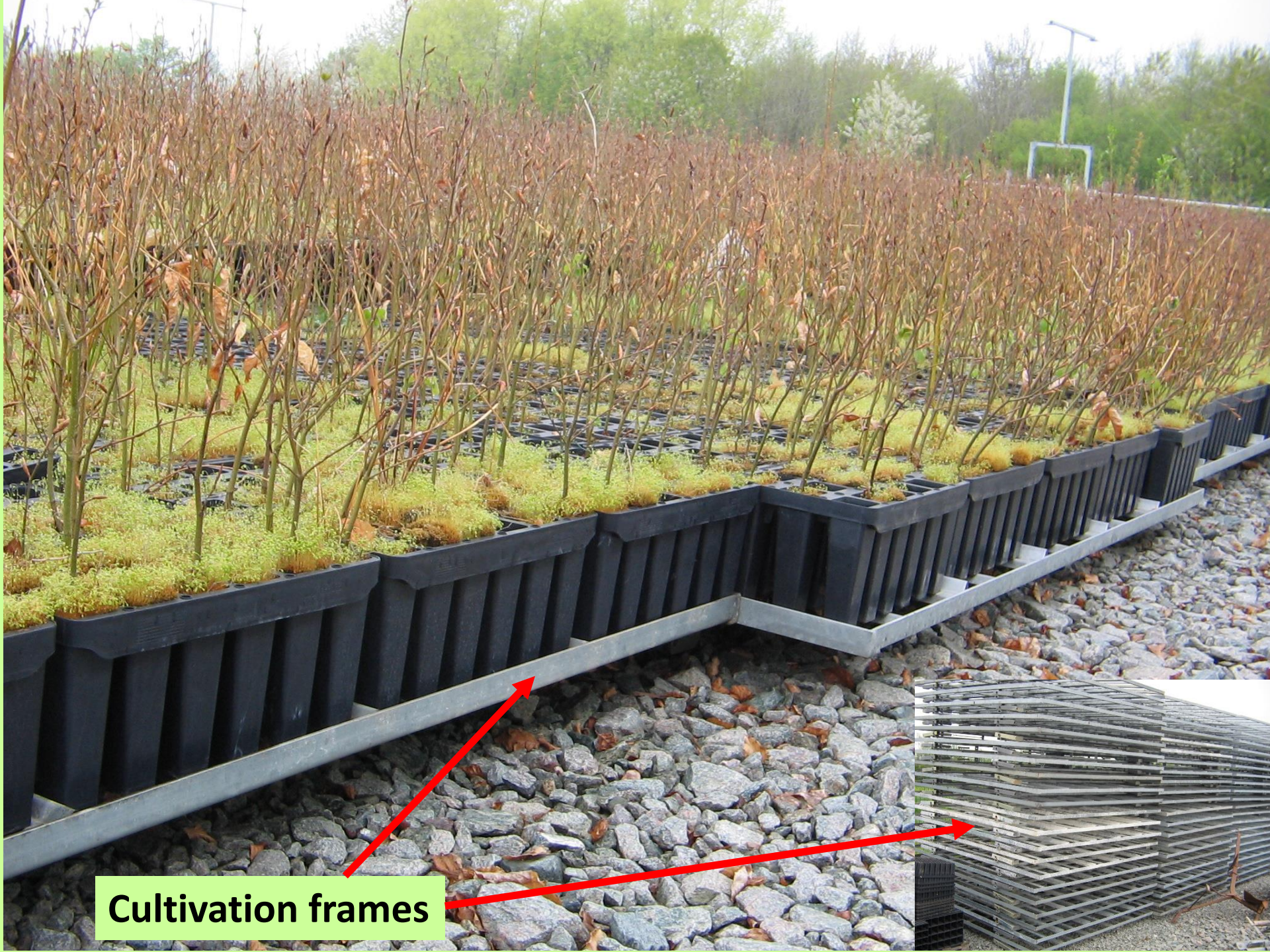
## **FURTHER CARE AT THE HOLDING AREA**

- similar to mineral soil
- irrigation in case of insufficient precipitation
- fertilize with phosphate and potassium fertilizers at the end of the vegetation period (fertilize with nitrogen until mid-July)
- possibility of accelerating dormancy (chemically)









**Cultivation frames**

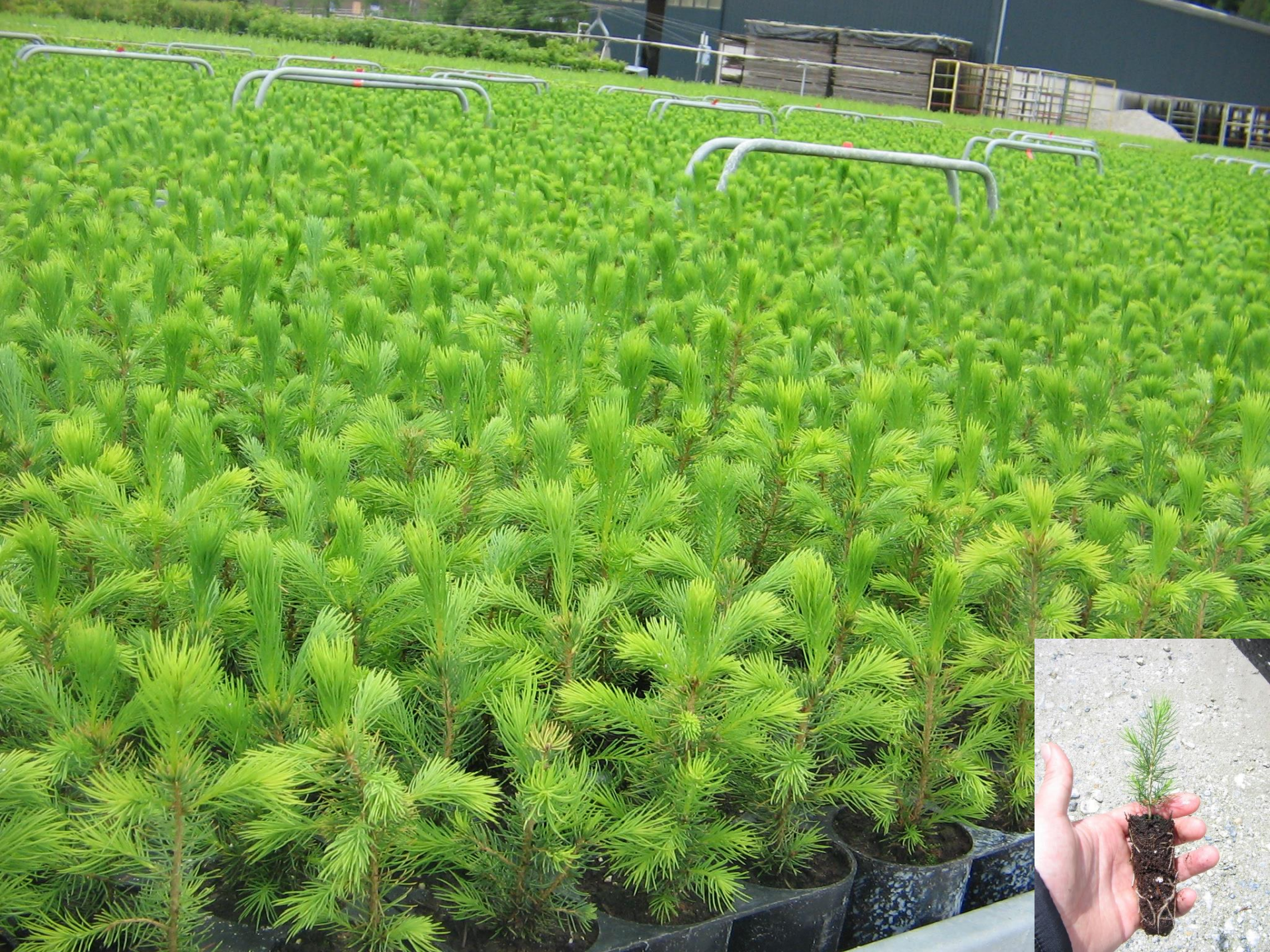
















**Side cover of containers  
on paths in a holding area**





**After sowing, the containers can be stored in the holding area (broadleaves with large seeds) – covering the sowing (birds, sunlight, temperature fluctuations...)**





## GENERAL PRINCIPLES OF CONTAINERIZED PLANTING STOCK CULTIVATION

- seedlings are grown under covers, in greenhouses
- (trans)plants are grown in the open-air holding area
- containers can be sown all year
- plants are planted into containers so they are not damaged and take root until frost arrives (with air-conditioned storage even in winter)
- when planting, avoid deforming the root system (all technologies deform the roots if not used correctly)
- prevent roots from penetrating into neighbouring cells and subsoil



## GENERAL PRINCIPLES OF CONTAINERIZED PLANTING STOCK CULTIVATION

- if the substrate is fertilized (before cultivation with full fertilizers), do not fertilize
- if possible, do not weed – damages plants
- maintain the same shape and size of the root ball until planting
- plant cultivation time (from rooting to 3 years; broadleaves, pine and larch 1 year old seedlings; spruce, Douglas-fir 2 years old plants and fir 3 years old plants)
- treatment of plants and containers until planting – especially irrigation – optimal!
- container disinfection (hot water is enough)



# **CONTAINER PLANTING – PRODUCTION OF CONTAINERIZED PLANTS**

- **In winter**
  - **Air-conditioned warehouse**
  - **Holding area – covered with snow (larch, broadleaves)**
- **The most suitable period**
  - **Beginning of root system growth**
  - **At any time for containerized seedlings after hardening-off**
- **Bare-rooted seedlings must take root until the start of winter**



- **Do not use plant not fulfilling standard/norm!!!**
- **Root system deformation must be avoided**
- **No overfertilized substrate – inhibition of root system growth**
- **The root system must not dry**
  - **Air-conditioned space max. +12°C**
- **Transplanting machines**
  - **Improve work hygiene**
  - **Do not improve the economics**



# Transplanting machine





# Transplanting machine













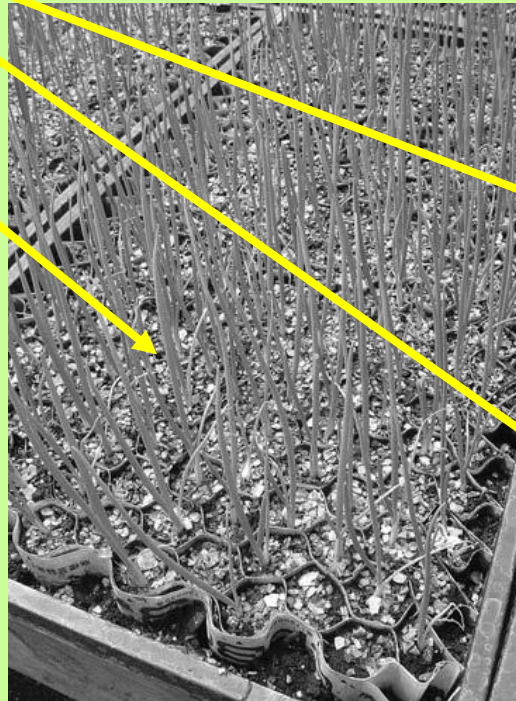
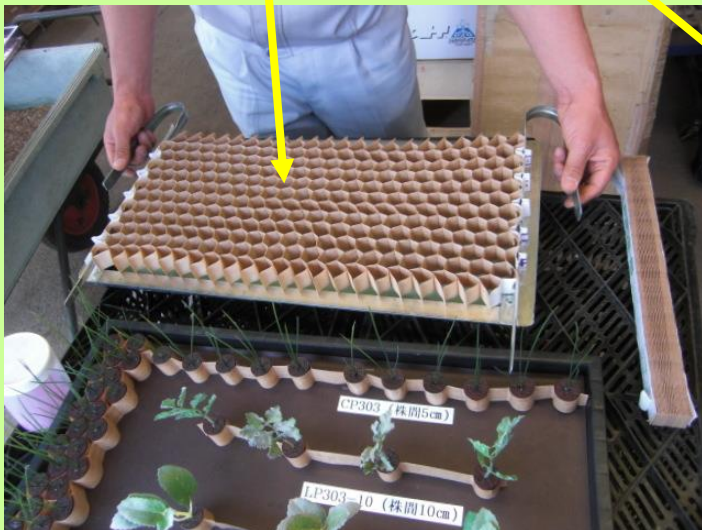
# **NOTES FOR WRAPPERS**

- **Must conform to standard (ČSN 48 2115)**
- **In CZ - only wrappers from the Catalogue of Authorised Containers can be used (Forestry and Game Management Research Institute)**
- **Colour – brighter is better**
- **Distance of plants such that the above-ground part is not deformed and irrigable**
- **Solid wrappers – frost, sun shorten their life**
- **Disinfection**
  - **Fungicide solutions**
  - **Hot water**
  - **Cold water pressure**



# Wrappers

- **Biodegradable and root-penetrable** pots or containers (Paperpot, Jiffy, peat pot)





# Wrappers

- Non-biodegradable and root-impenetrable pots





# Wrappers

- Non-biodegradable and root-impenetrable containers

HIKO



Styroblock



Quick pot



# Root deformation prevention

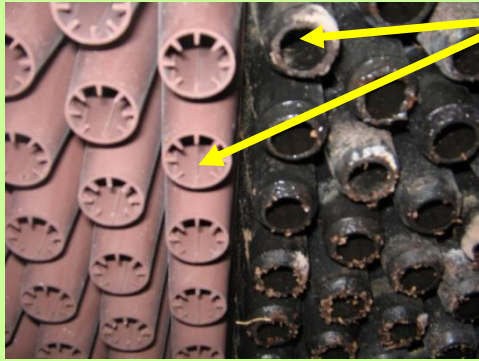
Without any root deformation



Root deformation



- Air cutting
- Guide ribs





Tray washer





