Establishing a Sustainable Seedling Supply:

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WASHINGTON STATE DEPT OF NATURAL RESOURCES

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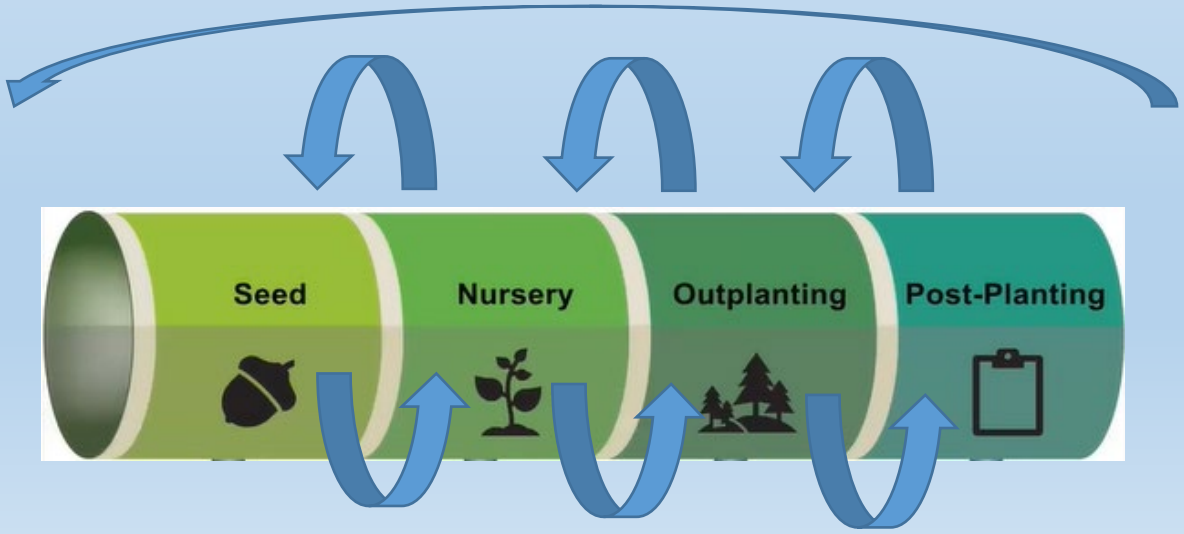
Outline

- Part 1: How nurseries can improve seed use efficiency
- Part 2: How nurseries can recruit and retain their workforce
- Part 3: How nurseries can strengthen end-user partnerships



Part 1: How nurseries can improve seed use efficiency

WADNR Webster Forest Nursery

70% Douglas-fir seedlings

2-3 million plugs/year

6 million bareroot/year

Additional spp.:
W redcedar
W hemlock
W larch
Ponderosa pine
Interior DF
True firs
W white pine
Lodgepole pine
Sitka spruce
Red alder

Nursery adjacent to Seed Center

Cold storage

$9MM seed inventory

Seed processing and lab testing

Space efficiency vs. seed use efficiency

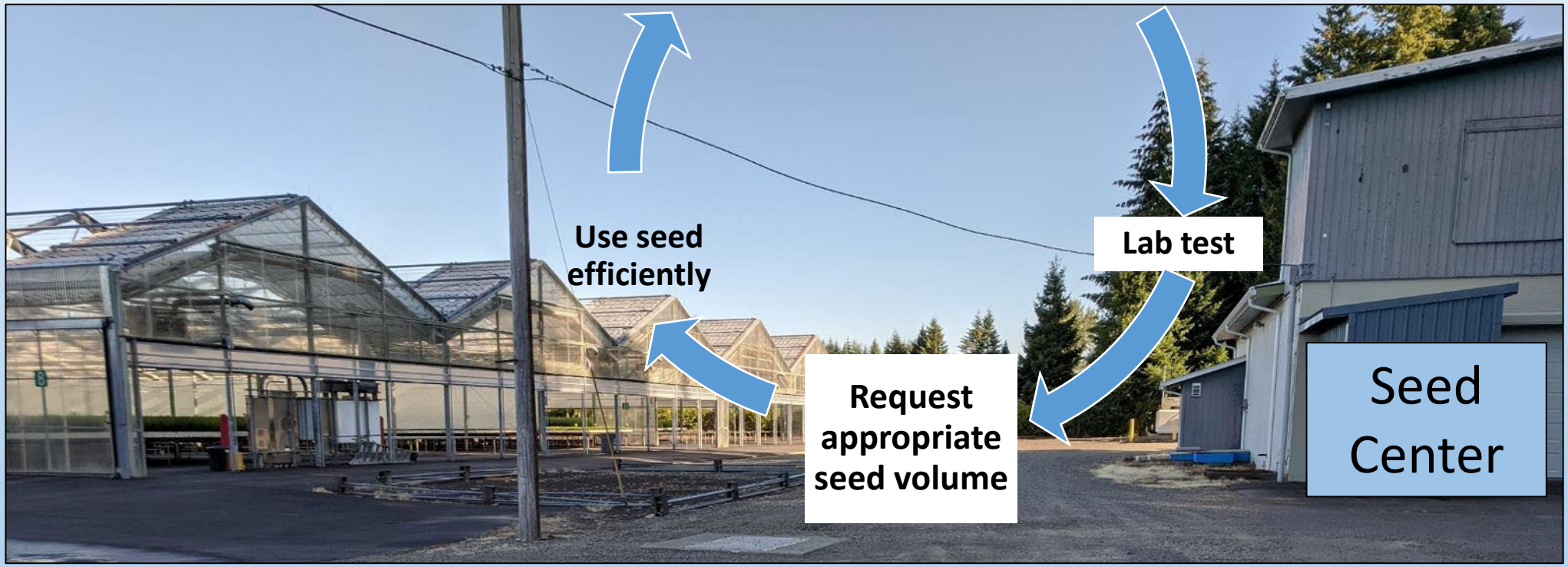
Greenhouse space is expensive…

...but so is this!

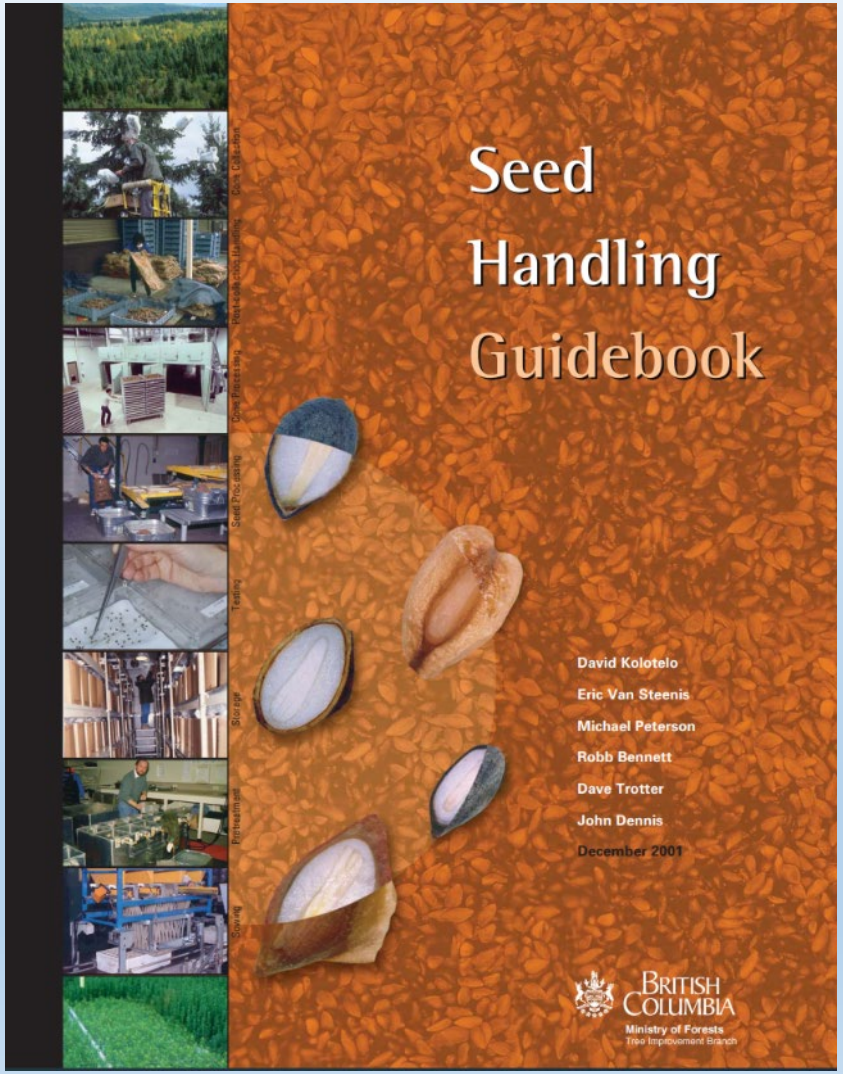
Proximity facilitates exchange of ideas

We need high germ, clean seed!

We need the nursery to use seed efficiently!



Sowing guidelines in nurseries



Kolotelo, D. et al. 2001
BC Ministry of Forests

Tech updates in Tree Seed Working Group Newsbulletin (Canadian Forest Genetics Association)

Why does grower ask for x # of seeds over request?

Germ %	Sowing factor	Empty cavities	Nursery handling factor	Oversow factor (# extra cavities to sow)	Seeds per seedling
90	2.0	1.0	20%	127%	**2.78**

Fractional sowing?

How valuable is space?

How precise is sow line at placing correct # seeds/cell?

Skill of grower/species challenge to meet specs?

How accurate is germ test, falldown from lab to greenhouse?

13% rule: For every 13% drop in germination capacity, expect a grower to request roughly 1 additional seed per cell

Germination %	Sowing factor (seeds/cell)
90	2.0
77	3.0
64	4.0

How can we reduce the number of seeds used per seedling produced?

- Determine lab vs. nursery germination values
- Apply germination techniques
- Invest in sowing line upgrades
- Value the importance of growers

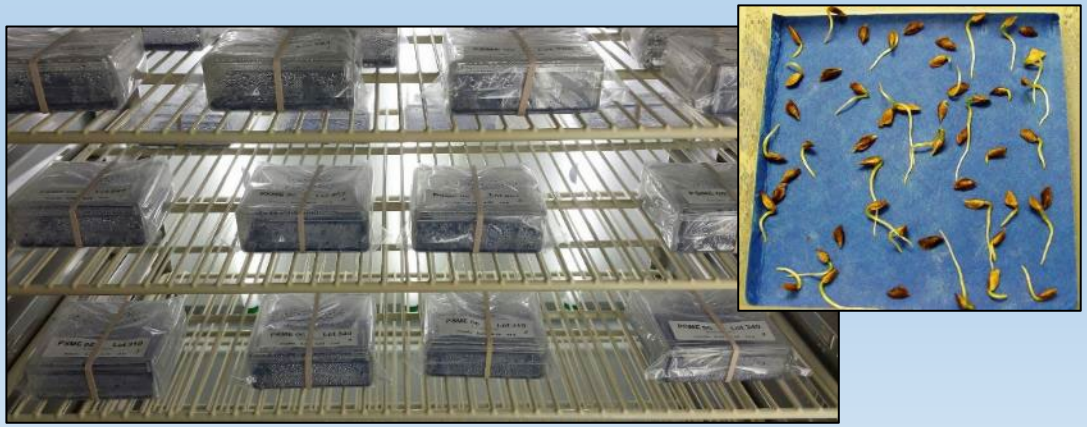
Why do lab and greenhouse germ results differ?

Lab testing

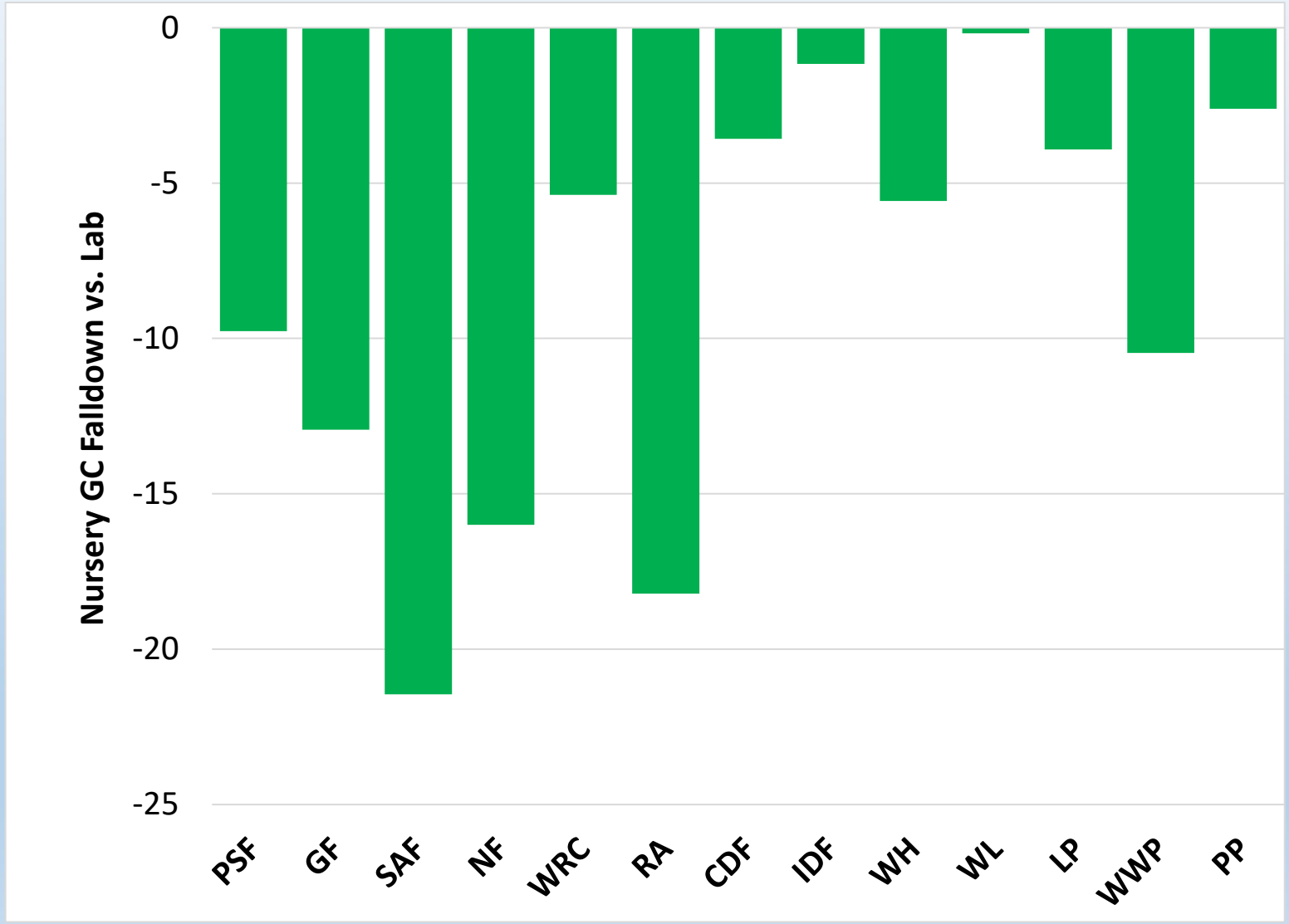
- Controlled environment
  - 8hr/16 hr day/night, 86°F/68°F
  - Only seedborne pathogens
  - Germination: radicle extension 4x length of coat
  - 4 reps of 100 seed

Greenhouse evaluation

- Semi-controlled environment
  - Temperature and irrigation variation
  - Additional pest pressures
  - Germination called later
  - Media, seed depth can vary
  - Variability in tracking



Nursery germ capacity usually lower than lab



Kolotelo 2021

Methods to improve operational germination

- Seed sanitation
- Targeted moisture content
- Extended stratification
- Delayed dryback
- Mid-strat high-grading
- Thermal priming

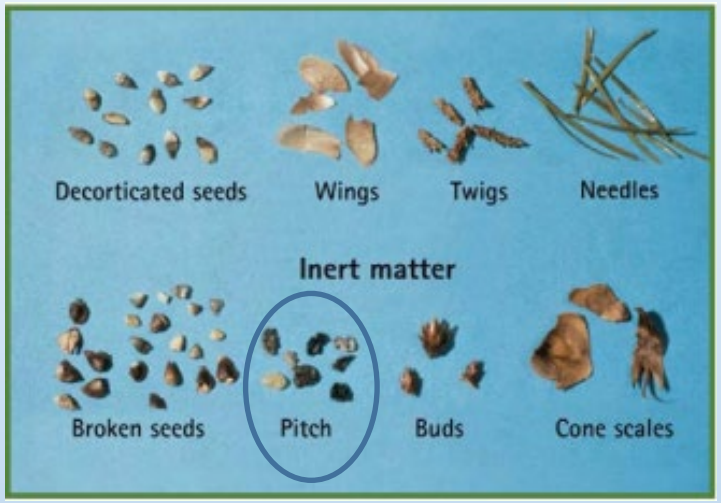
Surface drying

High-grading

Thermal priming

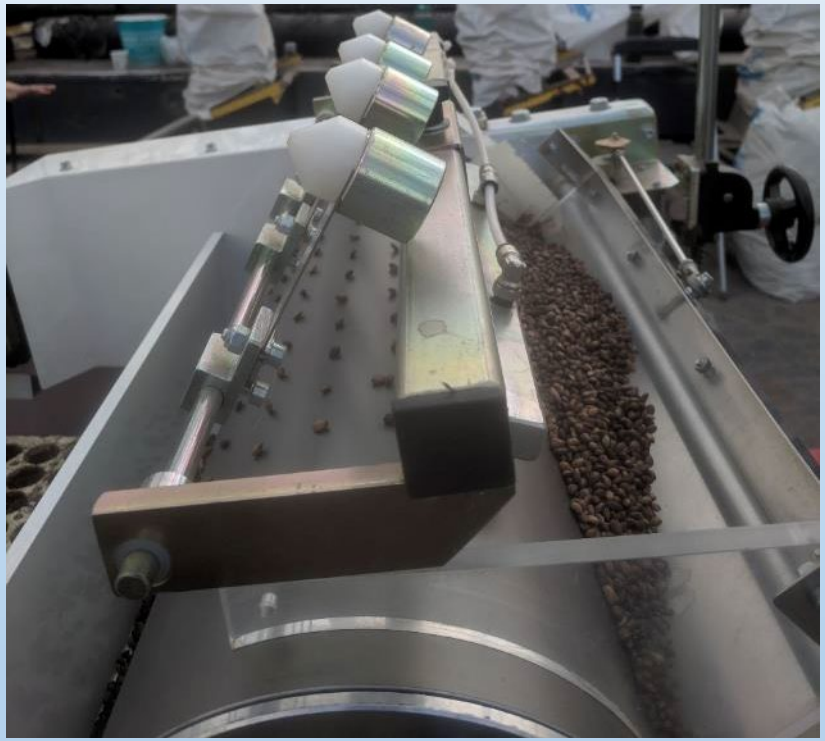
As value of seed increases, so should sowing equipment

B&L needle seeder



Clean seed particularly important for automated sowing

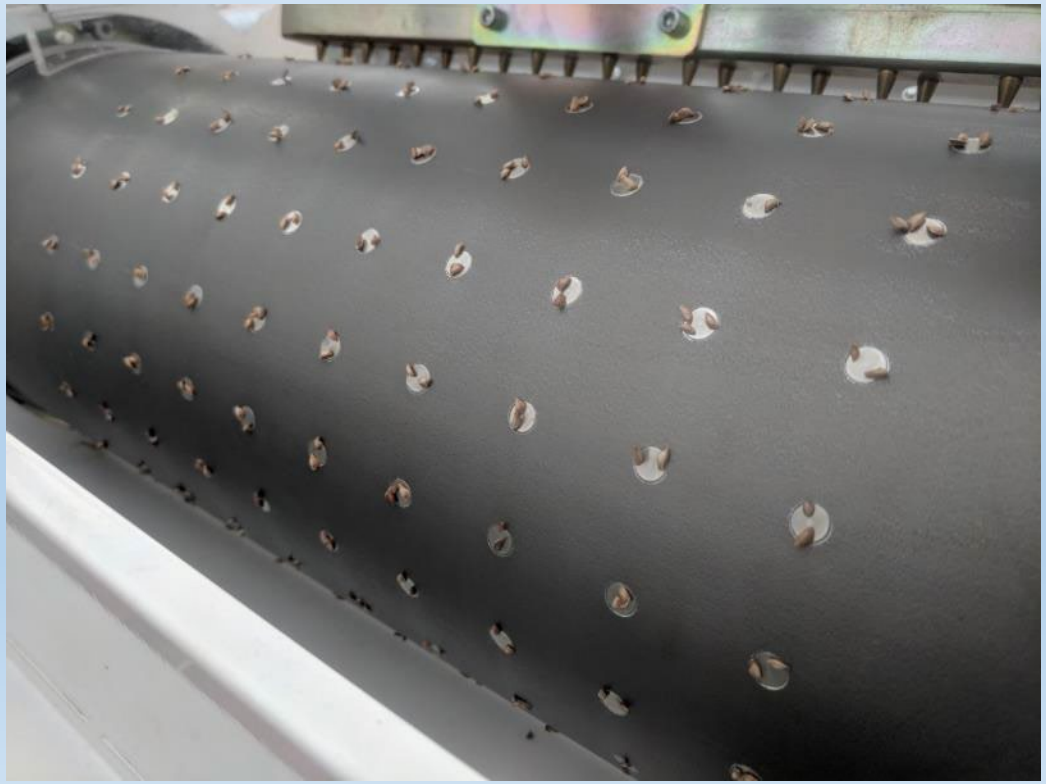
Experienced and skilled operator for advanced equipment

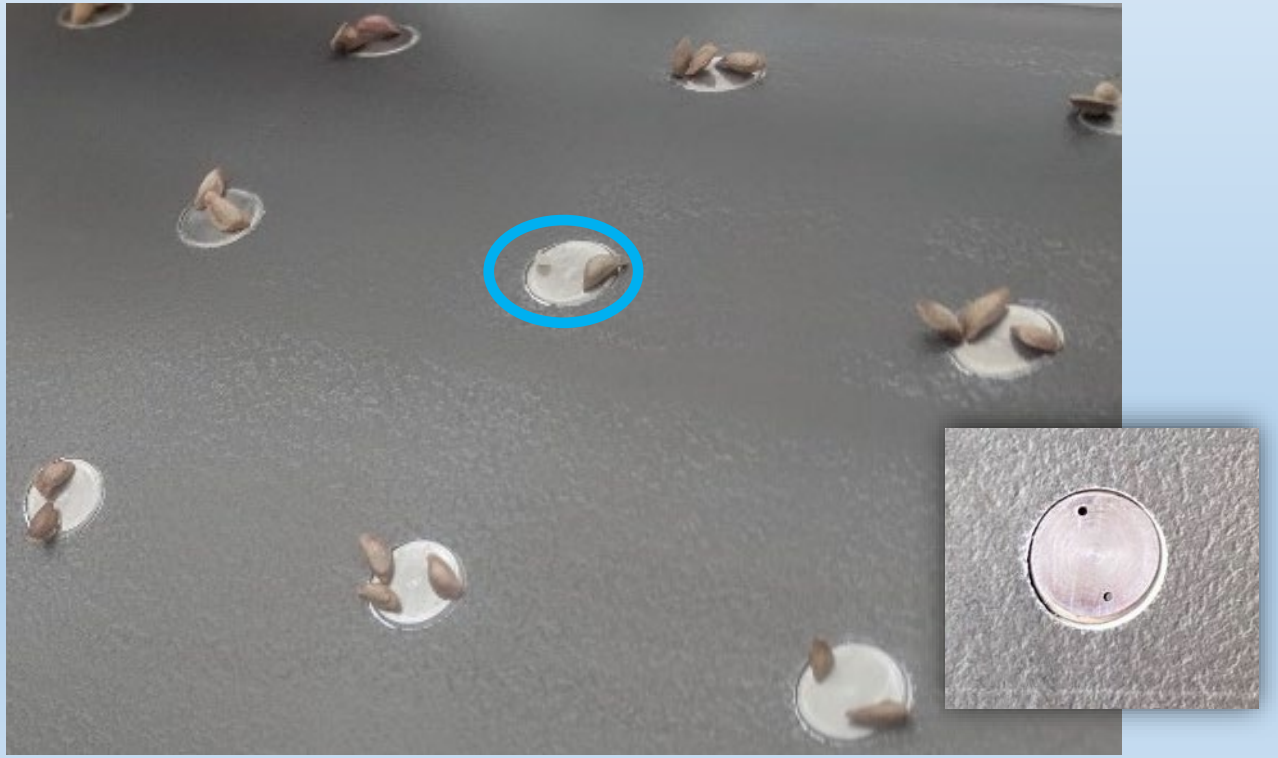


Mosa drum seeder

Many strategies for how a lot may be sown

- Some will conserve space (increase seeds/cell)
- Some will conserve seed (single or fractional sowing)





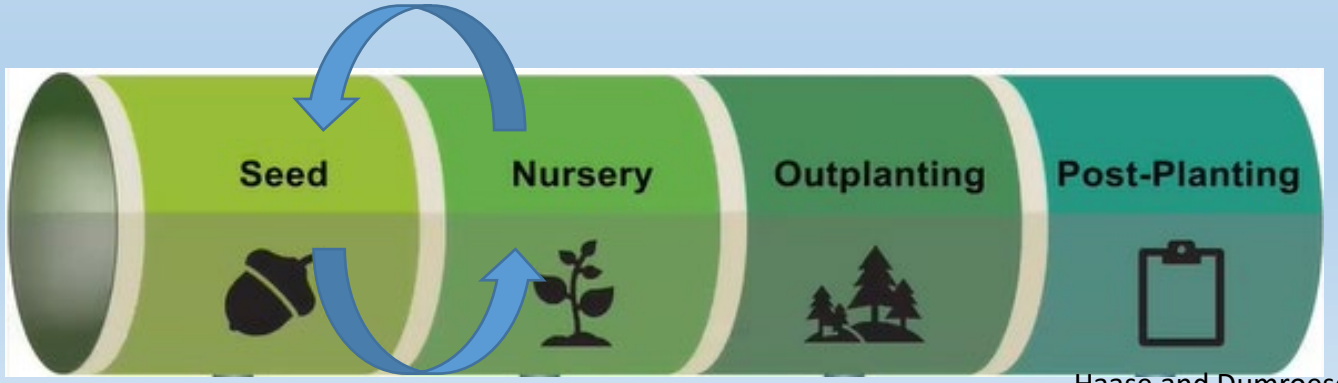
Many strategies for how a lot may be grown

Experienced and skilled grower more likely to achieve contract specs

- Species
- Seedlot history
- Container size
- Greenhouse style

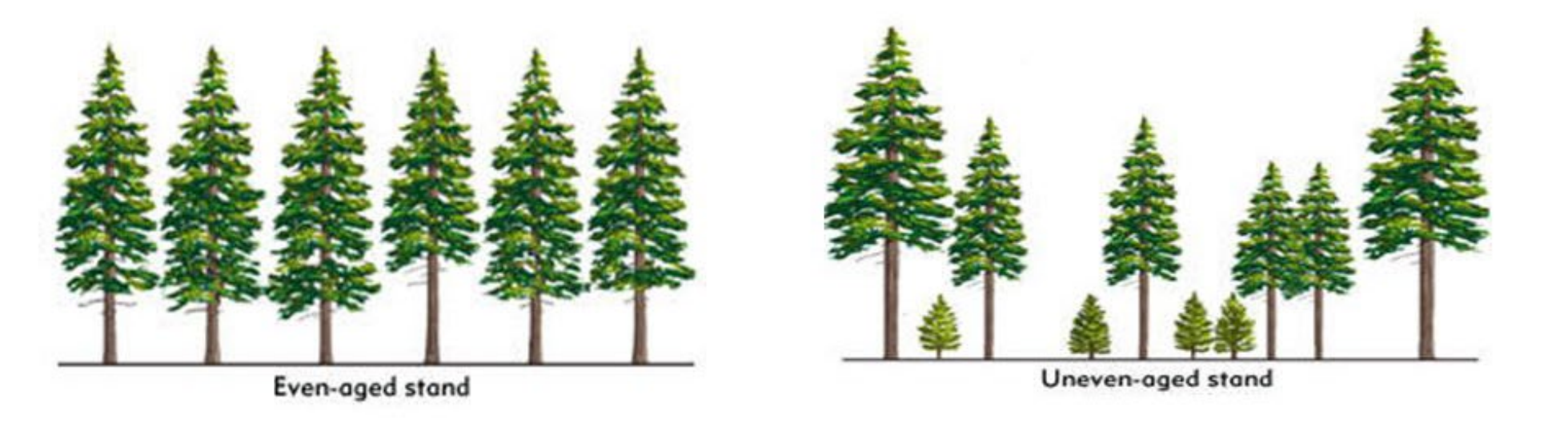
Takeaways: seed use efficiency

- In the reforestation pipeline, from seed production to post-planting, the greatest opportunity to improve seed use efficiency is at the nursery
- A nursery can best improve seed use efficiency when active and ongoing feedback exists with its seed supplier: exchange germination data
- Along with equipment investments, sowing, germination and growing techniques will help conserve seed



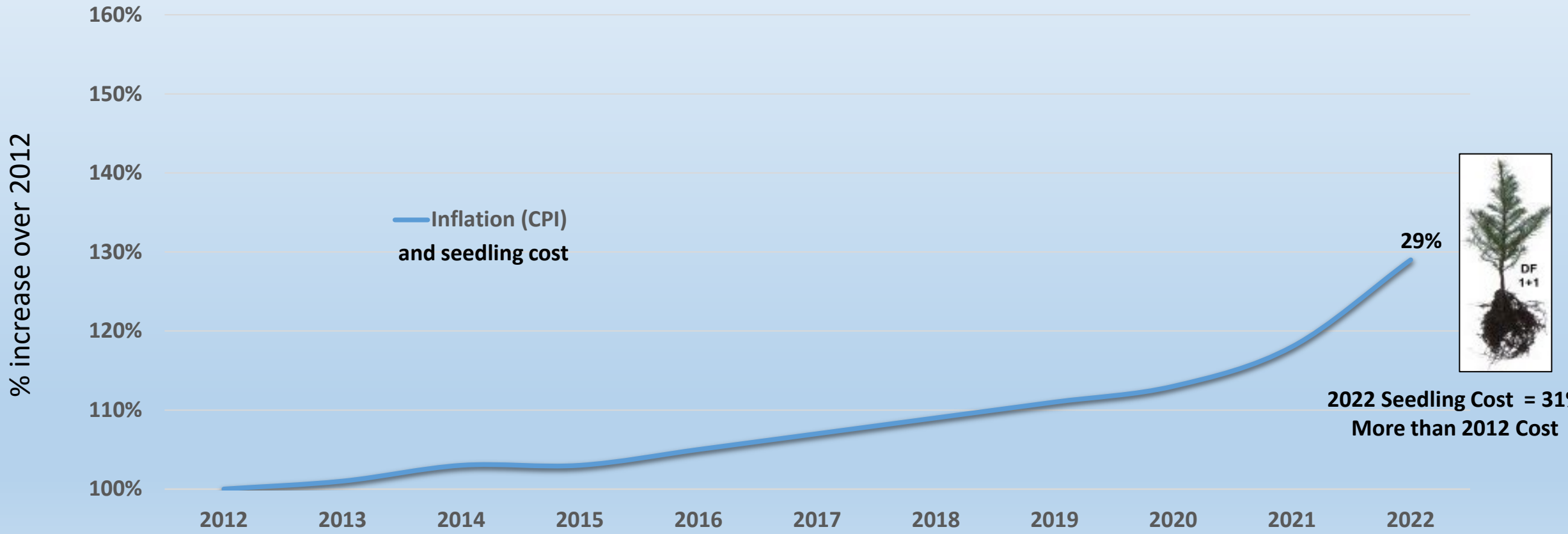
Haase and Dumroese 2021

Part 2: Recruiting and retaining nursery staff



- Recruitment through pay
- Cast wide net for internship programs
- Reward and retain employees through continuing education

WADNR nursery wages are increasing faster than inflation and seedling prices



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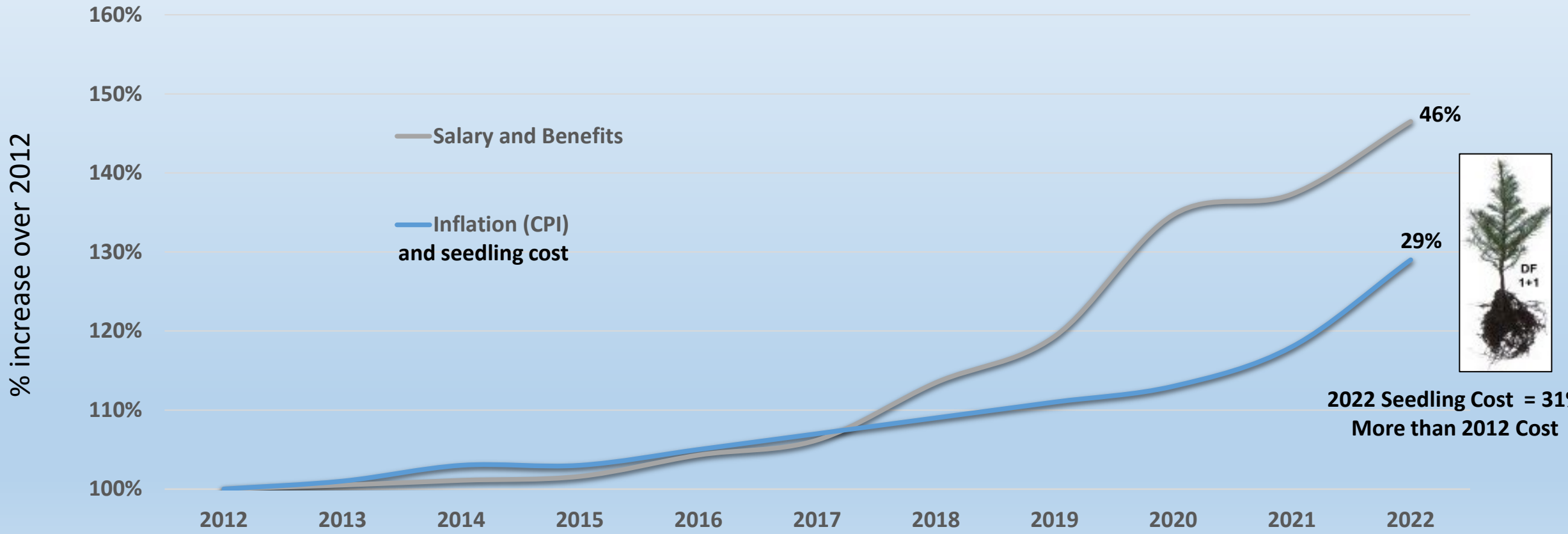

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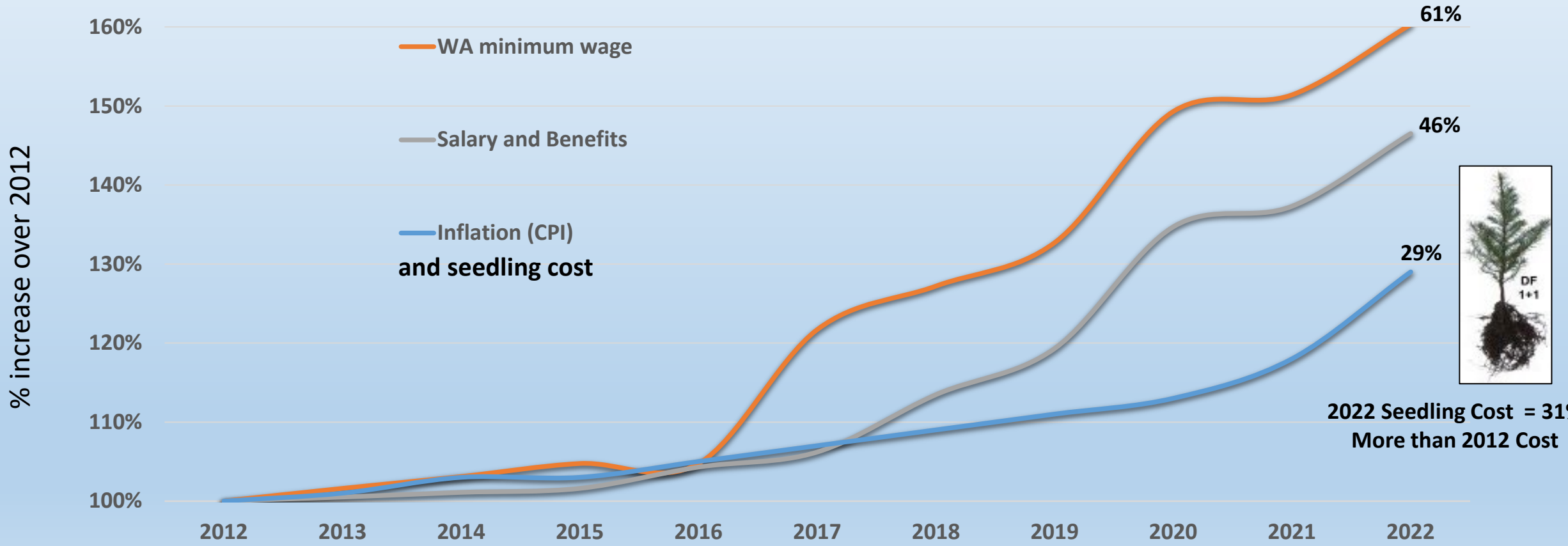


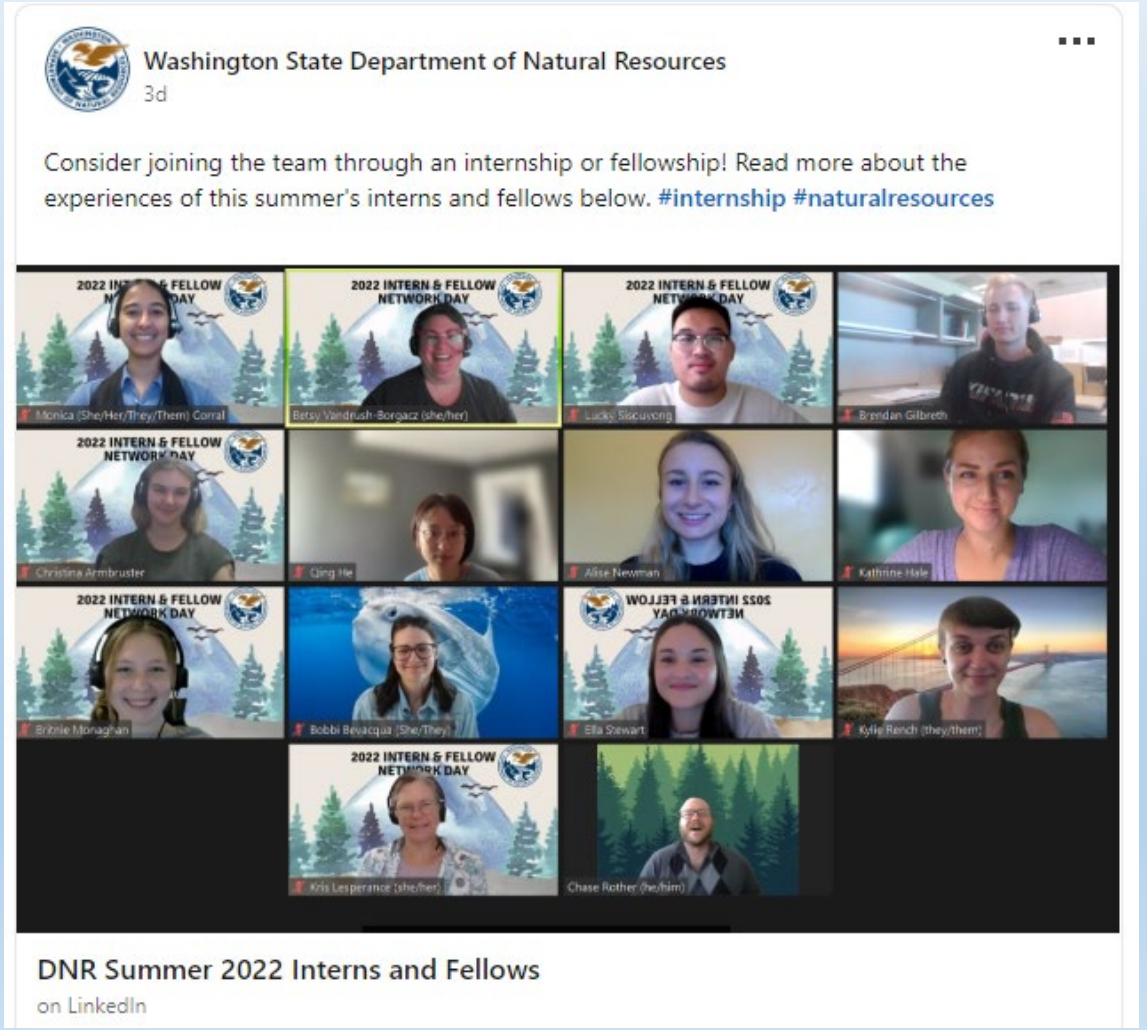
Recruit students through intern programs

- Need to market through <u>competitive</u> internships (hourly rate, housing stipend)

- Extended two-way interviews:

  Is this someone we really want?

  Is this a place I want to work?

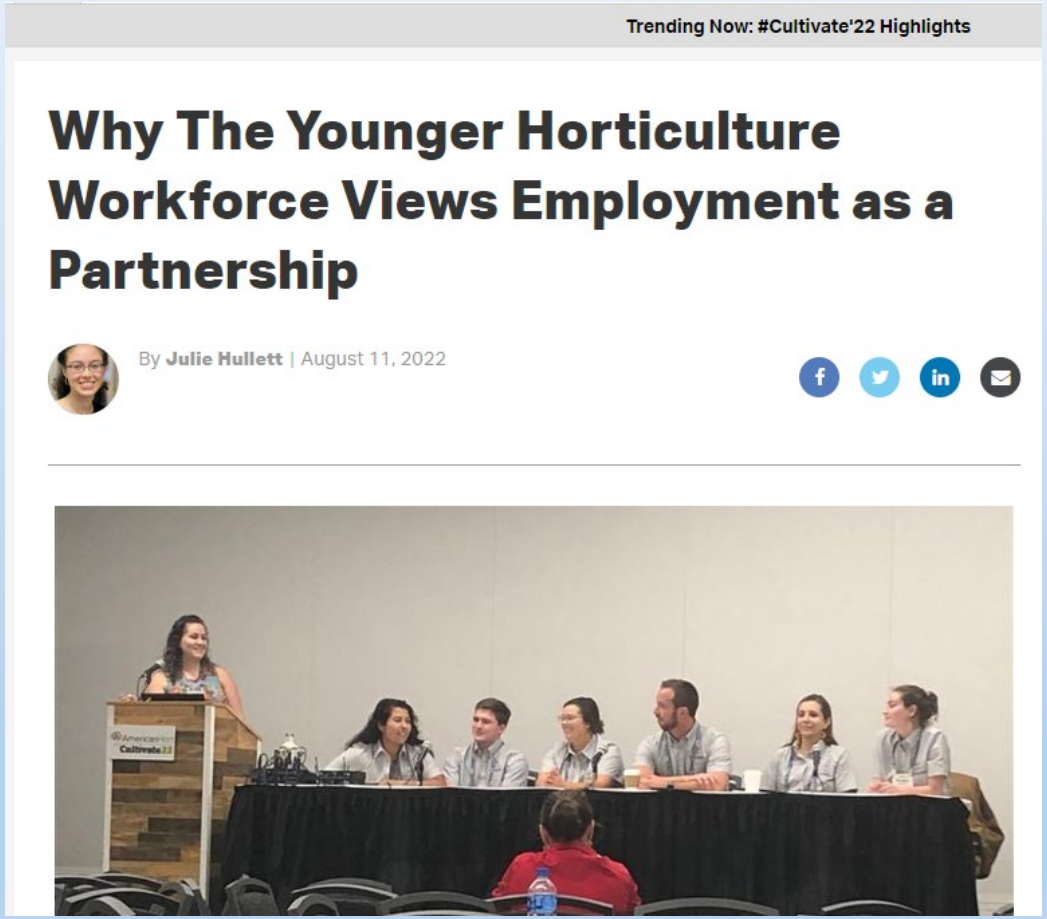


A two-way relationship

“The younger generation in today’s workforce will be loyal to their employer, but they expect their employer to build a positive work environment and help them reach their goals.”

If you don’t give them the same amount of energy, they will quit,” Knuth said of the younger members of the workforce. “It’s a partnership and they will be loyal to you.”

-Dr. Melinda Knuth of North Carolina State University



Trending Now: #Cultivate'22 Highlights

Why The Younger Horticulture Workforce Views Employment as a Partnership

By **Julie Hullett** | August 11, 2022

Greenhouse Grower, August 2022

How do we reward and retain employees?

- Competitive wage
- Not in it for the money, rather for the cause - our best selling point
- Continuing education can show that you care about current employees' development

Some suggested continuing ed resources

- RNGR website
- Online U of Florida/MSU extension greenhouse courses and backpocketgrower.org website/app
- New U of Idaho A.S. Degree in Forest Nursery Management and Technology, some courses may be offered in hybrid format
- Extension publications and other hort industry print and online resources

RNGR REFORESTATION, NURSERIES, & GENETIC RESOURCES

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RNGR is a leading source of technical information for nurseries and land managers regarding production and planting of trees and other native plants for reforestation, restoration, and conservation.

Popular Resources

- National Nursery and Seed Directory
- Intertribal Nursery Council
- Subscribe to Tree Planters' Notes
- Native Plant Network
- Webinars
- Employment and Education Opportunities

Upcoming Events

The Reforestation Pipeline in the Western United States
Missoula, MT
September 27th – September 29th

For more information, click here.

Webinar Series

- **2021 Root Development Symposium**
  October 19th – October 21st, 2021
- **2021 Northern Forest Genetics Association Zoom Meeting**
  September 8th – September 9th, 2021

Publications

- **Tree Planters' Notes**
  This publication is dedicated to technology transfer and publication of research information relating to nursery production and outplanting of trees, shrubs, and native plants for reforestation, conservation, and restoration.
- **A Nursery Guide for the Production of Bareroot Hardwood Seedlings**
  This guidebook is designed to provide an overview of topics related to the bareroot production of hardwood tree seedlings. It is highly revised from the previous guidebook published in 1994 (Agricultural handbook No. 473).
- **The Container Tree Nursery Manual**
  This seven volume set provides a comprehensive overview of topics concerning the production of tree and woody shrub seedlings in containers.
- **Tropical Nursery Manual**
  A Guide to Starting and Operating a Nursery for Native and Traditional Plants

  This comprehensive manual serves people who are starting or operating a nursery for native and traditional species in the tropics. Key concepts, principles, and processes are presented, based on proven practices and the best science available.
- **The Woody Plant Seed Manual**
  General principles such as seed biology, harvesting, storage, testing as well as nursery practices.

RNGR.net includes a repository of approximately 12,000 searchable and downloadable articles relevant to nursery production, seedling quality, reforestation, tree improvement, germplasm conservation, and native plant restoration. Click here for more publications.

Extension short courses: $250/4-5 wks

Course Subjects/Temas de los Cursos

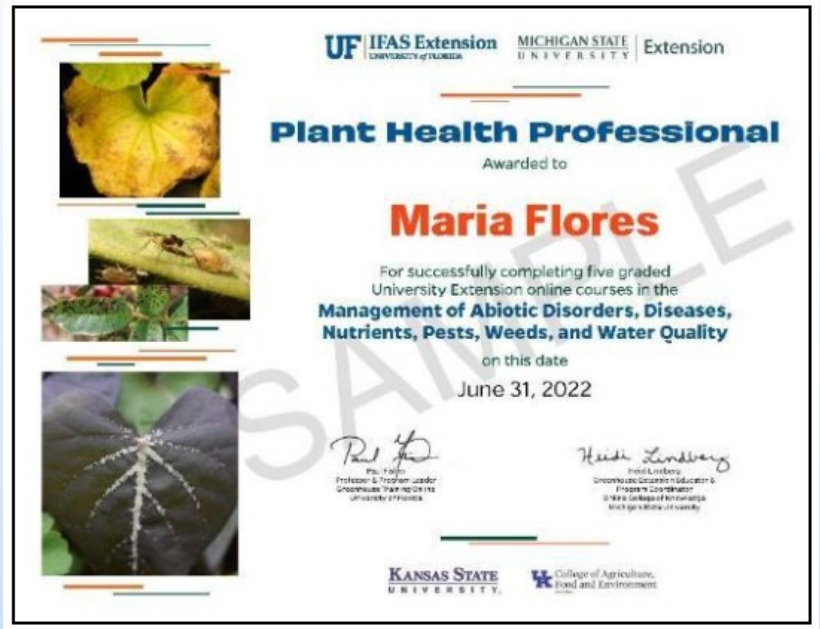
Title/Titulo	Level/Nivel
Greenhouse 101/Invernadero 101	1
Disease Management/Manejo de Enfermedades	2
Nutrient Management 1 (Intro)/Manejo de Nutrientes 1 (Introductorio)	2
Weed Management/Manejo de Malezas	2
Costing and Profitability/Costos y Rentabilidad	3
Nutrient Management 2 (Advanced)/Manejo de Nutrientes 2 (Avanzado)	3
Irrigation Water Quality and Treatment/Calidad y Remediacion de Agua	3

UF UNIVERSITY of FLORIDA · CLEMSON UNIVERSITY · MICHIGAN STATE UNIVERSITY · UNIVERSITY OF MINNESOTA · TEXAS A&M UNIVERSITY · UCONN UNIVERSITY OF CONNECTICUT

Backpocketgrower.org

- Free
- Referenced often in classes, stands alone
- University and industry-supported
- Practical, updated

Plant health certificate program



- Nutrient management 1 (UF)
- Disease management (UF)
- Weed management (UF)
- Water quality and treatment (UF)
- Abiotic disorders (MSU/University of Kentucky)
- Biological control (MSU/Kansas State University)

UF | UNIVERSITY of FLORIDA

MICHIGAN STATE UNIVERSITY
MSU Extension
Online College of Knowledge

U of I Associates Degree

A.S. Curriculum – Forest Nursery Management & Technology

Required course work includes:

Course No.	Course Name
ENGL 101	Writing and Rhetoric I
ENGL 102	*Writing and Rhetoric II*
COMM 101	*Fundamentals of Oral Communication*
CHEM 101/101L	Introduction to Chemistry and Lab
SOIL 205	The Soil Ecosystem
SOIL 206	*The Soil Ecosystem Lab*
MATH 123 or	Math in Modern Society or
MATH 143	College Algebra
ECON 201 or	Principles of Macroeconomics or
ECON 202	Principles of Microeconomics
MKTG 321	Marketing

FOR 152*	Careers in Forest Nursery Management & Technology
FOR 153*	Forest Nurseries Tour
PLSC 201	Principles of Horticulture
FOR 206*	Properties of Artificial Growth Media
FOR 220	Forest Biology and Dendrology
FOR 251*	Nursery Insects and Disease
ASM 112	Introduction to Agricultural Systems Management
FOR 255	Nursery Irrigation and Fertilization
LARC 288	Plant Materials and Design 1
PLSC 300	Plant Propagation
FOR 257*	Sustainable Nursery Design and Management
FOR 298*	Forest Nursery Internship

University of Idaho Center for Forest Nursery and Seedling Research

U of I Hybrid Option/Extension Courses?

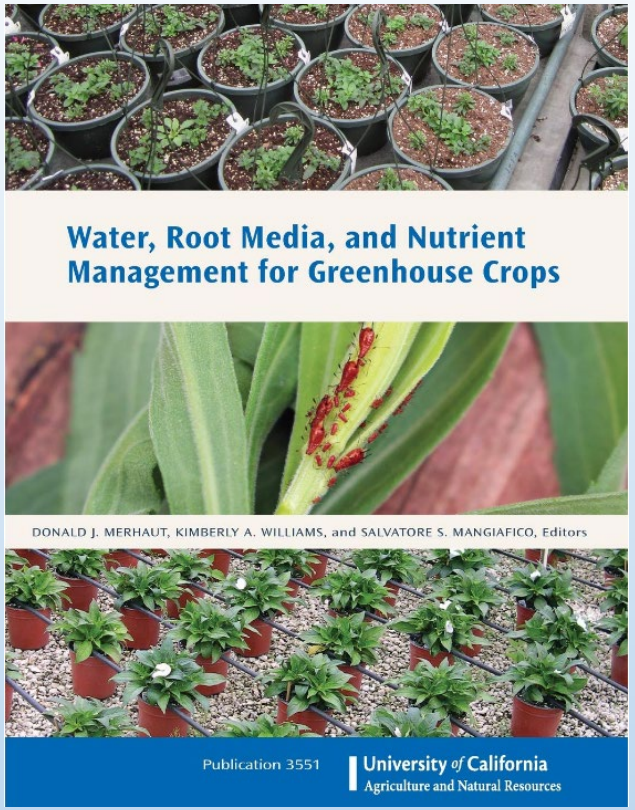
- Careers in Forest Nursery Management and Technology
- Properties of Artificial Growth Media
- Nursery Insects and Disease
- Sustainable Nursery Design and Management

University of Idaho | Center for Forest Nursery and Seedling Research

GREENHOUSE GROWER

GROWERTALKS

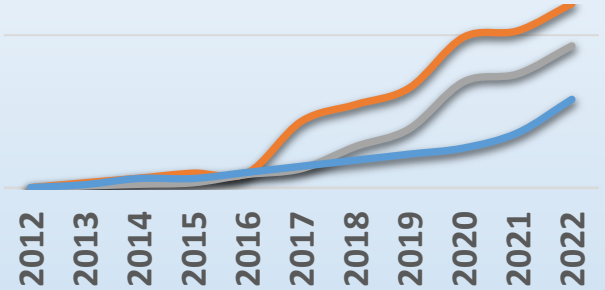
e-GRO Electronic Grower Resources Online



- Latest methods, technologies, and trends in horticulture
- Articles, webinars by industry and university experts
- Excellent search function of past articles

Takeaways: nursery recruitment and retention

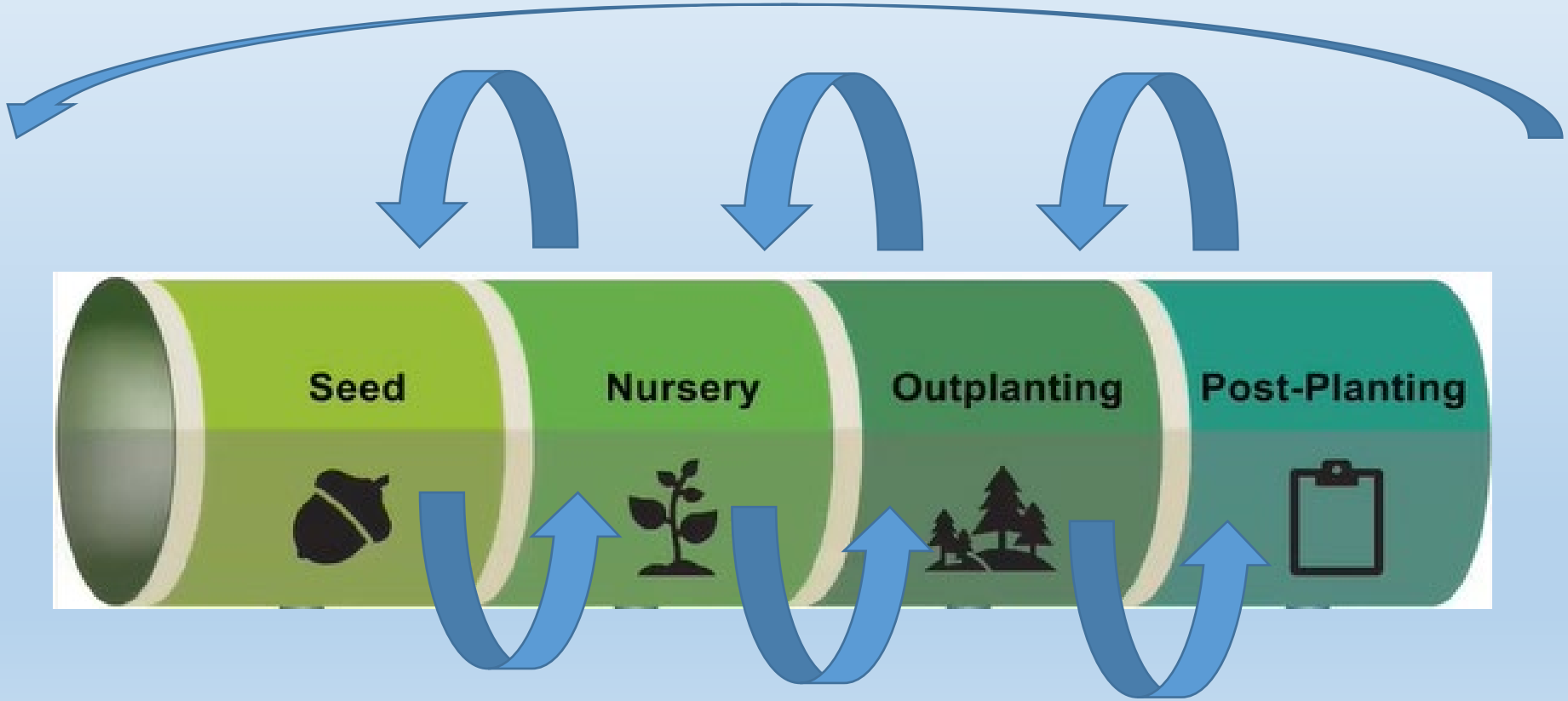
- Reforestation nursery sector has to keep up with competitive wages, seedling prices will need to keep up as well

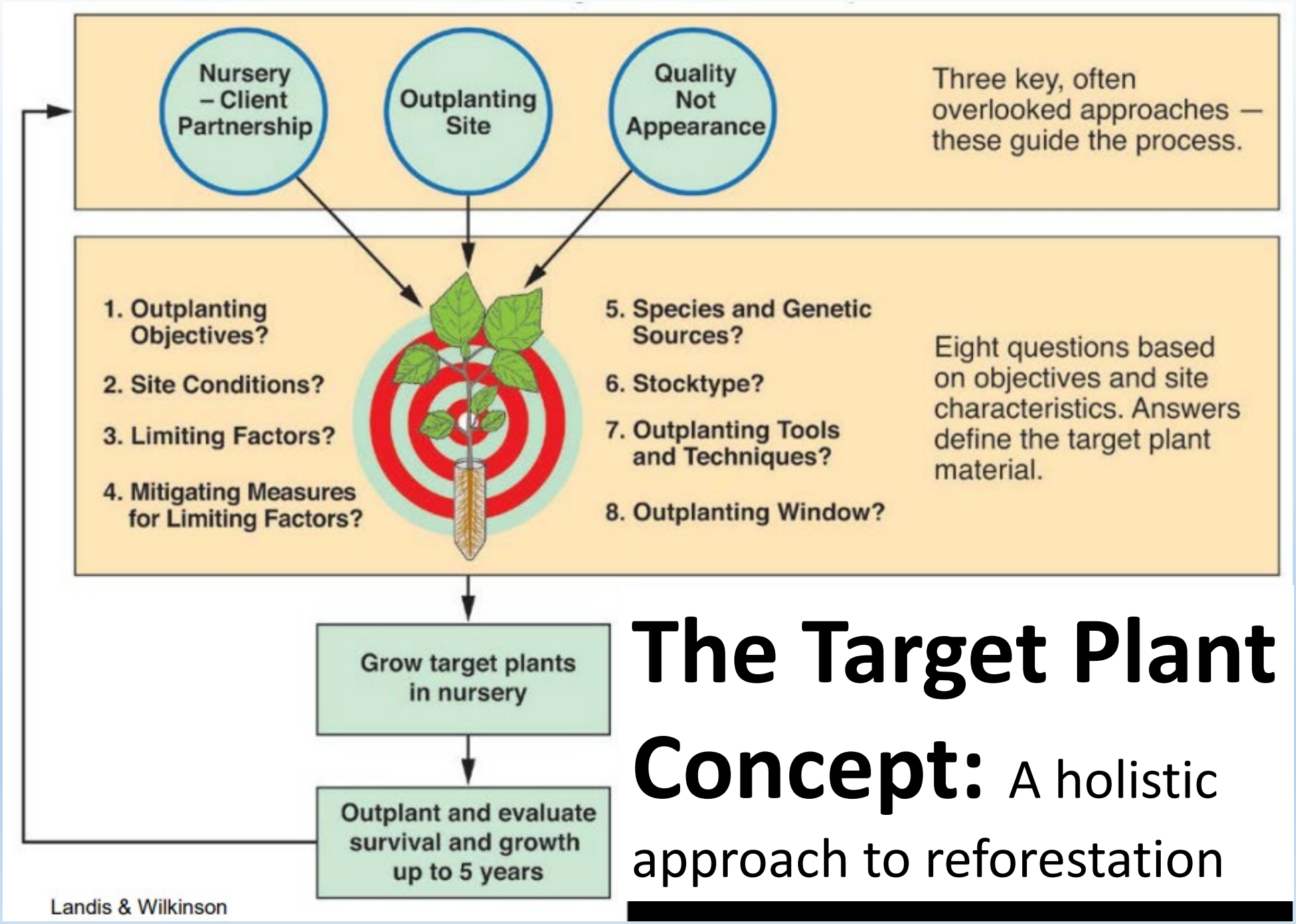


- Workforce is more mobile than ever, how will you build a lasting partnership?
  - Invest in prospective employees through competitive internships and other recruiting mechanisms
  - Reward and retain existing employees by offering continuing education opportunities

UF | IFAS Extension
UNIVERSITY of FLORIDA
GREENHOUSE TRAINING ONLINE

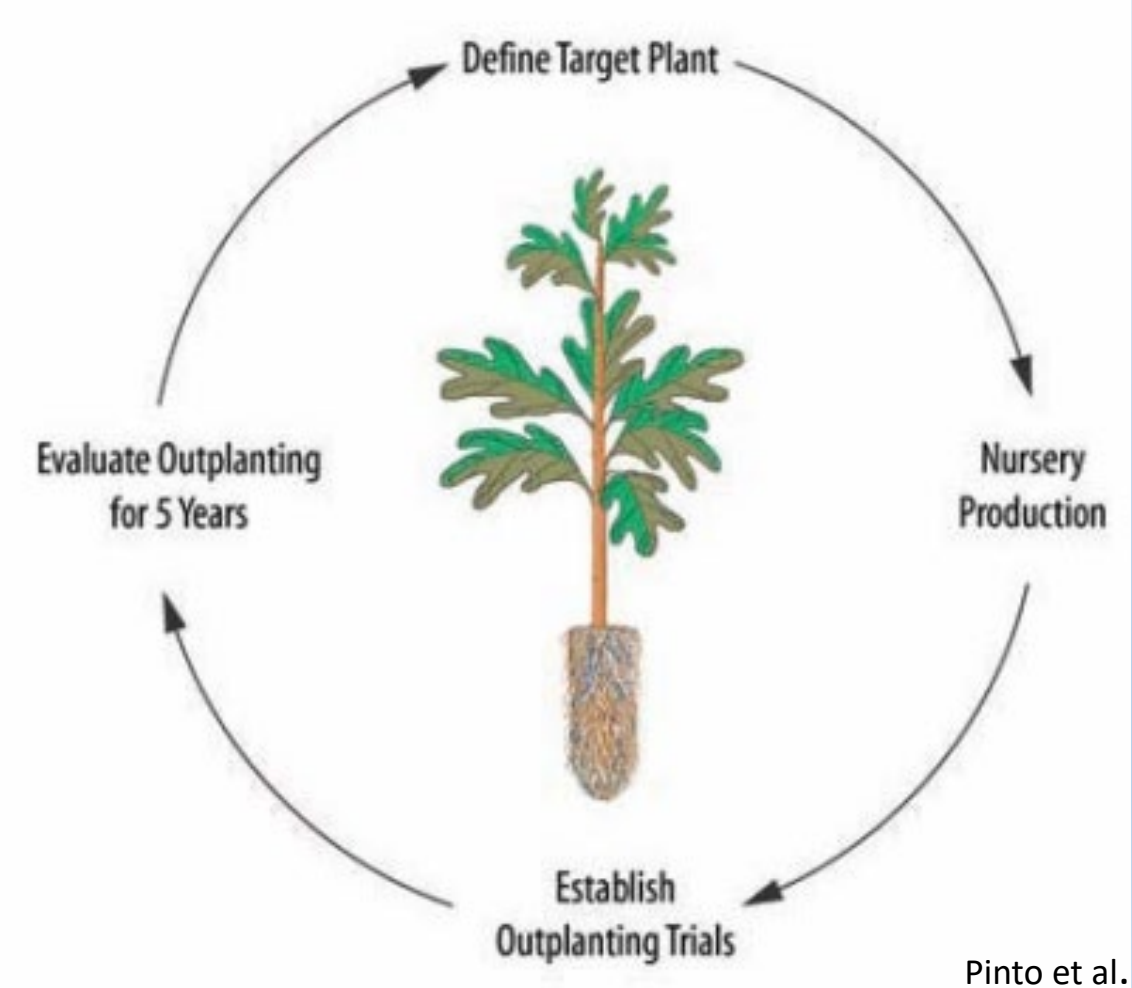
Part 3: How nurseries can strengthen end-user partnerships: stocktype trials using a paper-wrapped plug vs. styroblock plug example





The Target Plant Concept: A holistic approach to reforestation

Target morphological and physiological characteristics that can be quantitatively linked to outplant success



Pinto et al.

Stocktype trials: can paper-wrapped plugs enhance outplant survival and growth vs. styroblock plugs?

Paper-wrapped plugs

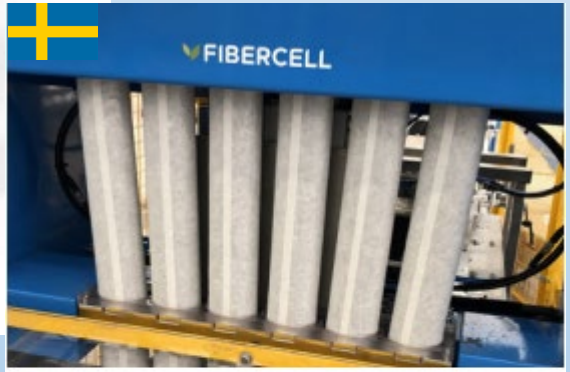
Styroblock plugs

The Gartner Hype Cycle

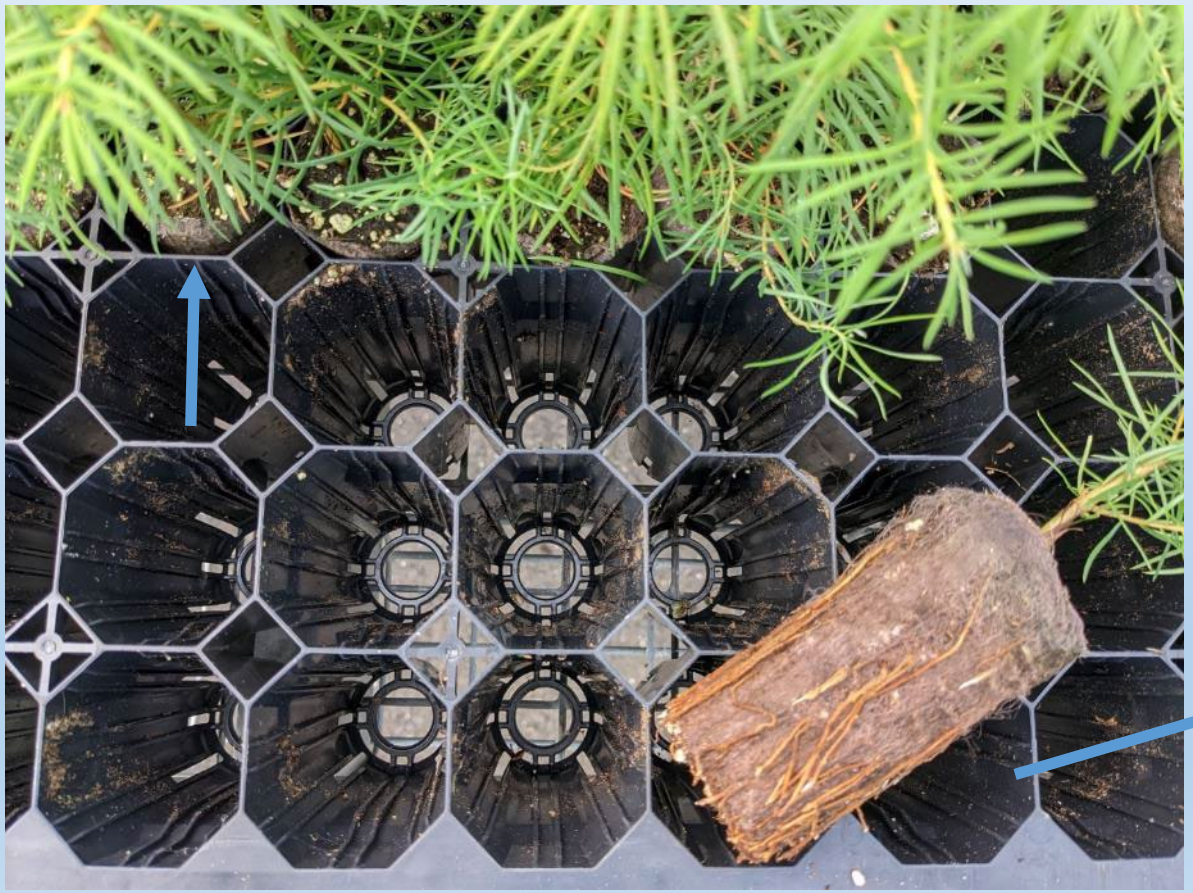
What are paper-wrapped plugs?

- Use a degradable paper to wrap around a “tube” of growing media

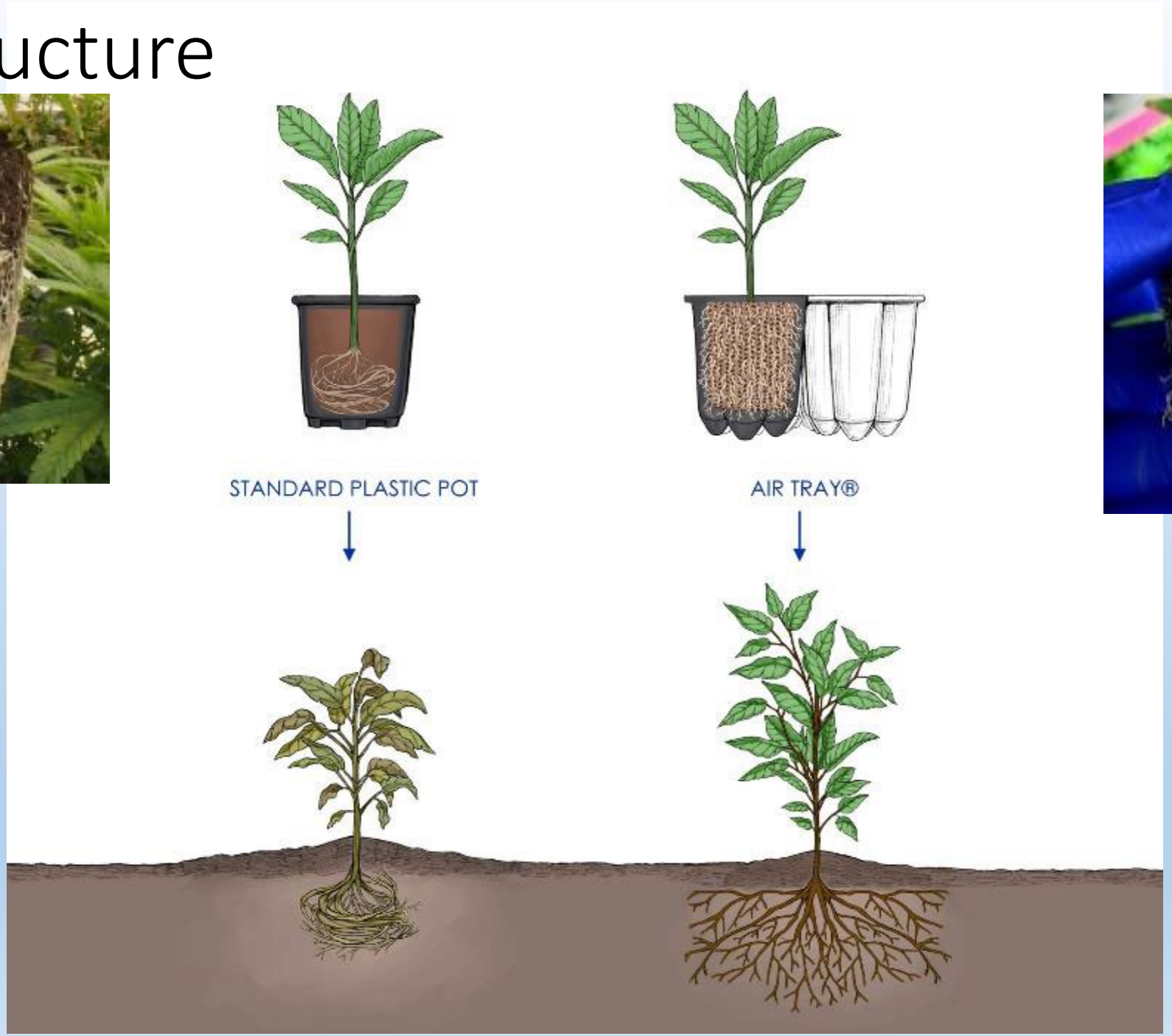
- BCC Fibercell is a similar paper-style system



Because they are self-contained, plugs can sit loose in a container and be air-pruned the entire length



Root structure



Compared to styroblock plugs:

- **More balanced root:shoot ratio?**
  evaluate at nursery
- **Higher root growth potential?**
  evaluate at nursery
- **Improved root architecture?**
  evaluate at nursery and field
- **Faster root establishment, improved survival/growth?**
  evaluate at field

Paper-wrapped plug root properties will be highly influenced by the type of tray used

Rigid, injection molded tray

thermoform plastic tray

injection molded tray

thermoform plastic tray

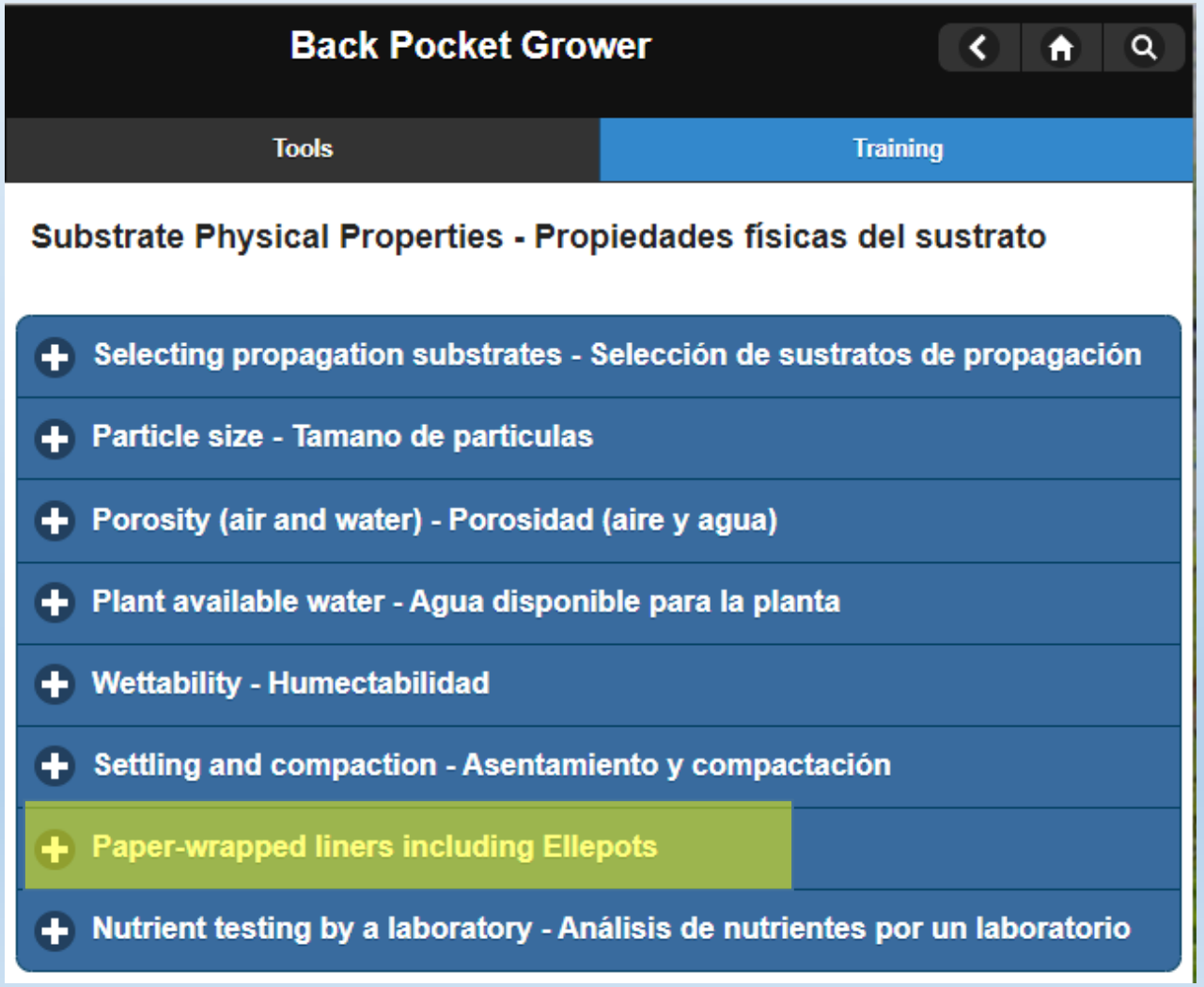
Paper-wrapped plug root properties will be highly influenced by the quality of production

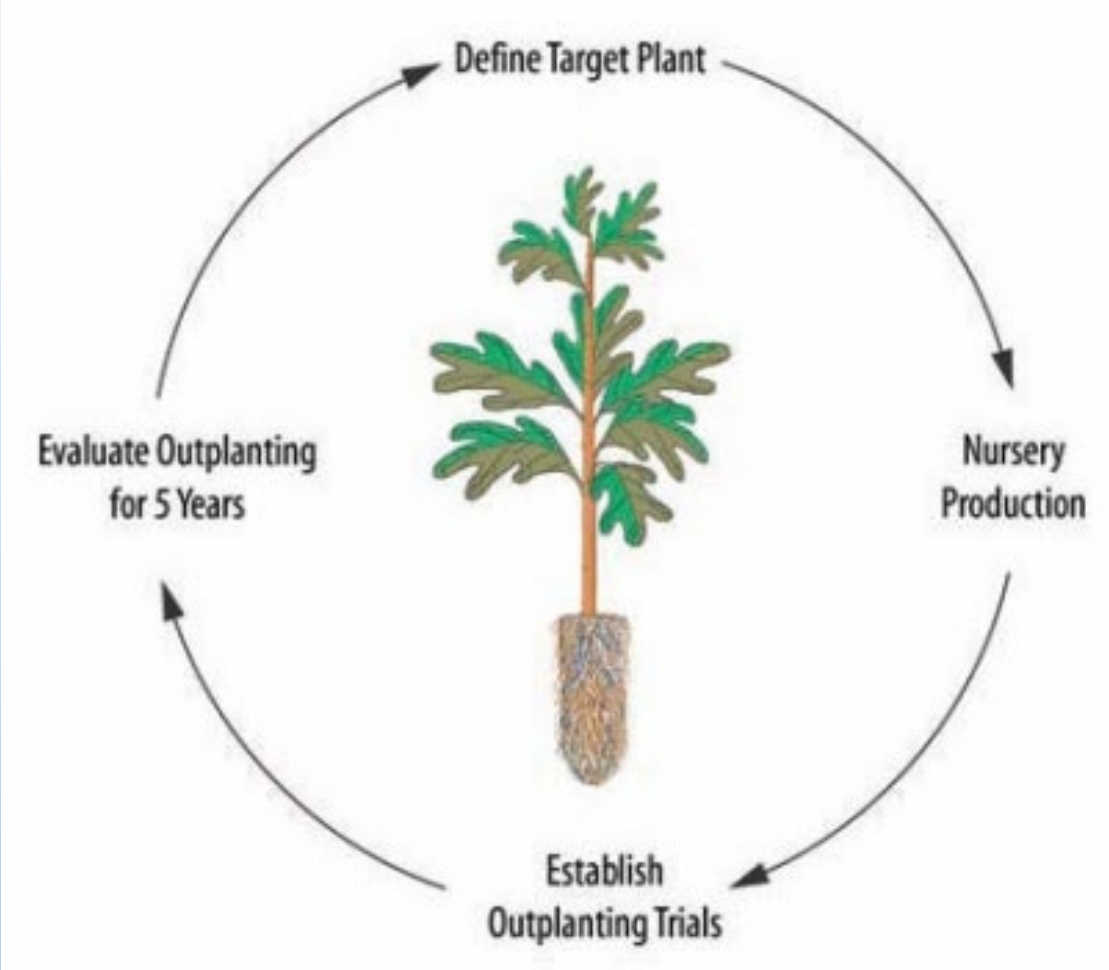
Make sure to track soil media parameters during plug production

- Soil media moisture
- Vacuum level
- Quantify and track physical parameters

Soil media quality control? There's an app for that

- **Backpocketgrower.org**
  - How to operate paper plug machines to optimize media properties
  - How to test media properties of paper-wrapped plugs
  - Plug-squeeze method for testing media pH/EC




Define Target Plant
Nursery Production
Establish Outplanting Trials
Evaluate Outplanting for 5 Years

Stocktype trials are hard to do well

PRACTICE OF FORESTRY

Conducting Seedling Stocktype Trials: A New Approach to an Old Question

Jeremiah R. Pinto, R. Kasten Dumroese, Anthony S. Davis, and Thomas D. Landis

ABSTRACT

Seedlings for reforestation and restoration come in many shapes and sizes, i.e., a variety of stocktypes. With so many choices available, land managers commonly ask which stocktype will best meet their management objectives. For years, stocktype studies have been initiated in search of an answer to this question, but few have been done without some degree of confounding. Past studies often confounded seed sources, nurseries, and culturing regimes, and/or failed to address differences in initial seedling quality, which sometimes led to inappropriate conclusions. This article reviews the reasoning behind stocktype studies, reviews common pitfalls of past studies, and suggests some key considerations to making future stocktype studies a viable resource to the practicing forester.

Keywords: target plant concept, outplanting, seedling quality, container, bareroot

materials for a site. The defined target plant material can then be produced by the nursery manager through manipulation of the growing environment to influence resulting phenotype. By varying, e.g., bareroot seedbed density or container type, seedling phenotype can be modified, even among seedlings coming from the same seed source grown the same year (Endean and Carlson 1975, Simpson 1991, Pinto et al. 2008).

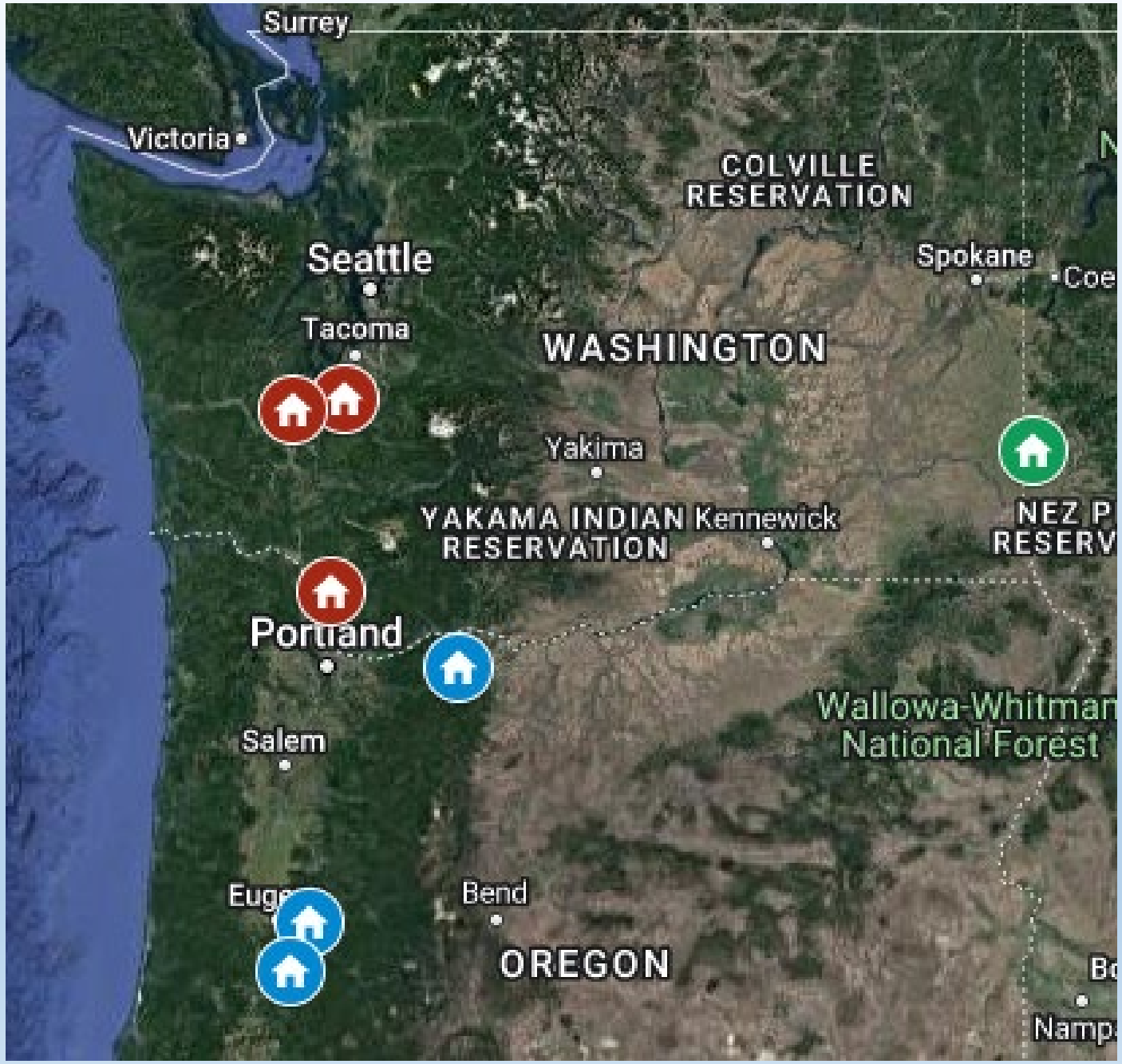
Phenotypic variation of seedlings (e.g., height, branching pattern, root collar diame-

Stocktype trial guidelines:

- Define objectives clearly, variables tested
- Match genetic sources
- Similar propagation environment
- Seedling physiology/quality should be uniform across stocktypes (adjust nutrition, irrigation as necessary)
- Hardening and storage regimes should be sufficient and similar
- Solid statistical design
- Outplant trials multiple years to account for wet vs. dry years

PNW Forest Nursery Ellepot Evaluation

- Nurseries familiarizing with technology
- Stocktype trials need solid nursery/field coordination for reliable conclusions
- Target Plant Concept in action: nursery and forester working together to target seedling specs to the site

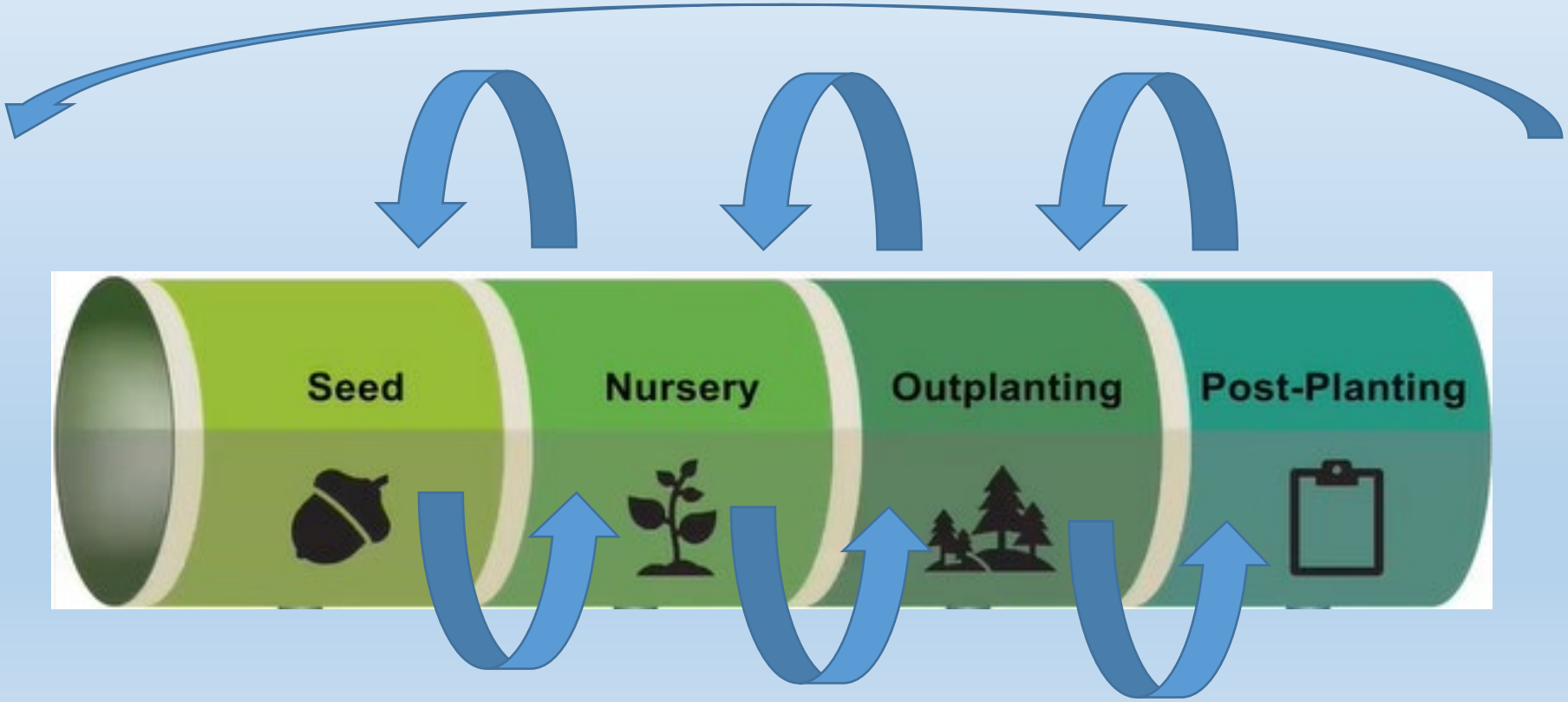


Wrap-up: what do we need to establish a sustainable seedling supply?

- **Invest in infrastructure**: cooler storage, water capacity, nursery expansion
- **Invest in equipment and automation**: more cost-effective than ever, especially in this labor market
- **Invest in people above all**: Hire and retain a staff that will interact and partner with seed and field professionals

Ultimately, partnerships will determine success

How do we get there?



What do we need, what works?

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- Diane Haase
- Dave Kolotelo
- Tom Landis
- Brian Morris
- Andrew Nelson
- Jeremy Pinto
- Tel Vaughn
- Jacob Witcraft

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