TITLE: PRACTICAL AND INNOVATIVE: A DESIGN FOR A NEW FIELD NURSERY AT THE MORRIS ARBORETUM

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ABSTRACT:

The Morris Arboretum is an exceptionally beautiful place to learn about and appreciate trees from around the world. Before these incredible specimens make their way out to the garden, many of these plants will spend at least part of their life in the field nursery. Unlike commercial nurseries where large quantities of relatively few species are grown, the field nursery at the Morris Arboretum serves a more dynamic role hosting a wide array of tree and shrub species from all over the world.

The purpose of the nursery at the Arboretum is threefold: to offer a more hospitable growing environment for plants that do not grow well in pots; to provide a space for trees to grow larger in size before being planted out; and to test the hardiness of a tree species. Some of the important considerations in designing a new field nursery are location, spacing, irrigation, weed control, fertilization, fencing, and shade structure. Given these considerations, a new nursery will be designed to minimize maintenance and environmental impact while at the same time creating an optimal environment for the young plants of the Morris Arboretum to thrive until they reach their ultimate destination in the landscape.

Practical and Innovative: A Design for a new Field Nursery at the Morris Arboretum

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INTRODUCTION

From time that seeds germinate at the greenhouse until they are planted out as young trees, most of the woody species at the Morris Arboretum will have a brief stay in a field nursery. Unlike conventional nurseries where many individuals of the same species are grown to maximize yield in a limited space, the field nursery at the Morris Arboretum provides a more dynamic role. The purpose of a field nursery at the Morris Arboretum is threefold: to provide a place to grow plants that do not grow well in pots (like *Quercus spp.)*, to provide a space for trees to grow larger in size before being planted out, and to test the hardiness of tree species.

OLD FIELD NURSERY

While well intentioned, the old field nursery became a black hole of the Arboretum (quite literally in fact, there was a sink hole in one corner). Like many conventional nurseries, the space was surrounded by cyclone fencing buried 1-2 feet below ground to keep out both deer and rodents. The nursery was divided into two fenced-in plots, one 50 x 103 feet and the other 60 x 100 feet. Given the space constraints and the fact that trees were planted too closely together, extraction became an ordeal especially when trees were not planted out in a timely fashion. Initially weed control consisted of several applications of Roundup along with pre and post emergent weed controls (Ulrey 1988). In 2005 intern Mark Binder suggested that the Arboretum use fine fescue as an inter-crop planting. This turned out to be a fairly effective biological weed control. Overhead irrigation on a metal tripod and oscillating sprinklers were used to irrigate the nursery.

When the new horticulture building was built on the Bloomfield Farm, a parking lot replaced the old field nursery. This provides an excellent opportunity to "start from scratch" with a new field nursery design so that some of the old problems might be re-thought and the successful aspects repeated. The ultimate goal of the new field nursery design is to be low-maintenance, low impact, functional, and provide flexibility in its design for years to come.

COMPONENTS OF THE FIELD NURSERY

There are several important considerations in any field nursery design. These include: site selection, size, spacing, irrigation, fertilization, weed control, pest control, and some form of shade structure.

LOCATION

For convenience sake it seems logical to place the nursery near the greenhouse operation, however; space-wise only the Bloomfield Farm side of the Arboretum is suitable. The old weather station located behind the magnolias near the horticulture center garages has been selected as the future nursery site. This space is relatively flat, with a gentle slope to allow for drainage (Heuser and Stinson 1988). There is water access from here with four hose bibs located in close proximity. This site is also conveniently located near the road.

SIZE

Nurseries can range in size from petite 60 x 60 foot enclosures that can be seen at Scott Arboretum or as sprawling as the multi-acre operation at Longwood gardens. We do not need a tremendous amount of space for our nursery at the Arboretum but we are wary of falling into another situation where we are tight for space; a 100 x100 foot plot should comfortably suit the needs of the Arboretum. Additionally for ease of tree extraction four large (12 foot wide) gates will be placed on all four sides of the nursery so that if needed, a backhoe, tree spade and mower can all enter.

SPACING

Within the nursery plot the spacing of trees is also very important. On average most nurseries, including Scott and the Arnold Arboreta, have a spacing scheme with 4-5 feet between rows and 5-6 feet between plants. At large production nurseries such as Rhode Island Nursery, as little as three feet may be left between rows. However, lest we are doomed to repeat the past, there should be ample space between trees at our new nursery. If we leave two feet on either side of each tree, and then six feet of lawn in between, the plantings will have 10 feet between them. This will leave plenty of space to grow and allow large machinery and mowers to move through easily. Rows should run east to west to follow the path of sunlight through the day (Bill Barnes, personal communication).

Crop rotation is also important so that the soil has time to recover after each planting cycle. Arnold Arboretum uses only two of their three nursery plots and then sows the third plot with winter rye leaving it fallow for a year. At the Morris Arboretum we will have enough space to leave one half the nursery fallow and plant the other half and then rotate each half annually.

IRRIGATION

There are two schools of thought in the great irrigation debate; overhead vs. drip irrigation. Overhead is by far the simplest and cheapest option; this is used at both the Scott and Arnold Arboreta where the nursery itself covers a relatively small space.

At larger nurseries such as the one at Longwood Gardens, drip irrigation is used. Drip irrigation is advantageous in that it conserves water, decreases the risk of foliar disease from leaf

wetting, and limits run-off (Davidson et al. 2000). Drip irrigation also aids in root development and more effectively limits weed growth by directly applying water to the area around the plant. However, like everything in life these benefits come with a cost. In 2005 intern Mark Binder got an estimate from Dave Cook at Trickl-eez in Biglerville, PA. For the parts and labor, drip irrigation at the Arboretum totals up to a substantial price.

I think that drip irrigation would be an interesting option for the Arboretum to pursue at some point but given the size and current budget of the nursery overhead irrigation may be the most practical option. Additionally, drip irrigation could always be incorporated into the nursery design in the future. A third "in between" option would be soaker hoses. Soaker hoses are relatively cheap and low maintenance; hoses could be run down each row and set to timers to soak the soil without the wasted water associated with overhead irrigation.

WEED CONTROL

Weed control is another vital component of tree nursery management. Left alone, weeds have the potential to out-compete the tree species planted by using up light, moisture and nutrients in the soil (Davidson et al. 2000). Controlling these weeds can be an incredibly labor and time intensive process depending on the method chosen.

Most nurseries, including the Arnold and Scott, use multiple rounds of the herbicide Roundup (*glyphosate*) accompanied by hand weeding. While this method is effective, I do not think that it is the best option for the Morris Arboretum for many reasons; *glyphosate* application is both expensive and labor intensive requiring Arboretum staff to properly protect themselves and spray several times a year. Furthermore, *glyphosates* are toxic and have been linked to mutations in aquatic animals and invertebrates (Buffin and Jewell 2001). Given the proximity of the nursery to the Wissahickon watershed and 100-year floodplain, I believe the Arboretum should minimize its use of this and other toxic products.

One way to limit weed growth is with biological controls such as a cover crop. At Longwood Gardens lawn is left between tree rows and periodically mowed to keep weeds down. The immediate area around the tree is mulched and then hand-weeded.

This option was the subject of an intern project in 2005 in which Mark Binder suggested the use of a cover crop as an inter-crop planting. Living mulches or cover crops are beneficial in that they increase the soil organic matter, reduce compaction from equipment, increase water percolation, increase soil aggregates, stabilize soil, and reduce erosion (Atland 2000). There is a wealth of literature and research on preferred cover crops. Experiments have been conducted with fescues (*Festuca*), rye (*Secale*), trefoil (*Lotus*), rye grass (*Lolium*), and members of the family *Brassicaceae*.

In the book, Managing Cover Crops Profitably, the authors extensively outline the advantages and disadvantages of each cover crop. I believe that *Brassica napus* in the family *Brassicaceae* could be an ideal cover crop to be used at the Arboretum. This species produces a

glucosinolate-containing residue; this residue suppresses plant-parasitic nematodes and soil-borne disease (Snapp et al. 2005). *B. napus* is also effective at weed control because the glucosinolate residues it produces are also toxic to weeds and fungal pathogens (Haramato and Gallandt 2004). These glucosinates also have been found to limit generalist insect feeding (Haramato and Gallandt 2004). When compared with other cover crops Brassica is most effective at capturing excess nitrate and therefore preventing nitrogen loss (Snapp et al. 2005). Given all the advantages that this cover crop species has to offer it would be interesting for the Arboretum to experiment using it in inter-crop plantings in the future.

Another potentially useful cover crop species is *Festuca longifolia.* This species was recommended and implemented by intern Mark Binder. This species, like *B. napus* reduces erosion, limits weed growth, but does not inhibit tree growth. Additionally, this species does not spread laterally as it grows making it easy to control and only needs to be mowed a few times a year (Binder 2005).

While I do think that the Arboretum should experiment with cover crops in the *Brassica* or *Festuca* family in the future, at least for the first year it seems most practical to leave the existing cover crop in the nursery with either rows or rings of wood chips. Curator Tony Aiello suggested the use of wood chips over mulch because they do not change the soil chemistry as dramatically. Finally, as needed, chemicals such as Roundup or hand weeding can be used as a last resort.

FERTILIZATION

While most commercial nurseries use some sort of fertilizer be it in slow release, liquid, or dry form, this component is of much less importance at the Morris Arboretum. Local expert Bill Barnes also points out that the less we "baby" trees in the nursery the more likely they are to be successful once they are planted out in the landscape where conditions will inevitably be harsher. Additionally, given that the Arboretum was unable to keep up with tree growth in the old nursery, the use of fertilizer seems counteractive to our intent.

PEST CONTROL

At the Arboretum we have another four letter profanity; deer. Deer and rodents are some of the worst Arboretum pests and given our proximity to the Wissahickon woods the chances of eliminating these irksome creatures are slim. Thanks to fencing we can coexist. There are two deer fencing options; one is the Benner Deer Fence that can be seen under the "Out on a Limb" exhibit or at the Scott Arboretum. The more conventional option is the cyclone fence used at Longwood Gardens; below is a quick comparison of the two options.

FENCING COMPARISON

	Benner	**Cyclone**
Appearance	High strength wire fence mesh does not stand out in the landscape	Galvanized steel or vinyl coated, fairly noticeable in landscape
Cost	$8,000	$10,000
Protection From:	Deer and rodents with additional rodent barrier	Deer and rodents if fence is buried
Height	7.5 feet	5-6 feet
Ease of Installation	Easily installed with steel pipes and ground stakes.	More involved, fencing must go into the ground, cement is used to set posts.

At other nurseries such as Colibraro's, simple cardboard blocks are constructed to protect from buck-rub. At Bigelow Nursery hanging soap is intended as a deer deterrent. However given the extent of the deer problem at the Morris Arboretum, I believe that protective fencing is the way to go.

LATHE HOUSE

A lathe house is another useful component of any nursery. The lathe house can protect plants in the summer from the heat and wind and reduce the intensity of sunlight in the winter. Lathe houses can be especially helpful for species such as *Acer* and *Rhododendron* that prefer a more protected environment (Davidson et al. 2000). These structures are also important in the winter because they protect evergreen species such as *Illex spp.*, *Camellia spp.* from harsh sunlight. (Bill Barnes, Personal Communication).

There are many different versions of the lathe house ranging from wooden lathe houses with protection on all four sides (Longwood Gardens) to structures as simple as four bowed metal poles draped with shade cloth (Colibraro Nursery or Arnold Arboretum).

Currently a lathe house is not in the immediate plans for the Arboretum nursery however, I do think this would be a worthy pursuit in the future. The lathe house should be at least 8-12 feet tall and arched to reduce snow load. The lathe house should also be placed perpendicular to the path of the sun so that plants get an even amount of sunlight throughout the day (Bill Barnes, personal communication).

BUDGET

It is difficult to estimate an exact budget for the field nursery. The nursery will be amended and altered over time and better models may replace many of the products purchased initially at a later date. However, a rough idea of the costs associated with the nursery now and into the future is laid out below.

Site Preparation		
Soil Test (6)	Prescription Soil Analysis	$49 each x 6 tests = $300
Water Test	Miller Pump	= $205
Till Rental		
Herbicides	In House Cost	----------
Cover Crop*	Green Cover Seed	Brassica rape $1 per lb need 8-14 lb per acre x .2 acre nursery = $2.4
Wood Chips		
Grading		$500
Fencing		
Cyclone	Glenside Fencing	$10,000
Deer Fence	Benner Deer Fencing	$7,000
Irrigation		
Hose lines	Sharkey Enterprises	$2,000
Timer (3-4)	DIG Digital	$100 each x 2 (for now the arboretum may purchase more in the future) = $200
Tripod	In House Cost	----------
Soaker Hose	Hummert	$15 each x 3 = $45
Hose Bibs (3-4)	Sharkey Enterprises	
Lathe house		
Shade cloth*	Gempler's	60% shade cloth 60' x 50' = $512.55
Metal posts*	Rimol Greenhouse Systems	Depends on size 60' x 50' = $5647

**indicates future costs*

CONCLUSION

Given the scope, price range, and purpose of a field nursery at the Arboretum I believe that current design should suit the needs of the nursery while also providing flexibility in the years to come. The development of the field nursery is a gradual process and over time elements may be added or removed to suit the needs of the Arboretum but it is hoped that these recommendations can guide the design and help get the process started.

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Nurseries visited:

Arnold Arboretum; Boston MA

Colibraro's Nursery; Willow Grove PA

Sam Brown's Nursery; Malvern PA

Scott Arboretum; Swarthmore PA

Longwood Gardens; Kennett Square PA

Rhode Island Nursery

Bigelow Nursery

Knowledgeable people:

Aiello, Tony, Director of Horticulture

Anderson, Bob, Director of Physical Facilities

Barnes, Bill, Owner, Lorax Nursery

Catani, CJ, Horticulture Intern

Clarke, Louise, Natural Areas Section Leader

Dillard, Shelley, Propagator

APPENDIX A: New Nursery Map