

Calculating Optimum Sowing Factor: A Tool to Evaluate Sowing Strategies and Minimize Seedling Production Cost

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Abstract: This paper illustrates how to use an excel spreadsheet as a decision-making tool to determine optimum sowing factor to minimize seedling production cost. Factors incorporated into the spreadsheet calculations include germination percentage, seeder accuracy, cost per seed, cavities per block, costs of handling, thinning, and transplanting labor, and more. In addition to numerical outputs, the spreadsheet generates a graphical representation of results to present and evaluate options. Example scenarios demonstrate how the tool can be used. A copy of the spreadsheet tool is available by emailing the author: eric@tlhort.com or eric.vansteen@gmail.com.

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Introduction

Seed is fundamental to the nursery industry. This paper illustrates how to use an excel spreadsheet to calculate optimum sowing factor (number of seeds per cell) and over-sowing factor (number of extra seeds to sow per cell). Some of the math involved is covered, and a graphical method for presenting and evaluating options is given. The objective is to evaluate different options for sowing and determine the best sowing strategy to minimize seedling production cost.

Selection Criteria Included in the Excel Spreadsheet Tool

The objective is for the nursery to produce 100% of the seedlings ordered by clients, all meeting contract specifications. The nursery also needs to be competitive and remain profitable. Hence the desire is to conserve seed, limit thinning, minimize extra non-salable green stems, and thereby arrive at the Minimum Seedling Production Cost. Employing the criteria listed below, the spreadsheet tool allows comparison of specific sowing factor strategies and alternatives.

Seedlot Germination Percentage

This is the number one selection criteria, and what sowing guidelines and seed allotments are largely based on. Sowing factor is calculated to limit empty cavity count. This varies with container type and nursery specific goals and costs, but the general goal is to have no more than a few percent

of cells empty after sowing. An example is a seedlot with 80% germination. Sowing 2 seeds per cell gives a probability of >1 viable seed in 96% of the cells, leaving 4% empties and a requirement for thinning. A minimum over-sow factor of 104.67% accounts for these empty cavities. Over-sow factors in excess of this minimum are designed to increase the “green stem count”.

Seeder Accuracy

Inaccuracy in seed placement and/or pickup is mathematically similar to a reduction in seedlot germination percentage. In my calculations, I apply 50% of the inaccuracy to generation of empties, and the other 50% to generation of a multiple sown cell. In other words, 50% of the inaccuracy is expressed through lowering seedlot germination percentage, resulting in the “*Adjusted Germination Capacity*.”

Cost per Seed

If calculated, cost per seed is a huge incentive to conserve seed. If borne by the nursery it becomes part of seedling production cost. It then weighs against thinning cost, and as a percentage of seedling production cost can be seen to carry less weight when producing larger and more valuable seedlings. This relates to the cost of carrying an individual empty cavity, which is higher for larger stock-types.

Cavities per Block

This is the # of cells (cavities) per seedling growing tray (styrobloc), and in the calculations determines seedling growing density. i.e. the potential number of seedlings/unit growing area depending on whether or not every cell (cavity) in each block (seedling tray = styrobloc) contains a seedling. The majority of the industry centers around growing seedlings in “styroblocs” with a standard outside dimension (format 600), and varying numbers of cells/cavities <http://www.bpgrower.com/styrobloc.html>

Cost to Grow/Produce a Block

This relates to the per square meter growing space production cost. A 160 cavity block takes as much space as a 77 cavity block, hence costs the same to produce. However, the number of seedlings produced per unit area changes (from 756 to 364 per square meter), thereby affecting seedling production price, and how other input costs weigh against it.

Cost to Thin

Extra germinants per cell has a cost. There is a basic cost per block to enter the crop, which is spread over the number of cavities per block. In addition, there is the per cavity cost depending on the number of extra seedlings that require thinning in each cavity.

Desired/Required Nursery Handling Factor

This factor is instated to account for the fact that seeding machines are not 100% “tidy”. It allows for spillage, damage and other “wasted” seed. This is normally a very low number such as 0.15 seeds per cavity sown.

Desired/Required Green Stem Count

This refers to the total number of seedlings required from which to choose 100% of requested seedlings. It must account for culls generated by seedling specifications, pests, diseases, and so on.

125% is usually adequate, but many growers strive to reduce this < 110%. Previous nursery proceedings papers have focused on seedling specifications and how they interact with chosen container type, seedling growing density, nursery growing context, species, genetics, and so on. This is nursery specific information based on experience.

Transplant Thinned Seedlings into Empty Cells

Transplanting thinned seedlings into empty cells has a cost, carries a risk of failure, but if done well, can be worthwhile. This option can be used to reduce both the sowing factor as well as the over-sow factor. It only takes a small increase in sowing factor to generate enough “thinnings” to allow transplanting to 100% cavity fill. Far less seed is required than merely multiple sowing and discarding the thinned seedlings. If 100% cavity fill is achieved this way, then the desired green stem count can be minimized. The risk relates to the ability for transplanted seedlings to achieve contract specifications, given that the shock sets them back.

Assumptions in the Spreadsheet Tool

A basic assumption throughout is that seedling customers are not interested in receiving overruns, and the nursery is not interested in producing overruns. The desire is to have all nursery space allotted to growing on contract. The assumptions are basic and simplified. Incorporation of more detailed, more accurate, and additional nursery costs and biological/physical concepts will increase the spreadsheet’s predictive value as a decision making tool.

Example Scenarios Using the Spreadsheet Tool to Calculate Optimum Sowing Factor

Several situational examples are provided below to illustrate how the tool can be used.

Example Scenario 1 (Figure 1)

Scenario 1 assumes seed is free, empty cavities are carried (no transplanting), and nursery space is available to allow oversow factor adjustment as needed to provide for required green stems. Seeder accuracy is assumed to be 100% so we can easily see relationships between seedlot germination %, thinning cost, and seedling growing density when seed has no cost. The chosen seedlot quality of 96% shows the benefits of high quality seed, which encourages single sowing, and all the benefits that go along with that (minimum seed use, reduced disease transfer, maximum retention of genetic variability). The production cost of \$20 per Styrobloc is arbitrarily chosen, but should reflect reality for many in 2012. Dividing this cost by the number of seedlings in a block, provides the minimum seedling production cost for a single sown, 100% germination capacity seed, where all seedlings meet contract specification by end of season. One moves up from this production cost by requiring extra green stems to select from, employing less than perfect seed and equipment, and so on.

Figure 1 shows that if sowing multiple seeds and thinning is chosen, there is a basic minimum jump in seedling production cost just to enter the crop for this purpose. Single sowing and carrying the empty cavities is the best scenario here (lowest seedling production cost).

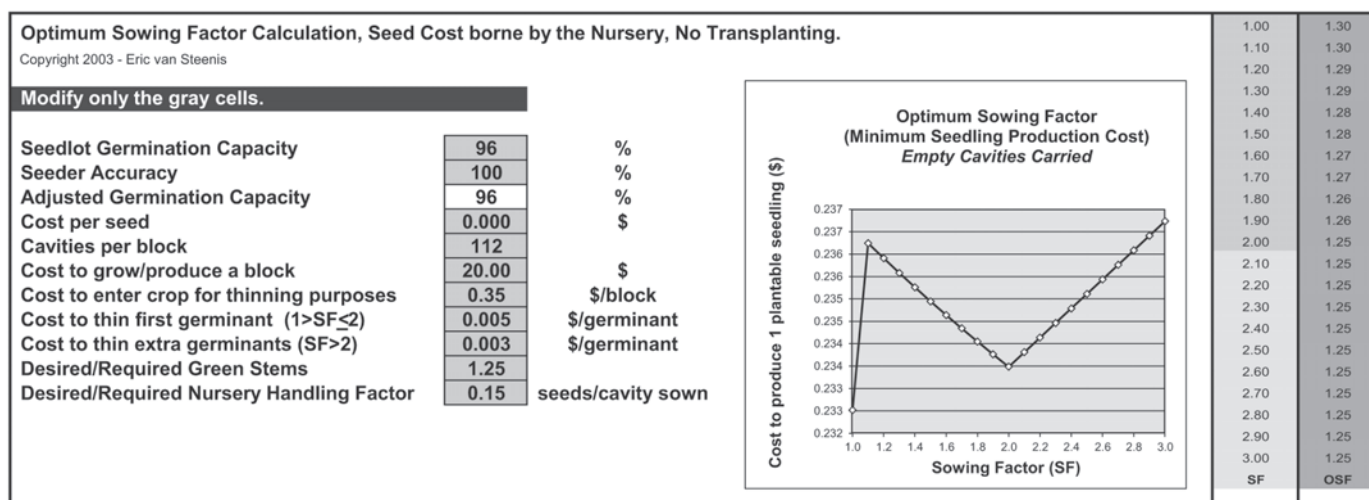


Figure 1. Optimum sowing factor calculation, seed cost borne by the nursery (no transplanting).

As sowing factor increases, required oversow factor decreases until we reach 2 seeds per cavity. For a 96% germination seed lot, the probability of an empty cavity remaining beyond 2 seeds/cavity is essentially zero. At greater than 2 seeds/cavity, thinning extra seeds/cavity drives increasing cost. In this case we cannot beat the production cost of single sowing. Please keep “2 seeds per cavity” in mind as we examine other scenarios below.

The only reason to sow multiple seed is in the event nursery space is limited and will result in having to turn away additional contracts. By going from 1 to 2 seeds per cavity, we reduce oversow factor from 130 to 125%.

Example Scenario 2 (Figure 2)

In Scenario 2, seed is also free, but a drastic reduction in seed quality to 85% is imposed, along with some seeder inaccuracy. The seedling growing density is the same as Scenario 1, so we can observe the cost influence of empty growing space due to seedlot germination capacity weighed against benefits of increasing sowing factor.

Thinning the crop increases seedling production cost, but due to the large number of empty cavities, as soon as we move beyond a sowing factor of 1.1 seeds/cavity we start reducing seedling production cost relative to single sowing. Note the fastest reduction in empty cavity count and subsequent seedling production cost occurs

between 1 and 2 seeds per cavity. Increasing sowing factor beyond 2 seeds per cavity reduces seedling production at a much decreased rate. Thinning costs weigh more heavily since extra seed expended does little in the way of eliminating empty cavities to offset additional labor costs.

Note that low germination seedlots require a larger commitment of nursery growing space at low sowing factors. Best approach in this case is to sow 2 seeds per cavity.

Example Scenario 3 (Figure 3)

Scenario 3 introduces a seed cost of 1 cent each. This might seem high/low depending on your situation, but gives an interesting result. We have raised germination percent to 94, but left seedling growing density and thinning costs the same as Scenarios 1 and 2.

Note the immediate impact on seedling production cost. Single sowing raises minimum cost per seedling by 1 cent/seedling. With a 94% seedlot in a relatively high density block (112), any increase in sowing factor adds proportionally significant (seed and thinning) costs to the price of each seedling.

Note that costs increase gradually up to 2 seeds per cavity, but then the law of diminishing returns takes effect in earnest. In this case, the lowest seedling production cost is at 1 seed per cavity. However, if nursery growing space is limiting and extra contracts are available, one could consider sowing up to 2 seeds/cavity. This

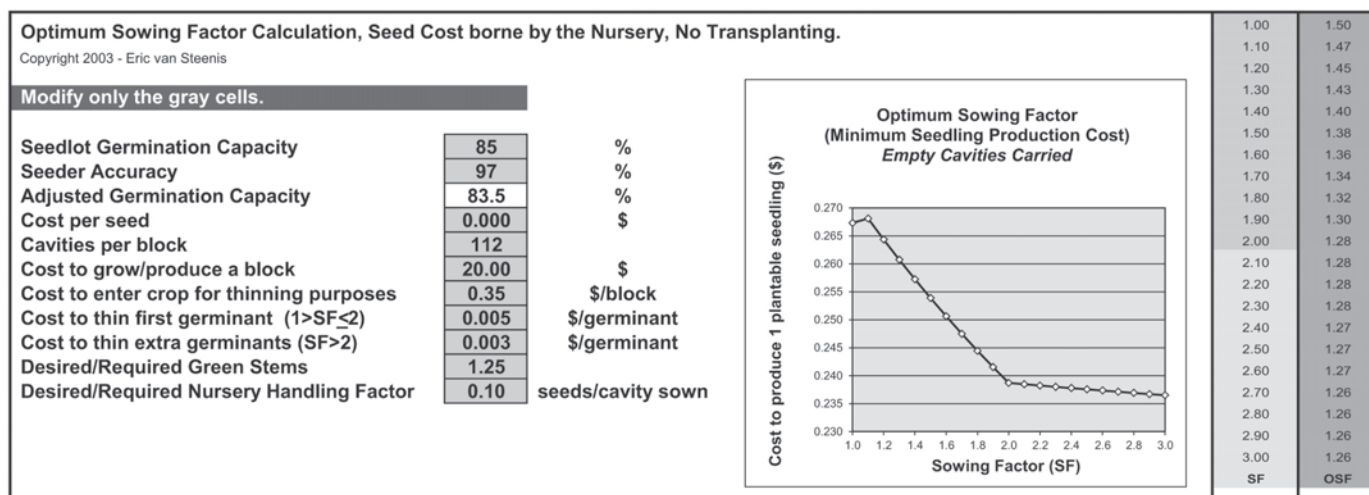


Figure 2. Optimum sowing factor calculation, seed cost borne by the nursery (no transplanting).

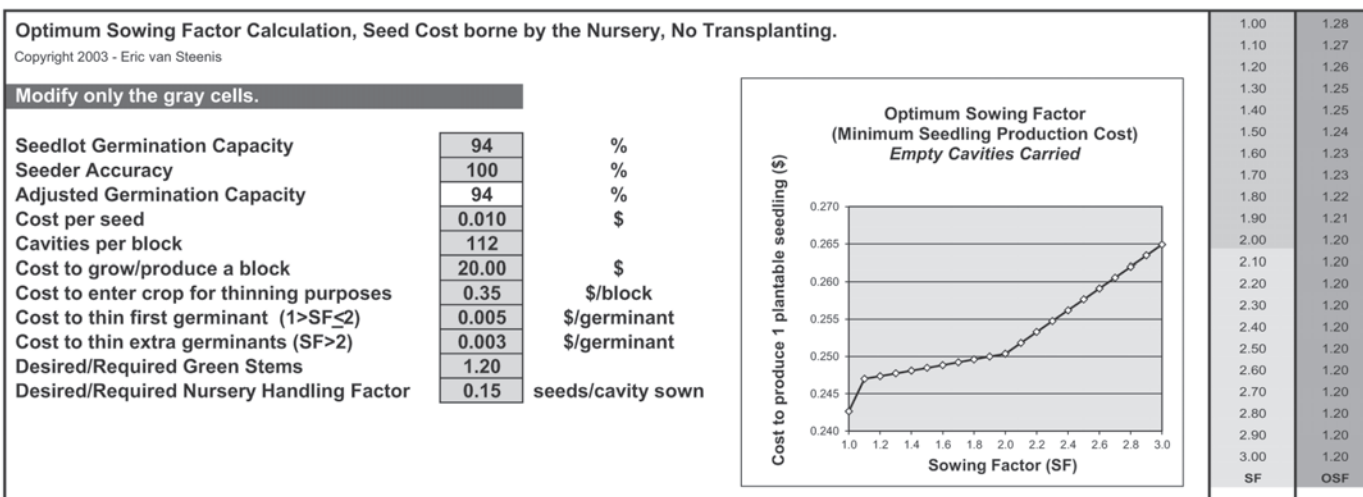


Figure 3. Optimum sowing factor calculation, seed cost borne by the nursery (no transplanting).

will reduce growing space for this contract by 8%. However, beyond 2 seeds per cavity it gets pricey, and we are not saving any more nursery growing space either. As seed price increases, single sowing becomes “economically” viable at lower seed-lot germination capacities, especially in small cavity blocks. This is in a 112 cavity block; results would be different for other sizes, such as a 240 cavity block.

Example Scenario 4 (Figure 4)

With seed cost at 1 cent each, in Scenario 4 we introduce a lower seedling growing density with a 77 cavity block. Notice that one can afford to throw extra 1 cent seeds at bigger cells (more valuable seedlings due to occupation of more growing space per seedling) to help eliminate empties, thereby reducing seedling production cost.

Again, sowing beyond 2 seeds per cavity does not make economic sense. At that point the minimum 1.20 oversow is realized, more seeds do not garner additional nursery space, and costs rise. In larger cavity blocks it is often economical to multiple seed even at higher germination capacities and incorporated seed costs. Basically, as the ratio of seedling production cost to seed cost increases, the more the economics favors multiple sowing.

Example Scenario 5 (Figure 5)

With seed cost remaining at 1 cent each, we introduce transplanting thinned seedlings. Note that at a sowing factor of ~1.4 you have enough thinned seedlings to transplant to 100% cavity fill. After that, the seed cost effects increasing seedling production cost, and there is no further gain in nursery growing space.

You can use the spreadsheet to insert your nursery’s cost and success rate for thinned transplants. These are very important numbers to have. If in doubt, stay conservative. Even the 50% success rate we have assumed in this scenario can be optimistic depending on your nursery context.

Example Scenario 6 (Figure 6)

Scenario 6 compares carrying empties to transplanting thinned seedlings into empties as they become available with increasing sowing factor. Carrying empties has a ~1.7 cent/seedling higher “minimum seedling production cost”. This is perhaps the most interesting spreadsheet in the workbook.

The spreadsheet assumes thinning costs are linear as sowing factor increases, which may not be correct. Note that in many cases a sow-

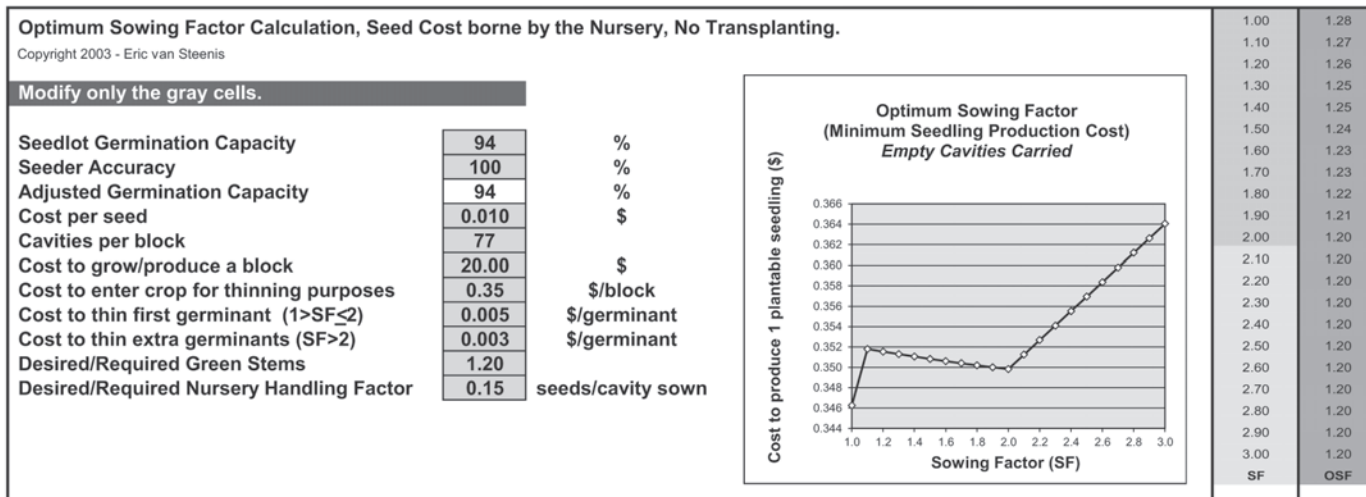


Figure 4. Optimum sowing factor calculation, seed cost borne by the nursery (no transplanting).

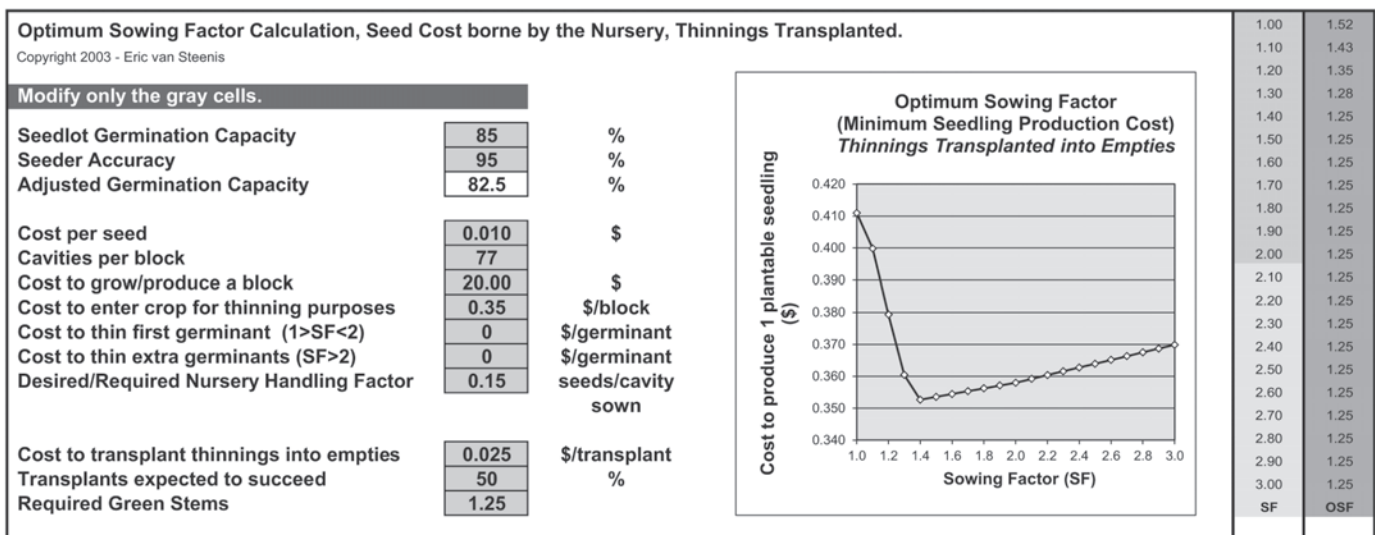


Figure 5. Optimum sowing factor calculation, seed cost borne by the nursery (thinnings transplanted).

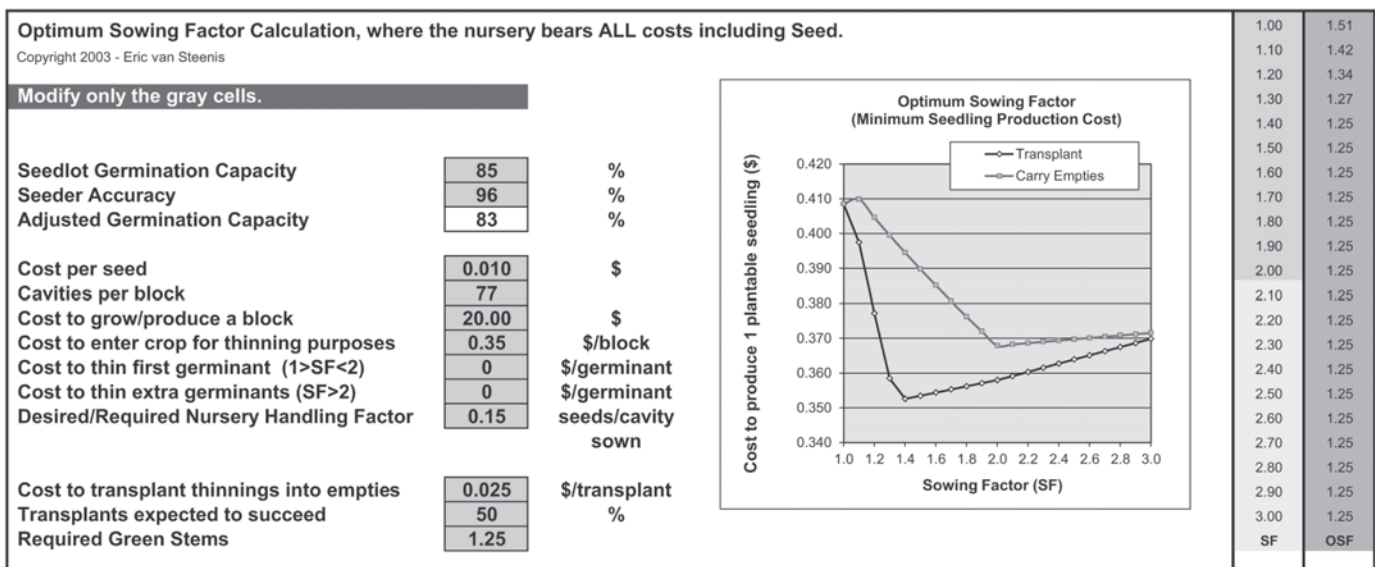


Figure 6. Optimum sowing factor calculation, where the nursery bears ALL costs, including seed.

ing factor of 2 seeds per cavity gives an inflection point in the graph. Thinning (and seed) costs start to assume a larger role in seedling production cost than the reduction in empties generated by incremental increases in sowing factors. An interesting discussion ensues if we introduce the genetic value of seed instead of merely its production cost. This can be a fun brainstorm.

Summary

This spreadsheet is a useful tool to evaluate options for sowing factors incorporating multiple nursery costs. Constructive criticism and ideas for improvements to this tool are welcome.