Evaluating Kernel Production for Young Nut Varieties

By John Kelsey

There appears to be a great potential for a commercial hazelnut industry in the eastern United States, particularly in areas suited for specialty crops. Plant breeders, experimental growers, and backyard hobbyists have plants that they like from an incredible variety of sources. They have experienced a wide range of results, from great promise to pure failures. The search is definitely afoot for the Great Eastern Hazelnut Cultivar.

This article explains a method to evaluate young nut varieties of mixed age. The age dependency is treated in a linear fashion based on roughly linear production growth shown in published data from Oregon orchards. Originally the basic evaluation idea was blatantly stolen from Dr. Thomas Molnar at Rutgers University. He is so gracious however, that he now acts as if it were all my idea.

The examples given here are from European hazelnuts, but the general method should be applicable, with minor adjustment, to any nut species. The method has been designed to evaluate young nut trees of mixed age and to be somewhat proportional to commercial value. This process is a bit time-consuming, so if there are a large number of seedlings we suggest only evaluating the obviously most promising. Each hopeful seedling is, of course, its own "variety".

The kScore method:

1. Begin by making a list (preferably in a spreadsheet) of each variety name to be evaluated. Add a column to the list for the total tree production years for each variety. For this evaluation, the year a seed was planted (or a fall transplant) at its current location is considered as leaf zero. The year a tree was spring transplanted at its current location is considered as leaf 1. For European hazelnuts, leaf 6 is the first production year. Production year is sort of like going to school, 6 year olds are in grade 1, 7 year olds are in grad 2, etc. For brevity, the production years will be called "pYears" or "pY". As an example, if you have 5 Yamhill hazels in their 7th leaf, each tree is in its 2nd production year and you have a total of 10 pYears for Yamhill.

	variety	site	leaf	pYear
1	Jefferson	03_08	7	2
2	Jefferson	07_02	5	0
3	Jefferson	07_06	6	1
4	Jefferson	09_04	7	2
5	Jefferson	09_07	7	2
6	Jefferson	09_09	7	2
7	Jefferson	10_05	6	1
8	Jefferson	11_10	7	2
9	Jefferson	12_02	6	1
10	Jefferson	12_07	7	2
11	Jefferson	12_12	7	2
12	Jefferson	13_07	7	2
13	Jefferson	13_12	7	2
	Jefferson			**21**

Figure A. Computing production years for variety Jefferson, with 13 trees totaling 21 pYears

Trees younger than pYear 1 are in kindergarten and are not expected to be evaluated, but applying the method to them has been instructive to help assemble the equipment and develop the physical details for collecting the required data. Just record kindergarten production "per tree" rather than "per pYear". Some good varieties are late starters, so resist drawing any important conclusions from kindergarten data. That would be like estimating a rookie's career batting average after his first game in the minors.

2. The next piece of data needed is the total in-shell weight for each variety. Harvest and weigh the nuts separately for each variety. Once weighed the varieties may be mixed together, but at some point save out a typical sample of about 100 good looking nuts for each variety. Store the samples keeping each variety sample separate in a dry and pest free location.

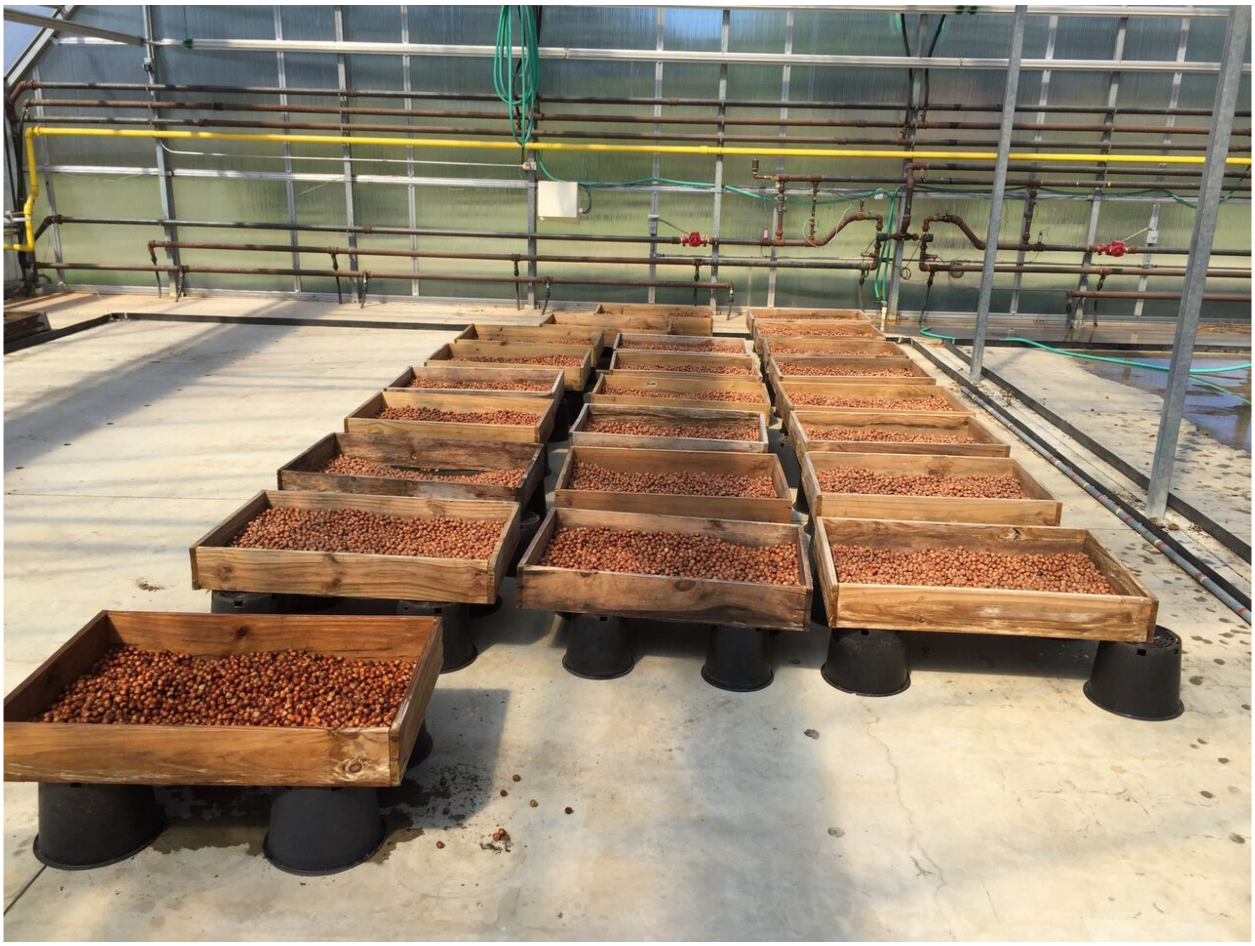

Figure B. Several varieties being stored in a dry location (photo courtesy of Dr. Thomas Molnar, Rutgers)

3. Determine the in-shell weight per pYear for each variety. A good answer for a European hazelnut variety would be around 2.5 pounds (about 1 kg.) in-shell per pYear. The in-shell weight per pYear is an intermediate result, and can often be misleading if the evaluation were to end here.

4. From the sample for each variety, crack 10 well-filled nuts and determine the percent yield by weight. Keep cracking until you get 10 good nuts. Penalties for bad and blank nuts will be applied below, so only use good nuts here. Weigh the 10 good kernels and then weigh their shells. Good European hazelnut varieties typically yield above 40% kernel by weight.

Figure C. Measuring the kernel yield of a 10 nut sub-sample.

5. To determine the kernel weight per pYear, multiply the in-shell weight per pYear by the percent yield. A good answer for a European hazelnut variety would be: 2.5 * 40% = around 1 pound (450 g.) kernel per pYear.

6. Now determine a kernel quality multiplier percentage (kMultiplier). From the variety sample randomly select 50 nuts. Crack the nuts and separate the kernels into three groups: good; blanks; and bad. Our test for “good” is, “would you eat it?” For a detailed descriptions of kernel defects see: https://www.ams.usda.gov/sites/default/files/media/FilbertHazelnut_Inspection_Instructions%5B1%5D.pdf and

https://www.ams.usda.gov/sites/default/files/media/Filbert_Visual_Aid%5B1%5D.pdf

Blanks get no credit, since they are unlikely to make it to our customers, but their weight is disallowed. Any kernel with mold or with a discolored spot is considered bad (no substitution and no favorites). These “bad” defects are far more serious than blanks, because they are hard to separate by equipment and are likely to reach our customers. The kMultiplier is the percent good minus the percent bad. If a variety has as many bad as good, then its kMultiplier is zero, which is about an accurate reflection of its commercial value for the year. Often a variety’s nut crop looks impressive under the tree, but cracking and evaluating the obvious kernel defects can change everything and send an apparent winner to the basement. For a really great variety, all the kernels are good, so a good kMultiplier should crowd 100%.

Figure D. Measuring the kMultiplier for BG4 seedling, showing 33 good, 11 blank, and 6 bad kernels.

kMultiplier = (33 good - 6 bad) / (50 nuts) = 54%

7. To determine a variety's final kernel production score (kScore); multiply the kernel weight per pYear by the kMultiplier. Since good varieties don't have much kMultiplier penalty, a good kScore for a European hazelnut variety is still around 1 pound (450 g.) kernel per pYear. Such a score is like par on the golf course. Few players (varieties) can achieve it.

Kernel production 2017

			in shell		10 nuts			kernel	50 nuts				
	cultivar	pYears	cleaned gm	cleaned gm/pY	kernel gm	shell gm	yield %	cracked gm/pY	good count	blank count	bad count	kMult %	kScore gm/pY
1	Butler	2	3,686	1843	12.7	16.5	43%	801	41	1	8	66%	529
2	Sacajawea	2	2,977	1488	13.1	12.2	52%	771	40	3	7	66%	509
3	Slate	4	6,804	1701	14.9	20.0	43%	726	37	8	5	64%	465
4	Tonda di Giffoni	6	3,459	576	14.7	18.2	45%	258	43	1	6	74%	191
5	Yamhill	16	11,793	737	9.7	11.8	45%	333	39	0	11	56%	186
6	BG4 seedling	7	4,309	616	13.0	18.7	41%	252	33	11	6	54%	136
7	G17	2	1,531	765	16.4	18.5	47%	360	33	1	16	34%	122
8	Royal	2	1,446	723	15.2	22.9	40%	288	28	9	13	30%	87

Figure E. Sample of varieties evaluated in Mason County, WV in 2017 sorted by kScore.(be warned: EFB is nearby, but has still not shown itself at our site.)

Variety	Trees	Planted	2015	2016	2017	2018	Max	Avg	sDev
Sacajawea	4	2012		11	504	832	832	449	413
Slate	4	2011	133	402	256	814	814	401	296
Royal	1	2011		0	385	627	627	337	316
York	2	2013			221	250	250	236	21
Butler	1	2011	131	0	641	160	641	233	281
Geneva	3	2011	587	12	62	125	587	197	264
Yamhill	10	2011	270	84	186	223	270	191	79
Carmela (208P)	5	2011	371	0	137	41	371	137	166
Jefferson	12	2011	381	0	127	34	381	136	172
Delta	1	2011	227	0	190	0	227	104	121
G17	1	2011	73	0	180	0	180	63	85
Tonda di Giffoni	3	2011		26	193	16	193	78	99
Dorris	2	2013			104	9	104	57	67
Gem	1	2011		0	214	0	214	71	124
GTSeedling	2	2011			104	54	104	79	35

	2015	2016	2017	2018
Avg	219	33	170	170

(shaded) Kindergarten

Figure F. Annual kScore data (gm/pY). Don't be surprised to see the ranking of varieties scrambled in the future. We also have high hopes that our younger selection will eventually move to the top of the list.

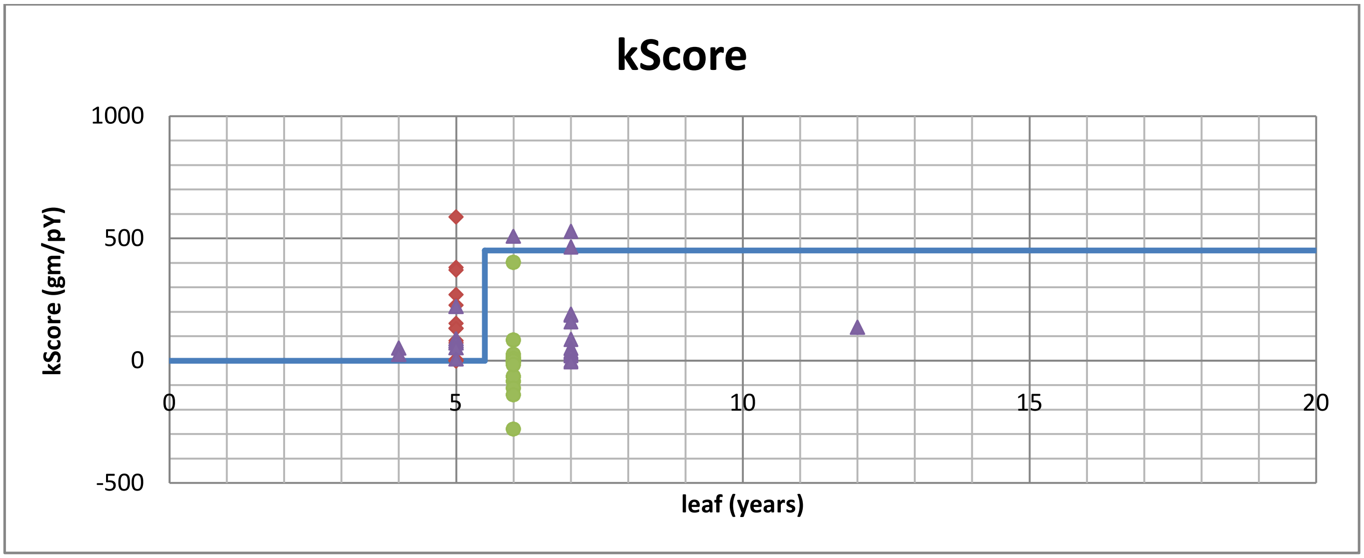

Figure G. Annual kScore results showing 3 years data for all varieties and the 450 gm/pY par line

Technical Note:

To apply the kScore method to other nut species or hybrids, the first production year needs to be established. This can be accomplished by linear regressing young tree production data vs. age from the better varieties of the species. The x-axis intercept from the regression is the zeroth production year and the regression slope will become the kScore "par".

Limitations:

The kScore method assumes that young trees are free to expand with open crowns on all sides, and that production increases linearly with age once production begins. The method certainly no longer applies once the canopy closes.

The kernel defects addressed in step 6 are rather obvious and their impact is clearly unacceptable for either in-shell or kernel markets. There are additional unaccounted kernel characteristic issues, like size, shape, blanching, splits, fiber, and taste. These issues are important but difficult to relate to commercial value, and are often equipment and customer dependent. The kScore measures the value of good kernel production, and then a grower can further rate their varieties with regard to other kernel characteristics, if they are locally important.

Conclusion:

The kScore method is a practical metric of kernel production value, without regard to the additional kernel characteristic issues. The value of having a standard evaluation method for breeders is that their prospects can be tested at various sites in a uniform and non-subjective manner. The value of having a standard method for growers is that their varieties can be compared (both locally and with others) and one gets a realistic sense of commercial value at an early stage – even if there is only one tree.

The variety Barcelona has been used as the “standard” European hazel, but the kScore method does not require the user to grow Barcelona. Another benefit of the kScore method will be in constructing more accurate models for analyzing the start-up economics for future commercial plantings. The sample size tradeoff is time vs. accuracy. The method uses rather small samples and does not have great statistical accuracy, but it is good enough to rank varieties in the correct order with minimum effort.

Anyone would want to know if their favorite young nut tree is really up to par.