FINAL PROJECT REPORT

Project Title: PNW pear rootstock trial

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Budget 1 – Cashmere and Tonasket Plots
Organization Name: WSU **Contract Administrator:** Jennifer Jansen
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	2009	2010	Total:
Salaries			
Benefits			
Supplies			
Travel			
Total	**$6,341**	**$4,950**	**$11,291**

Footnotes: Salaries and benefits are in support of 0.0769 FTE (4 weeks) of a full time technician. Travel is to plots: Tonasket – 244 miles round trip, 12 trips = 2,928 miles. Cashmere – 20 miles x 18 trips = 360 miles @ $0.55/mile.

Budget 2: Hood River Plot:
Organization Name: OSU **Contract Administrator:** Dorothy Beaton
Telephone: 541-737-4068 **Email address:** dorothy.beaton@oregonstate.edu

	Year 1 2009	Year 2 2010	Total:
Salaries[1]	$1,950	$2,028	
Benefits	$1,185	$1,233	
Wages			
Benefits			
Supplies	$300	$300	
Travel	$100	$100	
Total	**$3,535**	**$3,661**	**$7,196**

Footnotes: [1] 0.5 x FTE (2.5 weeks) of a full time technician (Hood River site.)

PACIFIC NORTHWEST PEAR ROOTSTOCK TRIAL

Original Objectives:
The six pear scions/rootstocks planted in 2005, now entering their 6th season, were evaluated on the following: 1. survival, 2. suckering, 3. vegetative growth potential (trunk size and tree diameter), 4. yield, and 5. fruit size. The yield and fruit size of the 2002 D'Anjou plots were also documented at both Hood River and Cashmere, as the trees were much slower than the other cultivars to yield crops adequate for evaluation.

None of the 2005 planted rootstocks induced both dwarfing and interesting yield efficiencies, nor did they prove equal or superior to OHxF 87 in productivity. Since no new 2005 trial rootstock showed promise by the end of the 6th leaf (fall 2010), this trial was terminated as was promised in the 2009 report. The 2002 planted D'Anjou have had good to excellent crops (finally) in the past two seasons, and data is sufficient to separate the performance of the various rootstocks in those trials.

JUSTIFICATION and OVERVIEW:
Most pear orchards in the USA have rootstocks that induce high vegetative vigor. While many of these orchards are quite old relative to other tree fruit orchards, the well-managed pear orchard continues to produce good yields of high quality fruit. However, many do not, often because high tree vigor brings multiple production and storage problems. These include: increased cost related to pruning, suckering, thinning and harvest labor, difficult insect management leading to additional sprays, fruit quality problems related to low fruit calcium, alternate bearing and crop loss due to post-harvest diseases that could have been greatly reduced with ground-applied fungicides a few days prior to harvest. Efforts to treat these symptoms of excessive vigor have cost a significant percentage of pear research dollars for decades, but the problems seem to remain at consistent levels. There has recently been very little obvious economic reason to change existing pear orchard systems, or even plant significant acreages of new pears. However, over the past two decades, it has become apparent to at least some industry leaders that pear growers may be forced to replace the current 1950's style pear orchard with either another profitable fruit, or, if they decide to stay in pear production, to grow their next pear orchard with smaller, easier to manage trees. In order to make the switch to possible semi-intensive or intensive systems, it seems obvious that dwarfing or semi-dwarfing rootstocks will be critical to the entire process, as they were to apple producers. While there had been efforts to create or test various pear rootstocks in the Pacific Northwest for several decades, and a few rootstocks in the Old Home x Farmingdale series had gained some recognition and use, there was general dissatisfaction with the speed and direction of the pear rootstock development and evaluation effort. It was proposed that trials be placed in environments that represented the wide variation existing in the Pacific Northwest. Therefore, pear rootstocks from various sources were tested with D'Anjou, Bartlett and Bosc in trials set up in Cashmere, Tonasket and Hood River.

Significant Findings of 2005 Trial:

1. No rootstock in the 2005 trial proved superior to OHxF 87 in most important factors.
2. Yields for trees on OHxF 87 have been consistently greater than the yields of trees on any other rootstock tested in this trial, in both the 2002 and 2005 trials.
3. Fruit size has generally been good to excellent on all cultivar/rootstock combinations.
4. Pyrodwarf has many negative attributes which vary in their intensity by site and year.
5. Pyro 2-33 has performed well, a close second place in over-all ranking with yields similar to those provided by OHxF 87 in some years and specific sites. This root has promise as a semi-dwarf choice for Bartlett superior to OHxF 87 in fruit size, yield and ease of hand thinning.
6. Horner 4a is neither dwarfing nor productive in this trial.

7. The 708-36, BU-2 and BU-6 rootstocks had significant mortality due to pear decline disease when planted in Washington. Trees on these roots had no death due to decline in Hood River.
8. Severe root suckering occurred only with Pyrodwarf. 708-36 produced a few suckers starting in the 8th leaf, but of much lower vigor and number.
9. It was demonstrated that pears can produce crop yields higher than the industry average by the 5th to 8th season, if planted on available semi-dwarfing rootstocks at 6 – 8 foot x 13 – 16 foot spacing, and trained to a central leader. In the 2002 planting, 9th leaf D'Anjou pears on OHxF 87, trained to a central leader, planted at 10 by 15feet, yielded 58,660 lbs/A (average box size 88) in the Hood River trial and 71,920 lbs./A in Cashmere (average box size 70). If the trees had been planted at 8 x 15 feet in the Cashmere trial, the tree spacing would have been optimum relative to tree size, and 9th leaf yields with OHxF 87 would have been about 90,000 lbs./A, and this yield was following 69,000 lb./A production in the 8th leaf.
10. The trellising of pears in two of the trials resulted in lower yields than those of the free standing trees at the same sites. Bartletts were more successful on the trellis than Boscs, and D'Anjous performed especially poorly on the upright trellis training system used in this trial.

Significant Findings of the Entire 2002 - 2005 - 2010 Trial:

1. A number of potential rootstocks, including some that were being sold commercially in Washington and Oregon, were shown to be inferior due to disease or cold injury susceptibility, yield, fruit size, the production of thorny root suckers, or a combination of these attributes. Early release of this negative data resulted in the cessation of production and sale of a poorly-tested rootstocks that in all three of the trials lagged behind the standard OHxF 87 as much as $20,000 per acre in gross receipts by the 8th leaf. No one will ever know how many acres of thorny roots-suckered, smaller-fruited, low production rootstocks would've been planted in the absence of this trial. Each 50 acres planted would have reduced gross returns by up to $1,000,000 in the first eight years of their production.

2. The OHxF 87 performed well enough in the D'Anjou and Golden Russet Bosc trials to become the current industry standard semi-dwarfing rootstock until something better comes along. These data have encouraged the nursery industry and WSU research to pursue better methods of propagating this rootstock, and they are making it much more available to Pacific Northwest pear growers.

3. Bartlett on Pyro 2-33 appears superior to Bartlett on OHxF 87. The lower fruit set induced by this root is adequate for good production, but leads to much faster fruit thinning, the fruit is consistently larger, and the compact trees are similar in size. The Pyro 2-33 remains free of diseases, such as pear decline, produces no root suckers, and seems to tolerate cold winter temperatures. This root did not generally out-perform OHxF 87 in Bosc or D'Anjou trials in Cashmere and Tonasket, but it was somewhat more dwarfing, and had slightly higher production efficiency in the Hood River D'Anjou trial.

Extension (Outreach) of the data and horticultural information developed trough this project:

1. Presentations to horticultural meetings: seven, to a total Washington/Oregon audience of 1900.
2. Web page and trial reports: about 800-900 "unique viewers" per year.
3. A summary to NC-140 of these rootstock trials was presented to the ISHS Pear Workshop by Rachel Elkins.
4. Pear horticulture orchard tours: eight, posters at WSHA meetings: three.

Summary of Results and Discussion:

D'Anjou- 2005 Planting Cashmere (*on a trellis*)	**2010 Pounds Fruit / Acre, 6th Year**	**2010 Average Box Size 44 / Avr. Fr. Wt.**	**2010 Total 1100 lb. Bins Fruit / Acre**	**2010 Lbs. Fruit / Tree**	**2010 Trunk Cross Sectional Area in CM^2**	**2010 lbs. Fruit per CM^2 of Trunk (Efficiency)**
OHxF 87	13,129	70	11.9	21.7	57.4	0.38
Horner 4a	5,264	73	4.8	8.7	57.2	0.15
BU-3	4,538	74	4.1	7.5	27.6	0.27
BM 2000	4,175	74	3.8	6.9	57.2	0.12
BU-2	3,267	78	3.0	5.4	30.7	0.18

Table 1. 2005 planting of D'Anjou pear, Cashmere, (6^{th} season), 6 x 12 ft. on 4-wire upright trellis, 605 trees / A.

D'Anjou- 2005 Planting Hood River (*free standing*)	**2010 Pounds Fruit / Acre, 6th Year**	**2010 Average Box Size 44 / Avr. Fr. Wt.**	**2010 Total 1100 lb. Bins Fruit / Acre**	**2010 Pounds Fruit per Tree**	**2010 Trunk Cross Sectional Area in CM^2**	**2010 lbs. Fruit per CM^2 of Trunk (Efficiency)**
OHxF 87	38,333	88	35	105.6	62	1.71ab
Pyro 2-33	38,273	87	35	86.2	44	1.95a
Pyrodwarf	32,960	83	30	90.8	56	1.61ab
708-36	31,124	87	28	70.1	49	1.44abc
28-119	30,374	81	28	29.2	23	1.29c
BU-3	29,836	78	27	67.2	42	1.60ab
Fox 11	29,038	82	26	65.4	49	1.35bc
Horner 4a	25,737	81	23	70.9	82	0.87c
BU-2	25,047	86	23	69.0	57	1.21bc
BM-2000	19,566	82	18	53.9	61	0.89c

Table2. 2005 planting of D'Anjou pear, Hood River, (6^{th} season), 10 x 18 ft. free standing, trained to a central leader, yields extrapolated as 8 x 15 feet, 363 trees per acre, smaller trees 444 / A.

D'Anjou 2002 Planting Cashmere	Pounds Fruit/ Acre, 9th Year 2010	Total Pounds Fruit/ Acre, 8th and 9th Year	2010 Bins Fruit / A	2010 Lbs. Fruit per Tree	2010 Average Box Size (fruit per 44 pounds)	Efficiency Lbs. Fruit per Square CM
OHxF 87	90,024	164,400	82	191	70	1.29
OHxF 40	75,141	134,915	68	153	70	1.01
Pyro 2-33	58,443	101,126	53	109	74	0.81
Fox 16	48,396	84,309	44	81	72	0.63
708 - 36	43,512	77,728	40	77	76	0.62
Fox 11	37,740	67,636	34	67	73	0.52
Pyrodwarf	26,136	50,208	24	62	80	0.44

Table 3. 2010 data from 2002 planting of Green D'Anjou, (9th season), yield, extrapolated yield, fruit size, trunk size and efficiency, in descending order of total yield. Planting space was calculated at 8 x 15 for the 363 trees / A, and 7 x 14 for the 444 trees / acre.

D'Anjou 2002 Planting Hood River	2010 Pounds Fruit/ Acre, 9th Year	2010 Bins Fruit / A	2010 Lbs. Fruit per Tree	2010 Avr. Box Size (fruit / 44 lbs)	Trunk Size Square CM	Efficiency Lbs. Fruit per Square CM
OHxF 87	73,471	67	202.4	89	126	1.61a
OHxF 40	68,208	62	187.9	92	131	1.43ab
Pyro 2-33	74,197	67	204.4	92	128	1.60a
Winter Nellis	62,981	57	173.5	88	138	1.26b
708 - 36	60,984	55	168.0	93	119	1.41
Pyro-dwarf	59,930	54	165.1	83	143	1.16
Fox 11	56,954	52	156.9	85	118	1.33

Table 4. 2010 Data from 2002 planting of Green D'Anjou, (9th season), yield, extrapolated yield, fruit size, trunk size and efficiency, in descending order of total yield. Planting space was calculated at 8 x 15 for the 363 trees / A.

Bartlett **2002 Planting Cashmere**	**2010 Pounds Fruit/ Acre, 9th Year**	**2005-10 Average Box Size: 44 / Avr. Fr. Wt**	**2010 Average Box Size: 44 / Avr. Fr. Wt**	**Total Bins Fruit /A 2004 - 2010**	**2010 Lbs. Fruit per Tree**	**Trunk Cross Sect. Area CM^2**	**2010 lbs. Fruit / CM^2 Trunk *Efficiency***
Pyro 2-33	62,100	88	69	116	172.5	117	1.47
Pyrodwarf	46,620	104	84	83	129.5	116	1.11
OHxF 87	62,400	90	71	102	173.3	109	1.59

Table 5. 2002 planting of Bartlett pear, Cashmere, (9^{th} season), yield, extrapolated yield, fruit size, trunk size and efficiency. Yields based on 390 trees per acre (7.5 x 15 ft.).

Survival of the tree:

The BU-2 and BU-3 in the 2005 trial appear to be affected by pear decline at the Cashmere D'Anjou and the Tonasket Bosc site. The Hood River site does not seem to have this pear decline problem, as even the 2002 planting of 708-36 did not become diseased. Tree survival at the Hood River trial has been virtually 100%. Temperatures of -10 to -15F, or lower have occurred at the Tonasket and Cashmere trial sites. If any of the 2005 planted rootstocks are not quite cold tolerant, this would have become apparent during the summers of 2009 and 2010.

EXECUTIVE SUMMARY:

1. In both trial plantings, 2002 and 2005, Old Home x Farmingdale 87 rootstock, the semi-dwarf rootstock standard at the time the trials were initiated, proved superior to the other rootstocks tested in almost every important aspect. Health and growth of the tree were equal or better than many of the other rootstocks. Precocity and yields were almost always superior. Although many experienced pear growers say it produces fruit smaller than those produced on large, seedling trees, the fruit produced on OHxF 87 rooted trees was invariably large, at times too large, and even with recent high yields of 70 - 90 bins per acre equivalence, has shown no trend toward smaller size. The precocity brought on by this root might cause oversetting of fruit in the early years of orchard establishment, leading to runting of the tree and subsequent smaller fruit size, but that scenario did not play out in the nine seasons of testing with Bartlett, Bosc and D'Anjou. This rootstock is not the equivalent of the Malling 9 in apples, it is perhaps more the equivalent of M 106; better by far than seedling or OHxF 97, but not what the industry is ultimately hoping to find.
2. The Pyro 2-33 and OHxF 40 vied for second place in over-all performance. The OHxF 40 probably did fairly well under the conditions of the trial (10 foot row spacing) because it is a fairly large tree, and had more bearing surface in the early years. Yield efficiency lagged behind other rootstocks in many of the test years and sites. Pyro 2-33 trended toward being more dwarfing than OHxF 87, and in some of the trials and years, had equivalent yield efficiency. It was the superior rootstock for free standing, central leader Bartletts, as it produced a tree that bloomed sufficiently for yield, but not in excess, leading to much simpler hand thinning, and usually larger fruit.
3. Perhaps as important as finding the top performers of the world's then-available rootstocks was the discovery of the limitations of those that performed poorly. Some of the rootstocks, such as the Fox 11 and 16, were neither bad nor good in any aspect we were looking for. Others, such as 708-36, BU-2 and BU-3 had serious problems with pear decline in the North Central Washington plots. However, Pyrodwarf, which was lightly tested for only several years prior to its release, and was being sold during the first few years of this trial, demonstrated some important deficiencies. While it often was one of the least precocious rootstocks in the trials, with subsequent low yields and relatively vigorous growth, the fruit size trended towards last place in the trials most seasons. In a few infrequent instances, the fruit size induced by Pyrodwarf has been competitive in a specific trial or season. Finally, under almost every Pyrodwarf rooted pear tree in the plot are numerous, vigorous and thorny root suckers that are unpleasant to work around and would require yearly attention.

Pear growers will benefit from the discovery of a practical semi-dwarf pear rootstock much as the apple growers did when apple production switched from using seedling rootstock to using more manageable and productive semi-dwarf roots such as Malling 106, but the pear grower will not face the collar rot issues that came with M 106. Semi-dwarfing apple rootstocks were not the final horticultural answer to apple growers, as they soon turned to more dwarfing rootstocks that were available. At this time, there is no M9 equivalent in pear rootstocks, so until a better pear rootstock is developed, we will need to better identify, understand and work with the best amongst the current semi-dwarf pear rootstock choices.