FINAL PROJECT REPORT **EARLY TERMINATOIN**
WTFRC Project Number: PR-099-903A

Project Title: PNW Pear Rootstock Trial

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Total Project Funding: **Year 1:** $9,876 **Year 2:** $8,611

Other funding sources

$4,000 grant from the Northwest Nursery Improvement Institute in support of the pear on trellis management demonstration at the Tonasket rootstock trial site.

Budget 1 – Cashmere and Tonasket Plots
Organization Name: WSU **Contract Administrator:** Jennifer Jansen
Telephone: 509-335-2867 **Email address:** jjansen@wsu.edu

	2009	**2010**	
Salaries	$2,880	$3368	
Benefits	1,353	1582	
Supplies	300		
Travel	1,808		
Total	**$6,341**	**$4,950**	

Footnotes: Salaries and benefits are in support of 0.0769 FTE (20 days) of a full time technician.

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**	
Salaries[1]	$1,950	$2,028	
Benefits	$1,185	$1,233	
Wages			
Benefits			
Supplies	$300	$300	
Travel	$100	$100	
Total	**$3,535**	**$3,661**	

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

ORIGINAL OBJECTIVES:

The seven pear scions/rootstocks planted in 2002 and the six planted in 2005, now completing their 9th and 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.

SIGNIFICANT FINDINGS

Impact of This Work:
There were at least four significant outcomes to this project:

- A number of potential rootstocks, including one that was being sold commercially in Washington and Oregon, were shown to be inferior due to disease or cold injury susceptibility, comparative yield, fruit size, the production of thorny root suckers, or a combination of these attributes. These findings stopped the sale of this rootstock, which helped potential buyers avoid great financial loss over time.

- The OHxF 87 performed well enough in the trial to become the industry standard semi-dwarfing rootstock until something better comes along. Nurseries responded by growing more trees on this root, rather than the easier to produce OHxF 97, a rootstock that induces much more vigorous, and larger, trees. This has resulted in availability of this root to pear growers who wish to take advantage of its benefits.

- Bartlett on Pyro 2-33 appears superior to Bartlett on OHxF 87, and especially to those on Pyrodwarf. Superiority is due to a more balanced fruit set, leading to less hand thinning, superior fruit size, and yields equal to or slightly higher than produced by OHxF 87. Several growers now have Bartlett on Pyro 2-33 planted.

- Planting of pears is relatively uncommon, and "traditional" pear growers usually see no need to change away from good quality orchards producing high yields of large fruit. However, if a grower has a reason to replace an orchard and wishes to grow pears, this rootstock trial has demonstrated that semi-intensive planting systems offer the best opportunity to achieve full production in less than eight years, rather than the traditional 14 to 16. Through the use of the best available rootstocks (OHxF 87 for most pears, or Pyro 2-33 for Bartlett), and good horticultural management, we have demonstrated and documented that a grower may be able to produce significant yields as early as the 5th or 6th season after planting.

- Planting D'Anjou and Bosc pears on OH x F 87 at 6 x 14 feet and training them on an upright trellis did not lead to production equal to that achieved by planting on the same rootstock at 8 x 15 feet and training to a free-standing central leader system. About 70% of the fruit could be harvested without a ladder in the mature free-standing system, which the harvesting crew considered a great advantage.

- Comparing the most productive (OH x F 87) to the least productive (Pyrodwarf) rootstock, full russet Bosc in a free standing system, by the 8th season the OH x F 87 orchard would have returned a gross total of $40,940 / acre, the Pyrodwarf rootstock orchard managed similarly would have returned $19,110 / acre. The Bosc on OH x F 87 will "break even" economically in the 9th or 10th year; about one-half of the necessary time for traditional pear

planting spacing and rootstocks. The year that the Boscs on Pyrodwarf will break even is not yet possible to predict.

RESULTS & DISCUSSION

D'ANJOU

9th and Final Season (2010) Data on 2002 Planted Trees, PNW Pear Rootstock Trial, D'Anjou:

D'Anjou 2002, Cashmere 2010 Harvest	2010 Pounds Fruit/ Acre, 9th Year	Calc. Trees Per Acre	2010 1100 lb. Bins Fruit / A	2010 Avr. Box Size (fruit per 44 pounds)	2010 Lbs. Fruit per Tree	2010 Trunk Cross Section Area CM^2	2010 lbs. Fruit / CM^2 of Trunk
OHxF 87	80,104	323	72.8	70	248	148	**1.68**
OHxF 40	66,861	323	60.8	70	207	151	**1.37**
Pyro 2-33	52,003	323	47.3	74	161	135	**1.19**
Fox 16	42,401	389	38.5	72	109	128	**0.85**
708 - 36	38,122	389	34.7	76	98	125	**0.78**
Fox 11	33,065	389	30.1	73	85	129	**0.66**
Pyrodwarf	23,256	323	21.1	80	72	140	**0.51**

Table 1-1. 2010 Data from the 2002 planting of Green D'Anjou, (9th season), listed in descending order of total yield. Planting space was calculated at 9 x 15 feet for the 323 trees per A, and 8 x 14 feet for the 389 trees per acre.

8th Season Data on 2002 Planted Trees, PNW Pear Rootstock Trial, D'Anjou:

D'Anjou 2002, Cashmere 2009 Harvest	2009 Pounds Fruit / Acre, 8th Year	Calc. Trees Per Acre	2009 1100 lb. Bins Fruit / A	2009 Avr. Box Size (fruit per 44 pounds)	2009 Lbs. Fruit per Tree	2009 Trunk Cross Section Area CM^2	2009 lbs. Fruit / CM^2 of Trunk
OHxF 87	61,693	323	56.1	81	191	145	**1.32**
OHxF 40	49,419	323	44.9	89	153	141	**1.09**
Fox 16	37,733	389	34.3	86	81	97	**0.84**
Pyro 2-33	35,207	323	32.0	88	109	119	**0.92**
708 - 36	29,953	389	27.2	93	77	102	**0.75**
Fox 11	26,063	389	23.7	86	67	105	**0.64**
Pyrodwarf	20,026	323	18.2	95	62	120	**0.52**

Table 1-2. 2009 Data from the 2002 planting of Green D'Anjou, (8th season), listed in descending order of total yield. Planting space was calculated at 9 x 15feet for the 323 trees / A, and 8 x 14 feet for the 389 trees / acre.

BARTLETT

Bartlett 2002 Planted 2010 Harvest	Total Yield To Date in Pounds per Acre	2010 Yield In 1100 lb bins per Acre	Average Fruit Box Size 2010 (Fruit / 44 Pounds)	2010 Pounds Fruit Per Tree	Trunk Size in Sq. cm (Veg. Growth)	2010 Yield Efficiency Lb. Fruit / cm^2	Total Yield 04-2010 Efficiency Lb. Fruit / cm^2
Cashmere Pyro 2-33	194,875	61	69.3	172.5	117	1.47	**4.27**
Cashmere Pyrodwarf	141,805	46	84.1	129.5	116	1.12	**3.13**
Cashmere OHxF 87	179,787	61	70.9	173.3	109	1.59	**4.23**

Table 2-1. Summary data for Cashmere site, 2002 planted (9th leaf) Green Bartlett pears, 2010 season and averages of all years. 7.5 x 15, 390 trees / Acre tree spacing.

Bartlett 2002 Planted	2009 Yield In lbs. per Acre	Total Yield To Date in Pounds per Acre	Average Fruit Box Size (Fruit / 44 Pounds)	Trunk Size in Sq. cm (Veg. Growth)	2009 Pounds Fruit Per Tree	2009 Yield Efficiency Lb. Fruit / sq. cm	Total Yield Efficiency Lb. Fruit / sq. cm
Tonasket Pyro 2-33 02 to 09	70,885 **8th Leaf**	191,259	82	71.3	160	2.24	**6.04**
Tonasket Pyrodwarf 02 to 09	72,489 **8th Leaf**	121,016	98	70.4	163	2.32	**3.87**

Table 2-2. Summary data for 2002 planted (8th leaf) Green Bartlett pears, 2009 season and averages of all years. Note data is from two sites, Cashmere 7.5 x 15, 390 trees / Acre tree spacing and Tonasket 7 x 14 ft for 444 trees / Acre. Note: the higher the box size number, the smaller the fruit.

BOSC

The Bosc portion of this trial suffered a serious crop reduction, probably due to frost at full bloom, and was not evaluated in 2010.

8th and Final Season (2009) Data on 2002 Planted Trees, PNW Pear Rootstock Trial, Bosc:

Bosc-2002 Planted, Tonasket	Trunk Size in Sq. cm (Veg. Growth)	2009 Yield In lbs. per Acre 8th Leaf	Total To Date Pounds per Acre	Average Fruit Box Size (Fruit / 44 Pounds)	2009 Pounds Fruit Per Tree	2009 Yield Efficiency Lb. Fruit / sq. cm	Total Yield Efficiency Lb. Fruit / sq. cm
OHxF 87	117	60,797	**204,696**	73	156	1.33	**4.49**
OHxF 40	98	45,513	**169,724**	77	117	1.19	**4.44**
Pyro 2-33	92	32,500	**156,243**	76	83	0.90	**4.35**
708 - 36	62	35,383	**131,057**	83	74	1.19	**4.40**
Fox 11	74	35,710	**130,434**	76	80	1.08	**3.97**
Fox 16	72	33.049	**108,602**	71	69	0.84	**3.16**
Pyrodwarf	108	28,557	**105,111**	78	73	0.68	**2.50**

Table 3-1. Summary data for 2002 planted (8th leaf) Golden Russet Bosc pears, 2009 season and averages of all years.

2005 Planted Section of the Rootstock Trial:

In Tonasket, the 2005 Golden Russet Boscs are spaced 6 x 14 ft on an upright 4 wire trellis, and had variable production in their 3rd leaf, and significant production in their 4th and 5th growing season. The 6th growing season, 2010 was essentially a crop failure due to frost damage at time of full bloom, so no data is available. The D'Anjous in Cashmere, also trellised, had a very light yield so far. Data is provided below (Table 4-1) to illustrate the frustration of growing a pear cultivar that is inherently slow to come into bearing (D'Anjou) with a semi-dwarfing (at best) rootstock, on a site with good soil.

Trunk size (vegetative growth:,
Trunk size, Cashmere D'Anjou on trellis, cross-section area in square centimeters, in descending order of size: OHxF 87 (57.4), Horner 4a (57.2), BM-2000 (57.2), BU-2 (30.7), and BU-3 (27.6). The trunk sizes in inches of diameter were OHxF 87 (3.36), Horner 4a (3.35), BM-2000 (3.34), BU-2 (2.45), and BU-3 (2.31). The Bartlett pollenizers on Horner 4a have a trunk cross sectional area of 83 cm^2 (or a diameter of 2.9 inches). The Horner 4a and BM 2000 trees are growing more vigorously than those on OH x F 87, even though the trunk sizes are similar.

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, and that root that had significant pear decline problems in the northern Washington trial site. Tree survival at the Hood River trial has been virtually 100%. Temperatures of -10 to -15ºF, or lower occurred at the Tonasket trial site in December, 2008, and October 8 – 10 2009 low temperatures reached 10-12ºF. No cultivar/rootstock combination in the 2002 and 2005 rootstock trial has shown any symptoms of damage due to these two cold temperature events.

Root suckering:

No significant suckering was observed on any rootstock other than Pyrodwarf, and to a much lesser extent, 708-36. Pyrodwarf roots started developing suckers by their third season of growth. In the 2002 planting, these Pyrodwarf suckers became large, numerous and thorny by the 5th season of tree growth. Fewer, and much less thorny and vigorous suckers began to develop in the 2002 planted trees from the 708-36 roots by the 8th growing year.

Yields, fruit size and Efficiency:

The Bosc scion/rootstock combinations began to produce commercially significant yields in the 4th, and especially in 2009, their 5th season. Unfortunately, in 2010, frost greatly reduced yields. The D'Anjou rootstock trial has never set a crop worth picking, except for those trees on OHxF 87, which, in the 6th leaf may have been worth picking, but barely (Table 3.1). The BU-2 and BU-3 rootstocks are the most dwarfing of any pear rootstock tested in either the 2002 or 2005 sections of the trial. Unfortunately, both of these roots have disease/survival problems, and almost half of the trees in the D'Anjou trial had symptoms of pear decline disease, and then died.

D'Anjou-2005 Planting Cashmere (on a trellis)	2010 Pounds Fruit/ Acre, 6th Year	2010 Bins Fruit / Acre	2010 Average Fruit Box Size	2010 Trunk Cross Sectional Area in CM^2	2010 Lbs. Fruit / Tree	Total lbs. Fruit per CM^2 of Trunk (Efficiency)
OHxF 87	13,129	11.94	69.6	57.4	21.7	0.378
BM 2000	2.481	2.26	74.3	57.2	4.1	0.072
Horner 4a	5,264	4.79	73.4	57.2	8.7	0.152
BU-2	1,876	1.71	78.3	30.7	3.1	0.101
BU-3	4,477	4.07	74.3	26.7	7.4	0.277

Table 4-1**. 2010 harvest of the 2005 planting, D'Anjou** pear, Cashmere, (6th season), 6 x 12 ft. on 4-wire upright trellis (605 trees/A).

Bosc-2005 Planting Tonasket (on a trellis)	**2007-08 Pounds Fruit/ Acre, 3rd and 4th Year**	**2009 Pounds Fruit/ Acre, 5th Year**	**Total Fruit Weight / Acre by 5th Season**	**07+ 08 + 2009 Total Bins Fruit / Acre**	**2009 Average Fruit Box Size**	**2009 Trunk Cross Sectional Area in CM^2**	**2009 Lbs. Fruit / Tree**	**Total lbs. Fruit per CM^2 of Trunk (Efficiency)**
OHxF 87	19,342	24,844	44,186	40.2	84	43.8	47.8	1.95
Pyrodwarf	12,307	24,209	36,516	33.2	78	41.8	46.6	1.69
BM 2000	11,519	17,531	29,050	26.4	81	42.8	33.7	1.31
Pyro 2-33	9,689	16,640	26,329	23.9	77	30.6	32.0	1.66
Horner 4a	7,463	13,195	20,658	18.8	85	40.1	25.4	0.99
BU-3	3,761	5,920	9,681	8.8	65	16.5	11.5	1.13
Bartlett Horner 4a	10,231	17,160	27,391	24.9	81	28.7	33.3	1.16
2002 Free-standing Bosc in 4th & 5th Leaf OHxF 87	*8,814*	*31,763*	*43,338*	*36.9*	*78*	*46.4*	*81.4*	*2.39*

Table 4-2. 2009 yields, 2005 planting of Golden Russet Bosc pear, Tonasket, (5th season), 6 x 12 ft. on 4-wire upright trellis. Bartlett is pollenizer, every 5th tree. Note the comparison of the 4th and 5th leaf results in the 2002 free standing trial at a similar stage of development, lower row of table.

No new 2005 trial rootstock was sufficiently productive by the end of the 6th leaf (fall 2010), so this trial was terminated.

EXECUTIVE SUMMARY

02 Bosc	Survival	Tree Size (dwarfing)	Suckering (no)	Yield	Fruit Size	Efficiency	Average
Multiplier	***5***	***3***	***5***	***4***	***3***	***3***	
OHxF 87	25	0	25	20	15	15	**16.7**
OHxF 40	25	0	25	12	3	9	**12.3**
Pyro 2-33	25	0	25	4	15	3	**11.8**
Fox 16	0	9	25	0	9	0	**7.2**
Fox 11	0	9	25	0	9	0	**7.2**
Pyrodwarf	25	0	0	0	0	0	**4.2**
708-36	0	15	0	0	0	0	**2.5**

Bosc 2002 Trial through 8th crop. Assigned score value re: place in factor ranking, 1st = 5, 2nd = 3, 3rd = 1, 4-7th = 0, then multiplied that score by multiplier factor valuing relative importance. 5 = Must have, 4 = Very important, 3 = Important.

2002 D'Anjou	Survival	Tree Size (dwarfing)	Suckering (no)	Yield	Fruit Size	Efficiency	Average
Multiplier	***5***	***3***	***5***	***4***	***3***	***3***	
OHxF 87	25	0	25	20	15	15	**16.7**
OHxF 40	25	0	25	12	9	9	**13.3**
Fox 16	25	9	25	0	3	0	**10.3**
Fox 11	25	9	25	0	0	0	**9.8**
Pyro 2-33	25	0	25	4	0	3	**9.5**
Pyrodwarf	25	0	0	0	0	0	**4.2**
708-36	0	9	0	0	0	0	**1.5**

D'Anjou 2002 Trial through 9th crop. Assigned score value re: place in factor ranking, 1st = 5, 2nd = 3, 3rd = 1, 4-7th = 0, then multiplied that score by multiplier factor valuing relative importance. . 5 = Must have , 4 = Very important, 3 = Important.

	Survival	Tree Size	Suckering	Yield	Fruit Size	Efficiency	Average
OHxF 87	100	53	100	100	97	100	
OHxF 40	100	63	100	83	92	99	
Pyro 2-33	100	67	100	76	93	97	
Fox 16	70	86	100	53	100	70	
Fox 11	70	84	100	64	93	88	
708-36	80	100	80	64	85	98	
Pyrodwarf	100	57	0	51	91	57	

Bosc 2002 Trial through 8th crop. Percentage re best performing root within the category. Higher average is better. Tree size = smallest tree / tree being scored. Fruit size = largest size / size from rootstock being rated. Higher score is better.

	Survival	Tree Size	Suckering	Yield	Fruit Size	Efficiency	Average
Importance Wt. Factor	5	3	5	5	4	3	**Total score / 6**
OHxF 87	500	159	500	500	388	300	**391**
OHxF 40	500	189	500	415	368	297	**378**
Pyro 2-33	500	201	500	380	372	291	**374**
Fox 16	350	258	500	265	400	210	**331**
Fox 11	350	252	500	320	372	264	**343**
708-36	400	300	300	320	340	294	**326**
Pyrodwarf	500	171	0	255	364	171	**244**

Above table with score weighted re importance of factor. 5 = Must Have ,4 = Very important, 3 = Important 1. Not wanted 0 =. A no-no. Bosc 2002 Trial through 8th crop. Percentage re best performing root within the category. Higher average is better. Tree size = smallest tree / tree being scored. Fruit size = largest size / size from rootstock being rated. Higher score is better

	Survival	**Tree Size**	**Suckering**	**Yield**	**Fr. Size**	**Efficiency**	**Average**
Importance	***1***	***3***	***5***	***1***	***2***	***2***	
OHxF 87	1		0	2	6	4	
OHxF 40	1		0	4	15	8	
Pyro 2-33	1		0	6	12	16	
Fox 11	5		0	12	9	20	
Fox 16	6		0	8	3	24	
708-36	7		30	10	21	12	
Pyrodwarf	1		35	14	18	28	

Lower score is better. 5 = Must Have ,4 = Very important, 3 = Important 1. Not wanted 0 =. A no-no. Score is weight factor x percent relative to the best performance root in that category

	Survival	**Tree Size**	**Suckering**	**Yield**	**Fruit Size**	**Efficiency**	**Average**
OHxF 87	1	7	1	1	2	1	**2.17**
OHxF 40	1	5	1	2	5	2	**2.67**
Pyro 2-33	1	4	1	3	4	4	**2.83**
Fox 16	5	2	1	4	1	6	**3.17**
Fox 11	6	3	1	6	3	5	**4.00**
708-36	7	1	6	5	7	3	**4.83**
Pyrodwarf	1	6	7	7	6	7	**5.67**