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Van Hazinga

1997 Organic Wheat and Edible Dry Bean Variety Trials in Orwell, VT

Dan Baker, March, 28 1998

Domesticated crop plants don't go back much farther than wheat, with barley being the only other real contender. After some 10,000 years supporting human society wheat remains a crop of supreme importance to our collective future. Grown on vast acreages west of Vermont, the increasing number of locally based flour mills may make this crop part of the future of Vermont agriculture. Well established companies like the King Arthur Flour Company Champlain Valley Milling, and small new mills such as the Green Mountain Milling Co. provide attractive markets for locally produced bread wheats. Ken Van Hazinga, farm manager at Mt. Independence Farm in Orwell, VT, along with Jeff Carter of UVM Extension and crop advisor Dan Baker applied for a SARE grant last summer to research varieties of spring wheat suitable for production of bread flour in Vermont.

The value of including legumes in a grain crop rotation is well established. Typically, farmers in Vermont include leguminous forage crops such as alfalfa and clovers. Recently, UVM Extension has sponsored workshops promoting soybean production as a profitable annual legume. As a counter-part to the wheat variety trials, Ken also received a SARE grant to conduct variety trials comparing edible dry beans.

Mount Independence Farm

Mount Independence Farm was purchased by its current owner in 1995 and has grown NOFA-certified organic winter wheat, organic soybeans, organic oats and transitional hay crops since that time. These crops are sold to area mills as organic feed and also used in the farm's 100+ heifer-raising operation. The 240 acre farm is located in Orwell, VT a few hundred feet from Lake Champlain and bordering the East Creek Waterfowl Area, an important wildlife conservation area. The farm was initially purchased by the Nature Conservancy, who permanently established wide buffer strips along the edges of the fields bordering surface waters and wetlands. In addition to the owner Ben Kernan, the farm employs a full-time farm manager, one full time farmhand, and part-time help.

Mount Independence Farm Crop Rotation

* 3-4 yr. legume/grass sod
* 1 yr winter wheat
* 1 yr. Soybeans
* 1 yr. Winter wheat
* 1 yr Soybeans followed by winter wheat cover (plowed down)
* Spring grain over grass/legume seeding

Much of the farmland is classic Addison County clays, including legendary Vergennes clay, along with Covington, Eldridge, and Swanton soils. The climate is relatively warm by Vermont standards and the climate is somewhat drier than surrounding areas in the county due to the influence of the Adirondack Mountains to the west.

Wheat Variety Trial

Most farms producing wheat in Vermont typically grow soft white winter wheat. This

fall-planted grain is very winter hardy and generally produces good yields harvested in mid-summer. Soft winter wheats are used for pastry flour, biscuits and some noodles but are generally not suited for bread flour, which requires a harder, higher protein wheat. Winter wheat yields are considerably higher than spring wheats. Cornell reports average New York winter wheat yields around 50 bu/A, compared to hard red spring wheat yields range from 30-45 bu/acre.

Little research is available that could help Vermont farmers choose a hard spring wheat variety and the grant application proposed to compare six varieties. In fact, seven varieties were grown, when seed for a hard white spring wheat was obtained. The naturally light color of the flour of white wheats is particularly appealing for the unbleached flour market. With the exception of *Classic*, all other varieties grown were hard red wheats.

Hard Spring Wheat Suppliers

Champlain Valley Milling:
- Oxen (bearded) } HRS
- Russ (bearded) } HRS
- Sharp (bearded) } HRS

Prograin:
- Diablo (bearded) } HRS
- Brio } HRS

Seedway:
- Katepawa HRS

American White Winter Wheat Producers Association:
- Classic (bearded) HWS

The spring wheat varieties were planted at 2 bu/A on May 8. Each variety was planted in four replicates using a randomized block design. Prior to planting the seed was treated with T-22 biological fungicide approved by NOFA. The grain was drilled on 7" centers at a rate of 2 bushels per acre. Soil temperature at planting was 53^0 F at 2" below the soil surface. The Swanton and Eldridge soil had a pH of 7.0 and soil tests show optimum phosphorus and medium potassium. A pre-sidedress nitrogen test (PSNT) taken on June 27th showed only 7 ppm N. Fertilization consisted of 6 tons per acres of chicken manure applied the previous fall.

Weed control in the trial consisted of a hand held flame weeder early in the season, followed by hand hoeing later. Primary weeds included bluegrass, velvetleaf, shepherdspurse, and smartweed, with the velvetleaf the most difficult to control.

The *Classic* wheat had headed out by June 23, followed closely by *Oxen.* By June 30th *Classic* had finished flowering, while *Sharp, Oxen, Russ, Katepawa,* and *Diablo* were still in anthesis. *Brio* was in the split boot stage at that time.

Although *Classic* germinated quickly and headed early, as soon as the seedhead could be seen it was apparent there were problems. The sooty black deposits of smut, caused by a fungus brought in on the seed, were easily identified. In addition to significant loss of plants from this disease, *Classic* was particularly susceptible to leaf rust and aphids. *Diablo* was also found particularly susceptible to leaf rust. *Oxen* appeared somewhat more susceptible to a stem boring maggot than other varieties, with occasional dead white heads apparent in the plot. In this trial less than 1% plants were affected and yields remained high. Over time if spring wheats continued to be grown these pests could build up, causing a greater problem for this variety.

The emergence of *Katepawa's* seedheads had pronounced twisted heads early in the season in all plots. Aphid populations did not appear to be heavy enough to account for the degree of distortion. As the season progressed the seedheads straightened out and appeared to fill nicely. The final grain yield was disappointing, coming in below all varieties except *Classic*.

The variety excelled at straw production, however, with tall, strong stems that yielded 0.3 tons more straw per acre than the second highest straw producer, *Russ.*

A field day was held on July 27th to give an opportunity for farmers, extension agents and other interested people a chance to look at the plots close to harvest. On the same tour a number of other winter wheat fields on the farm were also visited, providing an opportunity to compare winter and spring wheats.

Following the field day the most widespread and indiscriminate pest attacked the wheat plots. Large flocks of small black birds, augmented by Canadian Geese, destroyed 1 ½ of the replicates. Two complete replicates remained for harvest. The average yield data is summarized in Table 1 below.

The two varieties with the highest grain yields, *Oxen* and *Brio* were the most profitable varieties. If the wheat were being grown for a specialty market, such as straw bale houses, *Katepawa's* strong straw and good straw yields could encourage planting of this variety.

Table 1 : Results of 1997 Organic Spring Wheat Variety Trials
Mt. Independence Farm, Orwell, VT all figures per acre

Variety	Avg. Grain Yield (bushel/acre)	Gross Income- Grain only	Avg. Straw Yield (tons/acre)	Total Gross Income	Total Net Income‡
Oxen	38.2	$ 267.57	1.2	$ 365.90	$ 269.77
Brio	38.0	$ 265.80	1.1	$ 355.61	$ 260.00
Russ	31.0	$ 217.15	1.3	$ 324.88	$ 227.35
Diablo	30.4	$ 213.12	1.1	$ 299.17	$ 207.32
Sharp	27.7	$ 193.62	0.9	$ 267.39	$ 171.82
Katepawa	26.9	$ 188.24	1.6	$ 319.10	$ 222.44
Classic	14.8	$ 103.57	0.6	$ 150.49	$ 57.77

bushel = 60 lbs @ 12% moisture; grain valued at $7.00/ bu; Straw valued at $80/ton
‡ based on total variable operating cost of $93.80/Acre, calculated using on-farm field data
D. Baker, J. Carter, K. Van Hazinga, 1997

The wheat varieties were sent to a laboratory for analysis of flour quality and a "bake-out" analysis. Table 2 provides the results of the milling report. *Katepawa* showed the highest wheat protein, although all seven varieties had protein levels above the benchmark for hard wheat provided by the laboratory. *Oxen* delivered the most flour per unit of wheat (yield), with *Katepawa* also coming in above the lab standard for excellent yield.

Table 2 - Spring Wheat Laboratory Test Results Milling Report					
Variety	**Moisture**	**Protein N x 5.7**	**Yield**	**Sedimentation**	**Test Weight (lbs/bu)**
Oxen	12.80%	14.65%	72.65%	62	61.0
Brio	12.90 %	14.15%	70.3%	38	59.6
Russ	12.70%	14.30%	70.4%	38	59.3
Diablo	12.80%	14.35%	60.6%	39	59.4
Sharp	12.60%	14.70%	70.0%	61	61.0
Katepawa	12.60%	15.20%	71.1%	67	59.3
Classic	12.80%	14.75%	65.0%	69	58.4
Lab Standard	13%‡	11-12%	71% - Exc 65% - Poor	40 +	60.0
Source: Doty Laboratory, Kansas City, MO					

‡ Moisture reflects conditions in laboratory

Interpretation of Categories in Table 2 *(Source: Doty Laboratory, Kansas City, MO)*

Protein indicates the strength of the wheat. Hard wheat has a higher protein than soft wheat. Soft wheat usually has 9-10% protein, while hard wheat typically has 11-12% protein. Protein is measured as nitrogen (N) and multiplied by the factor 5.7 for food grade wheat and 6.25 for feed grade wheat. Protein usually corresponds to gluten levels, although not in all cases.

Yield represents the flour actually extracted from the wheat. Percentages run from 65% (poor) to 71% (excellent). The average yield is 68% to 70% (very good).

Sedimentation measures the quality of the protein. The higher the number, the better the quality. Soft wheats should have a sedimentation number of approximately 20. Hard wheats, such as those used in this trial, should be about 40 or higher.

Table 3 summarizes the results of the laboratory baking report for the seven wheat varieties. *Katepawa* had the highest protein levels, with all varieties well within the acceptable range. *Sharp* and *Diablo* both maintained their protein levels and exceeded *Oxen's* protein in the bake test.

In addition to protein levels, the "oven spring" of bread flours is an important criteria for farmers choosing a variety to grow. All flours had good loaf volumes relative to the lab standard, with *Classic* having the highest loaf volume and three others with volumes exceeding the lab standard for excellence.

The varieties with the second and third highest yields in the field had a "close and silky" texture, with *Oxen* fairing worse on this measure than *Brio, Russ* and *Sharp*. In terms of the flour color none made the highest standard, but three varieties, including the two wheats with the highest yields in the field, had slightly creamy color.

All varieties were found to have normal mixing and fermentation characteristics. Similarly, all varieties had a rough crust character. Typically a crust character of "smooth and bold" is considered the best, although this depends on the product and other factors.

Table 3 - Spring Wheat Laboratory Test Results
Chemical Analysis and Baking Report

Variety	Ash	Protein (Nx5.7)	Flour Color ‡	Loaf Volume (cc)	Grain & Texture	Falling Number
Oxen	0.498%	12.89%	96 SLC	830 - Exc	Slightly tight & silky	358
Brio	0.594%	12.63%	94 SLC	745 - Good	Close & Silky	401
Russ	0.587%	12.80%	94 DC	780 - Very Good	Close & Silky	346
Diablo	0.587%	12.97%	95 D SLC	845 Exc.	Open & Harsh	393
Sharp	0.564%	13.14%	94 SLC	765 Good	Close & Silky	327
Katepawa	0.565%	13.50%	95 DC	890 - Exc	Slightly Open & Slightly Harsh	370
Classic	0.564%	12.94%	96 D SLC	990 - Exc	Open & Harsh	345
Lab Standard	0.40% - 0.44% (lower is better)	Hard wheat range from 11.5 (low) to 13.5 (best)	In order from Best: Bright Creamy Dull Grey Yellow	800 - Exc; 750 - V. Good; 700 - Good	In order from Best: Close-even & Silky	400+

Source: Doty Laboratory, Kansas City, MO

‡ SLC = slightly creamy; D = dull, DC = dull creamy

Interpretation of lab results *(Source: Doty Laboratory, Kansas City, MO)*

Ash indicates the quantity of bran that remains in the flour that remains after milling. Higher ash usually indicates a lower quality flour.

Protein indicates the strength of the flour. Typically some protein is lost in the milling, thus the protein reported in the flour is lower than that reported for the wheat. Protein is measured as nitrogen (N) and multiplied by the factor 5.7 for food grade wheat (6.25 for feed grade wheat). Protein usually corresponds to gluten levels, although not in all cases.
Flour Color varies with bran content. Generally, a lighter colored flour is favored.
Crust Character describes the outside of the loaf after baking.
Loaf Volume measures in cc's how high the loaf rises in baking. The higher number the better; the "oven spring" (while the bread is baking) determines the loaf volume.
Grain & Texture describes the internal quality of the loaf after baking. Variations can be caused by the flour, mixing process, or handling by the baker in commercial bakeries. In the lab, grain and texture indicates the quality of the flour.
Falling Number determines sprout damage, if any. Unmalted straight wheat should have a falling number of 400+. The baker can determine if malt needs to be added to the flour by this figure.

Hard Spring Wheat Field Trial

One 10 acre field was planted to the *Diablo* variety hard red spring wheat to investigate the economics of growing this crop. The field includes Swanton and Eldridge soils, and was disked on April 20. The previous crop was soybeans and additional fertilizer requirements were supplied by 6 tons per acre of poultry manure. The crop was planted on April 25th with a 14 foot grain drill on 7" rows at 114 pounds per acre. On August 7 0.3 tons per acre were harvested with a 13' combine. Six hundred pounds of straw per acre (0.3 tons/acre) was baled the following day.

No weed control was done following planting and weed pressure was fairly heavy early in the season and lightened as the early spring weeds died and shading by the wheat limited later weed populations. Weeds with heavy populations included bluegrass and curly dock. Moderately severe weeds included canadian thistle, nutsedge and ragweed. Grasshoppers and aphids were present but did not appear to significantly impact crop yields. The main limitation to crop growth was the wetness of approximately 60% of the field, which did severely reduce yields.

Overall net returns for this crop were negative for this crop. Yields were less than 1/3 of the yield obtained for the same variety grown in the variety trial. The wet clay soil severely reduced yields, clearly showing the risk of growing spring grains on clay soils. The production budget is detailed below.

Hard Spring Wheat Production Budget

Expenses

Operation	Hours/Acre	Cost/Hour	Cost/Acre
Seed			$27
Soil Test Field	0.1	$8	$0.8
Soil Test Lab			$0.9
Spread Manure	0.5	$40	$20
18' Tandem Disk Harrow	0.2	$45	$9
14' Grain Drill	0.3	$30	$9
13' Small Grain Combine	0.4	$52.50	$21
Bale Hay	0.3	$40	$12
Total Cost			**$99.70**
Receipts			
	10 bu/acre organic wheat @ $7/bu		$70
	0.3 tons straw/acre	@ $80/ton	$24
Gross Income			**$94**
Net Return			**$(5.70)**

Wheat Variety Trial Conclusions

The wheat trial provided some good data on seven wheat varieties grown on the clay soils typical of much of Addison County, VT. The highest yielding variety, *Oxen*, also rated well in the lab tests of milling quality and baking. *Oxen's* good showing overall makes it the most promising of the hard spring wheats looked at this research. *Katepawa's* good straw yields were not matched by its grain production, but its top protein levels, excellent protein quality and excellent loaf volume encourage further trials of this variety. *Brio* also did well in yields, but the low sedimentation number suggests further investigation should be done on its relative value for milling.

Rainfall and timing during the 1997 growing season did not raise the problems with fusarium seen in 1996. Except for smut and aphid damage on the *Classic*, most varieties finished out the season with healthy stands with good yields. *Katepawa's* pronounced twisted heads and poor grain yield may indicate a greater susceptibility to aphid injury than the other varieties, although it did not appear that the variety harbored economically significant populations of this pest. It would be interesting to see how this variety performed in another year or location.

Bird damage was far and away the most damaging pest in the wheat trials. Birds have been a problem on the farm in the past, and their feeding could definitely significantly impact crop yields. Some methods used by organic fruit and vegetable farmers for bird control might help, although the larger scale of grain production limits the applicability of many of these techniques.

Clay soil is always a challenge, and the striking difference in yields between the variety

trial and the field trial highlight this. In the field trial the wetness of about 2/3 of the field accounted for the majority of the poor harvest. Population counts taken early in the season indicated low populations of wheat plants. Bird damage later further brought the population down. Conversations with Bridport, VT grain farmer Ben Gleason, who has grown *Diablo* on Farmington silty loam, obtained yields comparable to those seen in the variety trial. This suggests that farmers with clay ground should try to plant their wheat on their better drained fields or risk economic losses.

Edible Dry Bean Variety Trials

In comparison with the wheat trial, the bean research was more of a challenge, with problems beginning at planting and continuing throughout the season. A lot was learned, although it didn't come as easily as it did with the wheat.

Six varieties of edible beans were planted on June 5th into a Covington clay soil. Soil temperature in late afternoon was 80^0 F at 2" deep. Four tons per acre of poultry manure was spread in the fall and UVM soil tests indicated optimum phosphorus levels and optimum potassium levels in the soil. Organic matter was 4.5% and pH was 6.9. Seeds were inoculated with rhizobium and treated with T-22 biological fungicide.

Mt. Independence Farm uses a grain drill to plant soybeans and this variety trial sought to use a similar method to plant the edible beans. Consequently, a cone seeder was used to drill the beans on 20" rows at a rate of 80 lbs/acre. Although the drill performed properly during calibration, the actual planting turned out to be quite difficult. The large size of the beans, and the different sizes among varieties, led to uneven flow out of the tubes. Consequently, seeding rates varied between and within plots. The heavy clay made it difficult to assess the drills variability at planting.

Edible Dry Bean Seeds & Suppliers

Fedco Seeds
- Calypso

Freedom Beans
- Vermont Cranberry
- Soldier
- Maine Yellow Eye

Johnny's Selected Seeds
- Jacob's Cattle

Seedway
- Black Turtle Soup

The smaller *Black Turtle Soup* bean planted easily compared with the larger beans. This variety also germinated much more quickly than the other varieties and appeared well ahead of the others by the first week of July. Interestingly, they were the last of the beans to flower.

During the first week of July the *Black Turtle* beans developed problems, showing curled, mottled-looking leaves and yellowing tips. The other varieties looked healthy and it appeared that the black beans were susceptible to a foliar disease or fungus. Upon closer examination tiny potato leaf hopper (PLH) nymphs were observed. Over the next few weeks the populations of these piercing/sucking insects exploded and all varieties began to show the effects of their feeding. The *Black Turtle* beans, although earliest to develop true leaves and attract the pest, lagged behind the other varieties in maturity

and withstood the PLH infestation. *Maine Yellow Eye, Vermont Cranberry and Soldier* weathered the pest better than *Calypso* and *Jacob's Cattle*, which both continued to show yellow, curled leaves into early September. As it turned out, the 1997 growing season had one of the worst infestations of potato leaf hopper in many years. Some bean producers in Maine reported near total losses from this pest.

Weed control was also difficult. An extremely heavy seedbank of velvetleaf, which germinated throughout the season, was a constant challenge. The tall, tough, fast growing plants are not native to this area and if they're not on your farm, you don't want them. Seeds survive for up to 40 years in the soil, although the number of viable seeds will decline over time. Weed control in the trials included a propane flamer and hand hoeing. Other weeds included heavy patches of yellow nutsedge, along with moderate levels of yellow foxtail, ragweed and pigweed.

All varieties continued to flower throughout the season, making it difficult to determine when to harvest the plants. In September it was not uncommon to find plants with both drying pods and new flowers on the same plant.

Although in these trials harvesting was done by hand pulling, larger operations want varieties that keep lower beans off the ground to minimize yield losses when combining. *Jacob's Cattle* and *VT Cranberry* had pods that nearly touched the ground, *Calypso* and *Black Turtle* had their lowest pods at a height of about 1-1.5 inches, and *Maine Yellow Eye* and *Soldier* had pods that remained 1-3 inches above the soil.

To adjust for the uneven planting rate 10 foot sections of the plots were harvested to compare the effect of planting rate on yields. These results are reported in the table below.

Table 4 - Results of 1997 Organic Dry Edible Bean Variety Trials
Mt. Independence Farm, Orwell, VT

Variety	Plants/10' Row	Plants/Acre	Yield - Lbs/Acre‡	Yield - Bu/Acre‡
Large Seeded Beans				
Calypso	42	109,749	651	10.85
Soldier	30	78,392	677	11.29
Maine Yellow Eye	22	57,488	612	10.20
Jacob's Cattle	17	44,422	645	10.74
VT Cranberry	13	33,970	651	10.85
Small Seeded Beans				
Black Turtle Soup	28	73,166	1,042	17.36
Black Turtle Soup	62	162,011	2,442	40.69

‡ Yields calculated at 13% moisture, 60 lbs/bushel
D. Baker, J. Carter, K. Van Hazinga, 1997

The yield data provides some interesting information. It appears that the large seeded bean plants that were planted at lower rates were able to compensate by producing a greater number of beans. Although establishment rates varied significantly, yields among the larger seeded varieties was fairly uniform.

The *Black Turtle Soup* beans clearly provided the greatest yields overall. They also showed a significant positive response to doubling the planting rate, responding to higher numbers of plants with more than double the yield. There may be risks to this higher rate. In a wetter year the higher populations may be more susceptible to fungus or molds.

Black Bean Field Trial

A 1.5 acre field trial of *Black Turtle Soup Beans* was done on a Covington clay soil. Manure had been stacked on this field in previous years and soil fertility was high for all nutrients, except for reserve phosphorus, which was optimum according to the UVM soil lab test report. pH was also high at 7.8. Planting was done May 23rd at a rate of 80 lbs per acre on 7" rows.

Velvetleaf, competing against bean plants weakened and stunted by potato leaf hopper, smothered this crop. Although rotary hoed twice, the velvetleaf got ahead of the crop and it was apparent early in the season that this field would not provide a positive net return. The production budget for the field follows.

Black Turtle Soup Bean Production Budget

Expenses			
Operation	**Hours/Acre**	**Cost/Hour**	**Cost/Acre**
Seed			$80.00
Soil Test Field	0.1	$8	$0.5
Soil Test Lab			$0.9
Offset Disk Plow (2x)	0.6	$50.00	$20.00
Tandem Disk Harrow	0.3	$45.00	$ 9.00
7" Grain Drill	0.5	$30.00	$10.00
Rotary Hoe (2x)	0.4	$30.00	$ 8.00
Combine	0.6	$52.50	$21.00
Total Cost			**$149.40**
Receipts			
1.5 acres Black Beans @ 28.5 ~~lb~~ bu/A, $1.30/~~lb~~ bu.			$37.05
Gross Income			**$37.05**
Net Return			**$(112.35)**

Conclusions from the Bean Trials

The bean trials produced generally disappointing yields. Problems included difficulties at planting, heavy weed pressure and exceptionally heavy potato leaf hopper injury. Edible beans should be planted with a corn planter, which offers greater control over large and variable sized seeds.

Farmers interested in machine harvesting beans are likely to find *Maine Yellow Eye* and Soldier beans more suitable for machine harvest than *Jacob's Cattle* and *Vermont Cranberry*. The highest yielding beans were the *Black Turtle Soup*, and their dark color makes staining less of a concern. *Black Turtle Beans* also appeared to respond favorably to higher seeding rates and future research should consider optimum seeding rates for each variety.

Anecdotal information suggests that the market for edible dry beans is good and accessible. Further research into yield potential of edible dry beans in Vermont and local marketing opportunities should be undertaken.

Publicity

During the growing season two field days were held at Mount Independence Farm. Publicity for these events was done through the UVM Extension System and included mailings to persons attending winter small grain workshops in Vermont and announcements in Country Folks and Agriview. Also during the summer a sample of the wheat varieties grown in the trial were collected and made into a display shown by Extension at the Addison County Field Days.

Following the completion of the research a report was written on the trials and published in Cultivating Connections a publication of the University of Vermont's Center for Sustainable Agriculture. A full set of photographs documenting the research is available and will be used in future Extension presentations.

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